RP

SCIENTIFIC PRINCIPLES

OF HYPERTROPHY TRAINING

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Special thanks to:

Milo Wolf for scientific editing and additional research, Dr. Anna Swisher, Doug Park and Daniel DeBrocke for editing, and Carolyn Macdonald and Charly Joung for design and support.

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Introduction

Thank you for purchasing your copy of the **Scientific Principles of Hypertrophy Training**! We're delighted that you have decided to elevate your hypertrophy knowledge using our book.

Before you move on to the book itself, let's make sure you're prepared to benefit maximally from its contents. This is an advanced book and is intended for those who already have a baseline understanding of training principles. If the basic principles of training for muscle growth are very new to you, this book might be a tough and tedious read, but that doesn't mean your purchase was in vain! We have some recommended prerequisite reading to help you prepare to best benefit from this book:

The Art and Science of Lifting, by Greg Nuckols and Omar Isuf
This book is an excellent beginner's guide to understanding the very basics of lifting for strength and muscle growth. It will familiarize you with what kind, how hard, and how much lifting is effective and why. Once you've read this, you're ready for the next book:

The Muscle and Strength Pyramids, by Dr. Eric Helms, Andrea Valdez, and Andy Morgan
This is a two book set, and while the nutrition book is an excellent read and is highly recommended for its own sake, the training book is the one you'll find most valuable in preparing you to read the Scientific Principles of Hypertrophy Training. It's a bit more in-depth than The Art and Science of Lifting, and will prepare you for the last book in the prerequisite reading list:

The Science and Development of Muscle Hypertrophy, by Dr. Brad Schoenfeld
This book is a university-level textbook, so it's no breezy read, but it establishes the vast majority of the terms and the anatomical and physiological mechanisms which our book builds upon. If you read any one of these recommended prerequisite books before reading ours, it should be this one.

Once you've read these three books, you'll have a strong background that will make reading our book easy and informative.

To get even MORE out of your training, we also recommend a few other bonus books of our own:

- **How Much Should I Train?** by Dr. Mike Israetel and Dr. James Hoffmann
- **Recovering from Training**, by Dr. James Hoffmann, Dr. Mike Israetel, and Dr. Melissa Davis
- **Scientific Principles of Strength Training**, by Dr. Mike Israetel, Dr. James Hoffmann, and Chad Wesley Smith, BA

Now, without further ado, the Scientific Principles of Hypertrophy Training awaits! We will start with a glossary of important terms that will be used extensively in the other chapters. After that, each of the seven training principles gets its own chapter, ending with a final summary and some special cases. Enjoy!

Glossary

Hypertrophy Training: Training which directly causes muscle growth (or muscle maintenance in hypocaloric conditions) or trains and improves systems that underlie muscle growth and thus potentiate its later development.

Exercise: A movement pattern used to stimulate a muscle or group of muscles, usually denoted with a biomechanical or colloquial name. Examples: Deadlift, Overhead Barbell Triceps Extension.

Repetition (rep): The single execution of an exercise from the desired starting point, through the terminal range of motion, and back to the desired starting point.

1RM (2RM, 3RM, etc.): One (two, three, etc.) repetition maximum: the heaviest weight a person can lift for one repetition (1RM), two repetitions (2RM), three repetitions (3RM) etc. for a given exercise.

Set: A collection of (semi) continuous repetitions of an exercise, separated by bouts of rest.

Training Session: Dedicated training time usually consisting of a warm-up and one or more exercises.

Rest Time: Time spent allowing fatigue to dissipate between repetitions, sets, exercises, and training sessions. Most commonly used to describe the time spent recovering between sets.

Microcycle: The shortest cycle of training that includes all sessions and rest days and is repeated. Microcycles are typically, but not always, a week in length.

Mesocycle: An organized sequence of microcycles ordered to elicit a set of distinct training adaptations. The typical mesocycle is composed of two distinct phases: an accumulation phase and a shorter deload phase.

Accumulation Phase: The series of sequential microcycles within a mesocycle in which training gets progressively more challenging via some combination of set, rep, load, or relative effort increases.

Deload Phase: An entire microcycle composed of lower volume, load, and relative effort sessions, the purpose of which is to reduce fatigue while preserving adaptations.

Accumulation to Deload Paradigm: The ratio of time spent in an accumulation phase relative to a deload phase for a given mesocycle.

Block: A block of training is one or more mesocycles which share a specific unified goal. Common examples in hypertrophy training are muscle gain or fat loss blocks.

Macrocycle: A sequence of training blocks used to enhance longitudinal performance gains. In hypertrophy training a macrocycle typically consists of 1-4 blocks of training which share a unified long-term goal that resets at the end of the macrocycle.

Periodization: The logical sequencing of training variables for the purpose of eliciting maximal adaptations, reducing injury rates, and peaking the athlete for best performance at a predetermined time.

Autoregulation: Altering training variables and fatigue management strategies based on needs rather than predetermined changes.

Volume: The amount of total mechanical work (force x distance) done during a rep, set, exercise session, week, or any other measurement of training time. In hypertrophy training volume is typically measured in sets per session or sets per week.

Load: The absolute amount of resistance used on an exercise, otherwise known as 'absolute intensity'. For example, if you squat 225lb for 10 reps, the load is 225lb.

Relative Load: The amount of load being used relative to one's maximal abilities. In hypertrophy training this is typically expressed as a percentage of the lifter's 1RM on any specific exercise. Relative load is a component of 'relative intensity' along with other measures such as relative effort.

Relative Effort: The degree of difficulty of an activity scaled to a maximal effort. In hypertrophy training, the most common measure of relative effort is the number of repetitions in reserve (RIR) of a given set. Other measures of relative effort can include RPE and related concepts, but are more often used in strength training, and will not be used in this book. When we denote "relative effort" in this book, we will always mean RIR.

Reps in Reserve (RIR): Also known as reps from failure, RIR is a relative effort scaling which directs the individual to conclude a set of exercise at a prescribed number of repetitions away from going to muscular failure, technical failure, or making a maximal effort. An RIR of 2 would indicate that the athlete should cease when they feel they only have 2 more reps before hitting muscular failure. In the context of hypertrophy training, failure is denoted when another full repetition cannot be performed with proper technique.

Frequency: The number of times an exercise, muscle group, or session is performed per unit of time. In hypertrophy training frequency is commonly used to describe how many training sessions are performed per week, and how many times a muscle group is trained per week.

Maintenance Volume (MV): The amount of training needed to prevent deconditioning from occurring. In hypertrophy training this means the amount of training needed to prevent muscle loss.

Minimum Effective Volume (MEV): The amount of training needed to begin making measurable progress. In hypertrophy training this means the amount of training needed to begin stimulating robust muscle growth.

Maximum Adaptive Volume (MAV): The amount of training which at any given time provides the greatest adaptive outcomes. In hypertrophy training this means the amount of training which provides greatest muscle growth per unit of time.

Maximum Recoverable Volume (MRV): The maximum amount of training which can be performed before overreaching occurs. In hypertrophy training this means the amount of training at which no further growth can be expected to occur if continued on a consistent basis, possibly leading to diminishing or even negative returns.

Fatigue: Acute and chronic performance decrements resulting from the summation of physical and psychological stressors. In hypertrophy training fatigue is typically described in local terms (specific parts of the body being trained) and systemic terms (relating to all body systems and structures).

Overreaching: A state wherein the accumulation of fatigue is such that overload training is no longer sustainable. In hypertrophy training planned (functional) overreaching can be programmed at the end of an accumulation phase, when followed by a deload in order to push for higher levels of adaptation. Non-planned (non-functional) overreaching occurs when fatigue accumulates too rapidly within the accumulation phase and causes disruptions to planned training.

Minicut: A minicut is a shorter, more aggressive fat loss phase for which the purpose is not sustainable weight loss, but rather to potentiate subsequent weight gain or temporarily improve appearance.

Muscle Gain Phase (massing): A period hypercaloric eating and hypertrophy training (usually a block in length) with the distinct goal of gaining muscle mass.

Fat Loss Phase (cutting): A period of hypocaloric eating and hypertrophy training (usually a block in length) with the distinct goals of reducing body fat levels while maintaining muscle mass.

Weight Maintenance Phase: A period of eucaloric eating in which no significant body composition or weight changes occur. In hypertrophy training, a resensitization training phase is often coupled with eucaloric eating in order to reduce fatigue and potentiate subsequent body composition changes.

Resensitization Phase: A period of lower volume training, often at or near MV (maintenance volume), with the distinct goal of reducing fatigue and lowering adaptive resistance for future productive hypertrophy training.

CHAPTER 1

Specificity

The principle of Specificity is the most important principle in sport science theory. In simple terms, it states that to get better at something, you should train that thing or things that potentiate it. If you cannot describe how your training supports your goals, you are probably violating the Specificity principle.

The Principle of Specificity of Training: To improve at a specific sport or physical endeavor, training must either directly support or potentiate improved performance in that sport or endeavor.

There are two important components of the Specificity principle: *directed adaptation* and *training modality compatibility*.

Directed adaption describes the idea that repeated, sequential training is needed for best adaptation. Adaptation is a change initiated by the training stimulus, such as muscle growth from resistance training[1]. Human adaptive systems (muscular, nervous, etc.) respond best when similar, unambiguous training stimuli are presented repeatedly allowing adaptations to “stack” over time. If stimuli are spaced too far apart, or different stimuli are used week to week, this “stacking” does not seem to occur—leading to less adaptation. As an analogy, if you were to practice three different languages on three different days of the week, you probably wouldn’t get very far with any of them. Likewise, if you were trying to learn only one language, but practiced every couple of months, you would not progress much. But if you practiced the same language three times a week, your improvements would “stack” and progress would occur. A very similar effect occurs in hypertrophy training, as a muscle that is stimulated regularly and in similar ways across weeks tends to exhibit the best summated growth.

Training modality compatibility describes the idea that all components of your training should support your goal. There are finite resources and a finite capacity for change in the human body. Using our language analogy, if you only have three hours per day to study and you spend 1.5 hours each on Italian and Cantonese, not only will you have less time for each language, the different learning for each will interfere with the other—the languages have different roots, different tones, different structure, and one has a phonetic alphabet while the other uses characters, so overlap is minimal. Progress in either language will be compromised by studying both. Similarly, let's say you wanted to take up endurance running along with bodybuilding[2]. Endurance training would take massive nutrient and recovery resources away from your bodybuilding reservoir and would burn away some of the muscle you built. Likewise, the faster twitch fibers developed by bodybuilding would negatively impact endurance performance thanks to these fibers' low fatigue tolerance and their added weight[3]. There is direct competition between these two training modalities and you therefore cannot train for both without compromising your potential in each[4]. If on the other hand you wanted to train for physique and powerlifting, though there would be some interference, it would be much less than in the endurance example since training styles and needs overlap more[4]. In the language analogy this would be akin to spending half of your study time on Italian and the other half on Spanish—the languages use the same alphabet and have the same Latin root so a good amount of learning in one would support understanding the other causing less (but still some) interference. If you want to learn either language as well and as efficiently as possible, focusing on just one is your best bet. Similarly, if hypertrophy is your goal, making sure all of your training supports hypertrophy will lead to best growth.

To summarize, the principle of Specificity dictates that training should directly improve desired characteristics or support systems that underlie such improvement. Training should present a repeated, sequential stimulus *(directed adaptation)* and interfering training should be avoided *(training modality compatibility)* for best progress.

Specificity in Hypertrophy Training

The Specificity principle in the context of hypertrophy dictates that training should cause muscle growth directly or cause improvements that potentiate muscle growth. In other words, everything you do in a hypertrophy training program should either build muscle, or support muscle growth down the road. If you do leg presses for example, you directly cause muscle growth in the quads, meeting the criteria for hypertrophy specific training[5]. Doing very light squats that don't themselves cause growth can also meet the criteria however, if you are practicing and developing technique that will later allow you to load squats enough to cause growth[6]. Doing aerobics classes and punching a heavy bag on the other hand, would not support quad muscle growth directly or indirectly and would thus violate the principle of Specificity for hypertrophy training of your quads.

Specificity for physique competition requires even more than just hypertrophy. Occasionally muscle growth will have to be halted during fat loss phases to get lean enough to step on stage. In addition, the skills and tactics involved in posing routines for competition will need to be trained[7]. All sports use all of the training principles, but it's the Specificity of training that makes the difference between becoming better at endurance swimming versus physique sport, versus MMA, and so on[8-10]. The rest of this book's advice on how to train for hypertrophy is always bounded first by the principle of Specificity as applied for physique development.

Directed adaptation in hypertrophy training

When applied to hypertrophy training, the idea of directed adaptation leads to multiple training recommendations. The first being that the major features (exercises and fundamental structure) of a hypertrophy program should be relatively consistent for a period of time[11]. How long that time is and how little should be changed is a topic that will be covered in the chapters on Variation, Phase Potentiation, and Individualization.

Keeping the major exercises and training structure constant for a period of time supports hypertrophy training in several ways. First, as you practice and perform a given exercise, your technique for that exercise improves, allowing you to lift heavier safely[12]. Both improved technique and heavier loads increase motor unit recruitment, which better stimulates muscle growth and improves stability[13]. Second, practice with the same exercises improves mind-muscle connection—the ability to perceive tension and burn in the muscle you’re targeting, rather than just going through the motions[14]. Better mind-muscle connection has also been associated with more muscle growth[15].

More speculatively, but not without supporting data and theory, muscle hypertrophy might occur in two phases: a preparatory phase and a myofibrillar phase. Preparatory hypertrophy being the swelling of the muscle cell (increases in sarcoplasm might be in part responsible for this), the loading of more glycogen, the expansion of connective proteins such as titin and nebulin, and the translocation of satellite cell nuclei into the muscle fiber itself[16]. These processes begin right after training starts and pave the way for the myofibrillar phase—the creation of fully functioning myofibrils (the units of muscle cells that produce force). It’s unclear how long the preparatory hypertrophy phase takes, but there is some indication that aspects of the process can last weeks before full installation of functioning myofibrils occurs[16]. Preparatory hypertrophy seems to be the more fragile phase. If you stop training during the preparatory phase, your gains may disappear more rapidly[16]. If you make it to the myofibrillar phase, your chances of losing gains rapidly are probably much lower.

Switching exercises and rep ranges too frequently might also interfere with this two part progression. There is a great deal of overlap in terms of muscle fiber stimulation in similar exercises and rep ranges—most of your quad muscle fibers will get stimulated by leg presses as well as hack squats across a spectrum of rep ranges. Most, but not all. Different exercises and different rep ranges likely target at least slightly different pools of muscle fibers even within the same muscle[17-19]. This means that if you do leg presses for a week or two and then switch to hack squats, some of the muscle fibers in which you had generated preparatory hypertrophy via leg presses will not be sufficiently stimulated with hack squats to transition to myofibrillar hypertrophy. These fibers that are no longer stimulated will simply shrink back down to their pre–leg press state and your leg press efforts will have been partially wasted[16]. If instead of switching exercises, you had done leg presses for perhaps two months and *then* switched to hack squats, you likely could have locked in growth in those fibers that wouldn't slip away after the switch.

Beginners can often get away with paying slightly less attention to directed adaptation, while more advanced lifters usually need a very consistent stimulus, with weeks and weeks of specific combinations of exercises and rep ranges to get lasting growth.

Training modality compatibility in hypertrophy training

If hypertrophy is your only goal, then all of your training should support it. This gives you the maximum resources for the best gains possible. If you want to mix some other activities in, there will likely be some sacrifice to hypertrophy, but how large this sacrifice is will depend on the added training. If training for the additional pursuit is very similar to hypertrophy training, doesn't require much energy, and doesn't cause much disruption, interference will be lower.

Here is a list of some select sports/modalities, in order of least to most compatible with hypertrophy training:

- *Endurance Sports* (Triathlon, Distance Swimming, Distance Running, Distance Cycling, etc.)
- *Combat Sports* (MMA, Boxing, BJJ, etc.)
- *Team Sports* (Soccer, Basketball, Volleyball, etc.)
- *Glycolytic Sports* (Track Cycling, 400m/800m Running, 200m Swimming, etc.)
- *Gymnastic Sports* (Gymnastics, Parkour, etc.)
- *Strength Sports* (Strongman, Powerlifting, etc.)
- *Power Sports* (Weightlifting, High Jump, etc.)
- *Technique-Based Sports* (Table Tennis, Golf, etc.)
- *Low Impact Hobbies* (Light Day Hiking, Frisbee, Yoga, etc.)

One might wonder why a sport like MMA gets such a poor compatibility ranking when it is a sport that requires training nearly every muscle in your body. The non-hypertrophy aspects of MMA training (endurance, wrestling, jiu jitsu, stand up, clinch training etc.) are not very stimulative of muscle growth and using your energy and recovery resources for these will interfere substantially with hypertrophy. Likewise, spending much of your resources working towards hypertrophy and skipping the rest of MMA training would not be productive if your primary goal were to excel at MMA.

Assessing the compatibility of an activity with hypertrophy:

1. *The more the added training utilizes the same structures (especially in differing ways; see 2.), the more interference.*

Example: If you want a bigger lower body, doing lots of running will interfere much more with this compared to developing a bigger upper body. Running utilizes the same structures as training for lower body hypertrophy, but does not provide as good a growth stimulus and thus interferes with gains.

2. *The less similar the stimulus type for the overlapping structures, the more interference.*

   Example: If you're training the lower body for both hypertrophy and strength, the stimulus type is very similar (resistance training for strength and hypertrophy overlap quite a bit) and thus interference is low. If you're doing hypertrophy training and marathon training, the type of training is very different and thus interference is high.

3. *The more calories required for the execution of the added training, the more interference.*

   Example: If you play badminton for 30 minutes twice per week, the calorie demand is very small and interference with hypertrophy will be minimal. If you play tennis for two hours a day, six days a week, the calorie demand for that output means that interference will be high.

4. *The more disruptive (muscle damaging) and fatiguing the added training, the more interference.*

   Example: If you do tai-chi along with hypertrophy training, although it uses nearly all of your body's muscles, the movements are slow and without resistance. This means that the disruption and fatigue from tai chi training are minimal and training interference will be low. If you're adding grappling, you also use all the same muscles, but with much more intensity and physical damage which means much more disruption and fatigue, causing more interference.

Now that we understand the basic elements of the Specificity principle, let's dive into building a hypertrophy program that adheres to this principle in more detail.

Needs analysis in physique training

Before any training program is built or any diet written, the most important step is to write a needs analysis. This is an analysis of what qualities are required by a sport and its athletes. This information can then dictate what specific training must be done, what diet phases are needed, and what skills and tactics must be practiced for the athlete or enthusiast to progress. Although a needs analysis for a physique competitor or enthusiast will dictate dieting phase requirements and posing and tactical practice requirements as well as training needs, we will focus on the training for hypertrophy aspect here. It is important to remember that muscle growth results are highly dependent on calorie intake. Details on the impact of dieting phases and periodization for physique development on training choices will be discussed further in subsequent chapters.

The needs analysis process might sound intuitive, but it is skipped or misunderstood all too often. Some people do no specific needs analysis and also fail to design a training program that supports any specific outcome. An example of this is following the fitness routines of social media figures who have desirable physiques. This strategy amounts to a Russian roulette version of program design—maybe it will work for your goals, but why take the chance? Instead, write your own needs analysis and design a training program based on it so that *your* training supports *your* specific goals and needs.

Another common mistake is to make a needs analysis, but design training without an understanding of hypertrophy principles. If you have been in the lifting world for a while, you have undoubtedly met someone who's goal is to "get big", but who trains near their 1RM (one rep maximum) all the time, unaware that lower weight and higher reps will stimulate growth more effectively[20]. On the other end of the spectrum, you have also probably encountered people trying to get rounder, firmer glutes by doing endless plyometric drills and box jumps, not realizing this training will not cause much glute hypertrophy. It's not enough to simply use the muscle you want to grow; the training stimulus must be specific to the desired outcome (hypertrophy) as well. Thankfully, the subsequent chapters of this book will help you avoid missing this training specificity mark. For now, let's go over writing a needs analysis for hypertrophy training in more detail.

Step one: First, what is needed to perform in a sport or pursuit must be assessed. In the case of training for physique development, this will differ depending on whether the pursuit is for competition or personal hobby. A personal physique pursuit needs analysis might better be described as a "wants analysis"—it can be more subjective, such as 'I want bigger arms'. A competitor's needs on the other hand, must be more objective, such as 'my arms need to be two inches larger in circumference to be equivalent to my average competitor'.

Step two: Strengths and weaknesses must be assessed. For those who compete in physique related sports, these can be determined using scoring feedback in competition, normative standards for size and leanness, and comparison to respective competitors. Hobbyists must determine their specific 'wants', as the goal of training is to develop a personally-satisfying physique—it does not matter if the hobbyist's calves are small if they do not personally care about calf size.

Step two details: *Making training specific to address strengths and weaknesses.*

A lot of bodybuilders say they want bigger rear delts, but they never manage to formally rank rear delts as a high priority in their program. They simply continue to do the same standard muscle magazine shoulder workouts (essentially some variation of an overhead press, followed by some lateral raise variation, and rear-delt machine work once a week). If this isn't one of the worst program designs for rear delts, it's hard to imagine what is. Such training comes from a lack of a commitment to making training specific to the needs defined in the needs analysis.

Another brief example is a female who has legs that respond very well to training and are as big as she wants them to be. She might want a bit more upper body development, but those muscles do not respond as well as her legs. Continuing to do the same lower-body dominant workouts for females that are floating around online will not change this. There's nothing wrong with such workouts, but they are not *specific* to the task of improving upper body growth *in relation to the lower body*. Simply adding more upper body training to the current program pits the upper body against the lower body for resources, a battle that, because of its superior lower body growth genetics in this case, the legs will usually win. Secondly, because the upper body is trained toward the end of most workouts, energy levels are lower for its training and the stimulus and thus total growth is lower. The much better approach would be to take the needs analysis and prioritize upper body training, placing it toward the beginning of most workouts and reducing lower body training. That way, the genetically not-so-gifted upper body is given its best chances to grow. It's often when genetics are not amazing for a particular body part that a principled approach yields that much more dividends; something we'll see throughout the book and something that will be discussed in depth in the chapter on Individualization.

Competitor or hobbyist, you must identify which muscle groups you need or want to grow during the training program you are preparing to write. While it is easy to say "all of them"; in most cases, especially for advanced lifters, growing all of them efficiently in a single training phase or set of phases is not realistic. Create an ordered priority ranking for body parts; muscles that are ranked higher on this priority list should usually be trained closer to the beginning of a training session, be trained with higher total volume per week, and with more isolation exercises, among other differences to be extensively explained in the chapter on the Overload principle.

You might be able to get good results from your program without applying a needs analysis and only checking the very basic boxes of the Specificity principle. But even if "might make gains" is satisfactory to you, remember that it might not cut it for those you help with hypertrophy, including paying clients if you are a coach.

The Critical Role of Diet in Hypertrophy

Although not an aspect of training specificity, diet is critically important to muscle growth; its quality and specifics can have a very large influence on the amount of muscle gained from the exact same training program. A poor diet can make an amazing program seem almost completely ineffective and a great diet can make a mediocre program lead to consistent growth—as many IFBB pro bodybuilders unfortunately demonstrate.

Without digressing too much into diet details (which can be found in our [Renaissance Diet 2.0 book]()), one of the most important features of a diet that supports muscle growth or maintenance is sufficient protein intake (around 1g per pound of bodyweight per day)[21,22]. Calorie intake will then dictate whether tissue is lost or gained[23]. If you are trying to conserve muscle while losing fat, a hypocaloric condition is probably mandatory[24]. If you are trying to gain muscle, a calorie surplus is your best bet[25]. Those that are fat-phobic sometimes meander between a deficit and a maintenance level of caloric intake, lamenting their disappointing gains year after year, all the while avoiding hypercaloric eating. In the most direct way, new muscle is built from new raw materials. Unless you're very new to training or very overfat, eating at a caloric surplus is central to optimal muscle gain[25]. Though not as important, a notable feature of a basic muscle-supporting diet is the inclusion of four to six roughly evenly-spaced meals containing a roughly even fraction of daily protein each[26].

Under-Application of Specificity

Not being specific enough with body part training to match your goals

When people first begin their muscle growth journeys, they are often bombarded with programs and advice they hardly know what to do with. Some programs ride the perception of being "hardcore" to earn popularity. By virtue of this reputation and some "newb gains" results, such programs continue to be recommended and performed in vast excess to their actual effectiveness. The quintessential example of this type of program is the "squats and milk" approach—which recommends you drink milk (up to a gallon a day) and do a lot of squats.

Increasing protein and calorie consumption and doing resistance training are solid ideas for muscle growth, so if your goal is to get decent quad hypertrophy, there are certainly worse programs out there[21,25]. But purveyors consistently claim that this program "grows you all over." It's hard to imagine a more egregious violation of the Specificity principle than this. You might get some growth in your upper body from a program like this if you have never trained or held a bar on your back, but it is not remotely the best way to approach efficient all-around muscle growth. The program's purported ability to cause full body growth from one specific exercise is proposed to occur via hormone fluctuations, the whole-body nature of the squat exercise, and several other notions, all of them woefully insufficient to explain the non-phenomenon of upper body growth from just squatting[27].

The more general example of this under-application of Specificity is when people train with training partners and just do what their partner does, or what a non-customized app tells them, or follow a program from social media not designed for them. Either way, the person is not getting the kind of workout that is tailored to *their* needs (and perhaps not even efficiently to hypertrophy needs). To get one of those, you have to do a needs analysis, decide what muscle groups you want to grow, which of those you want to prioritize, and then design a program to achieve those exact goals.

Conflating hypertrophy and strength training

Muscle and strength have been so closely tied through the course of the whole cultural history of weight training, that in many cases people don't even know that they are two distinct training goals. Most people will ask bodybuilders how much they can lift (though that is not why they train) and ask powerlifters to flex their biceps (though that is not why they train either). While gaining more muscle does support strength goals, getting stronger doesn't always mean muscle growth[28]. In fact, the best strength gains in the medium term (months) often come from sets of 3-6 reps, which is not stimulative of muscle growth for anyone but beginners[20,29]. You can train simultaneously for both peak strength (1RM ability) and hypertrophy, but either training goal takes some potential gains out of the other. There are other concerns for more advanced lifters, such as the higher injury risk of strength training if hypertrophy is the goal[30]. As will often occur in program design, it all comes down to the needs analysis. If you want to prioritize getting stronger, you have to plan your program accordingly and accept the tradeoff away from optimal growth.

A common example of this under-application of Specificity is the gym-goer who works up to a heavy single in the bench press, squat, or other heavy compound exercises and then performs back down sets, or even drop sets, after the max effort work. This is a common way to train, mostly because it causes decent growth results and also satisfies the urge to go super heavy. While this urge comes at the expense of their growth, many people training this way do not know that it's an expense. Most think that near-maximal weights are an efficient way to build muscle, which they most certainly are not. Individuals only interested in aesthetic changes and using this strategy are dedicating time, energy, and injury risk to programs that are only partially designed to get them what they want.

Training for muscle size can potentiate strength, but there is no evidence for the potentiation of growth via strength gains nor any logical mechanism by which this could occur. If you want muscle growth, train for that. If you want strength, train for that. If you want some combination of the two, by all means train for both, just understand that you will trade-off best results in each pursuit in order to train for both.

The multi-sport illusion

Specificity, particularly in terms of training modality compatibility, dictates that any kind of physical training, especially the more energy demanding and less like hypertrophy training it is, will detract from your best possible gains in muscle size. Thus, trying to be a jack of all trades means that, well, you can maybe be good at all trades, but probably not reach your personal potential at any. This is not to say that it isn't perfectly fine to choose involvement in more than one sport or physical hobby on top of hypertrophy training. It is, however, to say that the more you put on your training plate that isn't hypertrophy training, the less muscle growth you can expect. Understand the trade-offs and choose according to your preferences.

Over-Application of Specificity

Specialization programs for beginners

The muscles of advanced physique athletes are often so large and require such high volumes of weight training to grow that training part of the body hard often means having to back off of all other parts. The ultimate and most extreme examples of this are when bodybuilders will stop training a body part altogether so that recovery ability is freed up for the remaining, prioritized parts to be trained that much harder and grown that much more. Branch Warren, owner of one of the most developed (and genetically gifted) pairs of legs in the history of physique sport, has gone without training his legs for up to an entire year at a time so that his relatively smaller upper body could catch up to some extent. This course of action was very effective, and because of years of training history and amazing genetics, Branch was able to bring his legs back within weeks of training them again. This very specific training plan was needed in his case.

If you are a beginner, however, your muscles are almost certainly not big enough to warrant putting whole muscle groups on hold during a hypertrophy cycle. Smaller muscles do not demand a whole lot of the body's systemic recovery resources and so training them all in the same program is likely possible for quite a long time. Thus, for beginners, excessive prioritization of muscle training volumes is often unnecessary.

For most people who have been lifting less than three years or so, training the whole body each mesocycle will probably not impede the growth of any individual muscles. Placing the more prioritized muscle groups earlier in the lifting session will suffice. As muscles get bigger over the years, this becomes less the case, and prioritizing and deprioritizing body parts accordingly becomes necessary. There is a time and a place for super-focused priority programs, but that time and place is mostly reserved for highly muscular, very advanced (perhaps seven years or more) lifters.

Needless limitation of exercise variations

Simplicity in training is a very favorable feature of program design, but it has some limitations that must be considered. Direct studies have found that doing training for one muscle group with a few different exercises per week causes more muscle growth than doing only one exercise per week, even if the number of sets is equated[17]. This direct assessment is very convincing when taken into account with the following theoretical predictions:

Regional hypertrophy differences exist

Some people will take simplicity in design to its extreme and only train each muscle with one or two exercises for years on end. For example, some seek maximum quadriceps growth from only squatting, or maximum back development from only doing pull ups. While good gains can occur from such an approach, they will not be the best possible gains for several reasons. First, regional hypertrophy occurs with specific exercises[17]. Hack squats really do grow parts of your quads well that leg presses don't grow as well, and vice versa. Different exercises can utilize a somewhat different combinations of muscle fibers. In fact, some muscle fibers seem to activate in some exercises and ranges of motion and be largely dormant in others[18,31-34]. By only doing one exercise, you can miss out on small but significant swaths of fibers, limiting growth potential. Using the same exercises or set of exercises across a mesocycle or several mesocycles may supply directed adaptation, but variation every few mesocycles or so is advisable. We will delve into knowing when to switch out exercises in the chapter on Variation.

Multiple muscular biomechanical actions and ranges of motion exist

Perhaps more importantly for within mesocycle exercise choices, many muscles have several biomechanical actions. It is probably best to employ all of these major actions regularly in training. Doing so will activate specific motor units (parts of the muscle connected to the same motor neuron and acting together) and put forces through specific parts of the muscle that the other kinds of movements won't[35-37]. A good example of this is the use of the pectorals to close the arms together in a cable flye, versus their use in pressing up a barbell, where they stop well short of their natural terminal range of motion. Another good example is hamstring curls and hip-hinge movements (like the stiff-legged deadlift), which utilize different ranges of motion for the hamstrings. Using both variations is recommended because the hamstrings both flex the knee and extend the hip, and neither hip hinges nor leg curls do both at the same time[35]. If they are both done in a program, all parts of the muscle can be stimulated and thus grown maximally.

Repetitive movement injury risks exist
Doing all of your training for a given muscle group with just one or two exercises indefinitely can lead to a higher chance of wear-and-tear injuries. You are exposing connective tissues to the same stress patterns all the time, risking chronic irritation[38]. Though squats and leg presses both grow the quads, their patterns of stress on knee structures differ. If your knees are starting to feel the leg presses a bit too much, removing them and doing more squats is likely wise to continue to provide growth while allowing your knees to heal. Additional benefits and limitations of training variation will be discussed in depth in the Variation chapter.

The sentiment that often leads to programs with very few exercises is the “hardcore, just the basics, brother” attitude. But like most simplistic notions, this one falls short of being the best advice.

Excessive use of isolation

In very unimaginative, linear thinking, if you want to grow a muscle, you train it with the exact exercise that isolates the muscle. This is why those ridiculous universal exercise machines from decades ago nearly all have the leg curl and leg extension module. Because how would you train legs other than to literally flex and extend the knee through resistance?

The answer to that question is that you could do it through a myriad of ways, the best of which, for many reasons, are compound movements. If you do squats, not only do you train your quads, but you train your glutes, your adductors, and your spinal erectors too[39]. Because you can safely use more weight, the forces you can generate in compound movements, even when measured at the muscle level itself, are often higher with compounds than they are with isolation movements. For anyone who is fairly well trained, the realization that compounds usually tax the muscle much more than isolations can seem painfully obvious, but it is worth noting.

What you can get from compound movements is a greater overall stimulus, and, in fewer sets than with isolations[40]. After all, even if leg extensions and squats stimulated the quads equally set-for-set (which they don't), you'd have to do glute kicks, adductor work, lower back work, and some hamstring work to get all the stimulus you get from just a few sets of squats. Isolations can be great when one muscle (let's say, your lower back) is approaching its maximum recoverable volume (MRV) but other muscles, such as the hamstrings, still need more volume. In that case, something like leg curls becomes a good choice to add hamstring volume without continuing to tax the other already-fatigued muscles.

Isolations, just like compounds, have their advantages and disadvantages and we'll explore those in-depth in later chapters. For now, suffice it to say that we should consider both as potential tools in a program designed to support specific goals based on a needs analysis, rather than favoring one over another as a matter of course.

CHAPTER 1

Summary

The principle of Specificity states that all training should directly or indirectly support the desired end result. If you cannot justify how your training supports your goals, you might be violating the principle of Specificity.

Directed Adaptation is an element of Specificity that states that repeated, sequential training is best for adaptation across weeks and months at a time.

Training Modality Compatibility is an element of Specificity that states that any one kind of training interferes with any other kind—there is an inherent cost to training for more than one goal. The more goals you have, the less effective the training for any of your goals will be, and the more different your goals are (hypertrophy versus endurance, for example), the less effective the training for all of them will be.

There are four factors that determine how much one training type will interfere with another.

- The more different training types use the same structures, the more interference
- The less similar the training stimuli are the more interference
- The more calories required to execute training, the more interference
- The more disruptive and fatiguing the training is, the more interference

A needs analysis and an understanding of training stimuli facilitate the use of the principle of Specificity in generating the training program. (We will go over training stimuli in subsequent chapters).

Writing a needs analysis involves the following steps:

- Determining the general qualities needed for the target sport or pursuit
- Determining individual strengths and weaknesses in the context of the sport or pursuit

The principle of Specificity directs all of your training efforts and is the single most important of the training principles. If you want or need bigger legs, but you're training only your arms, no other training principle can correct this mistake.

CHAPTER 1

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CHAPTER 2

Overload

The Overload Principle is the next most important training principle after Specificity. Specificity directs Overload strategies. You can think of Overload as the rocket and Specificity as the guidance system. The fanciest rocket in the world is useless without a guidance system—it can go somewhere, but the destination will be a surprise. On the other hand, the best guidance system can't do much without the propulsion of the rocket and this is where Overload comes in. Overload drives the improvements that Specificity defines.

The Principle of Overload Training: In order to produce improvements in performance, training must be challenging enough to the targeted systems or tissues to stimulate adaptation.

There are two important components of the Overload principle: *acute overload* and *progressive overload*.

Acute Overload describes the basic idea that any individual training session must provide a stimulus that reaches a *threshold* capable of initiating physiological adaptations that can support improved performance.

Progressive Overload describes the idea that training must get progressively more challenging (in volume, load, frequency, duration, etc.) in order to continue to stimulate adaptation.

Notice that the sport science definition of "overload" is a bit at odds with common parlance. "Overload" implies an above-maximal load, but this is not required (or possible) for training. Overload could also be interpreted as using more "load" than has ever been used before, but this is not actually a requirement of Overload either. More "load" than last time might be a more apt description. Depending on the system and specific adaptation, pushing to around 90% of maximum ability seems to provide a robust stimulus in many cases. In other cases, far less than that is needed. Thus, despite the connotation of the word, you do not have to achieve maximal output in training to achieve Overload, but you do need to challenge your physiology progressively to stimulate change.

Overload in the Context of Hypertrophy

Overload for hypertrophy dictates that training must be sufficiently, sequentially challenging enough to initiate muscle growth. The point at which training is sufficient to initiate change is called the "stimulus threshold". This threshold is generally achieved via a combination of variables. In the context of hypertrophy, reaching the stimulus threshold means providing enough volume, load, and frequency of training to initiate muscle growth. A range of values for each variable can be effective, as long as they collectively summate to drive change. An example of this is the fact that a range of reps and loads for a given exercise can produce hypertrophy, but on the lower end of the weight range, more reps will be needed to maintain sufficient stimulus and visa-versa.

A downside to the body's ability to adapt is that, as you get better, the stimulus threshold moves, and the volume, load, and frequency of training that is "enough" increases. For example, if your load stimulus threshold for sets of 10 reps in the barbell curl is between 90 and 110lb, then you will get stimulative workouts with 100lb for a long time. As you get bigger and stronger, your threshold will slowly shift upwards. In this example, once the threshold creeps up to between 101 and 121lb for sets of 10 curls, using 100lb will no longer be stimulative. At this point, weight must be increased to within the new range for continued growth from sets of 10.

Because the stimulus threshold is a range and not an exact value, different results will come from training at different ends of the range. This doesn't mean that you should try to train exclusively at the very top of the range, since the fatigue generated will make such training unsustainable over weeks or even days. The best trade-off of stimulus and fatigue probably occurs somewhere in the middle of the stimulus range, but a progression from the lower to the upper end of the range might make the most sense. In almost any adaptive system, the muscular system included, increased stimulus leads to increased responses until some point where adding more stimulus begins to produce incrementally less response (Figure 2.1). The inflection point at which robust gains first begin is the stimulus threshold. From this threshold to the maximum system capacity is the stimulus range. If we start training close to the stimulus threshold, we can get increasingly better growth as we progress across the stimulus range over time. In order to get our best progress, training must not only be "hard enough" (within stimulus range; acute overload), but also get slowly and steadily harder over time (progressive overload).

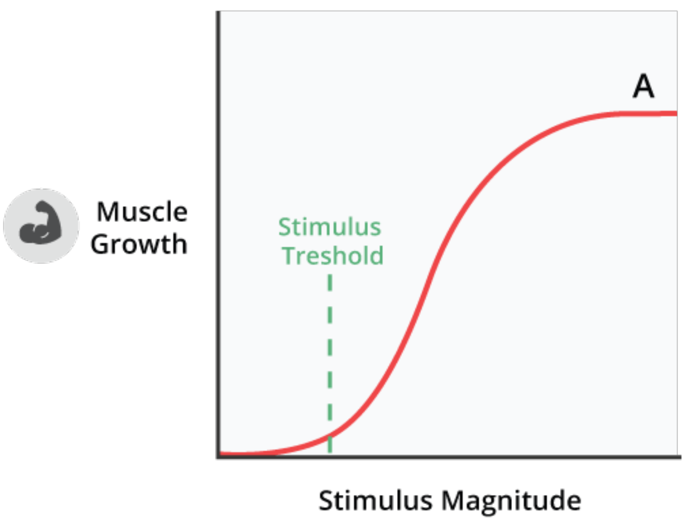

Figure 2.1: The S-Curve Relationship of Stimulus and Growth

Minimal muscle growth occurs before the stimulus threshold, but beyond it, large increases in growth occur as stimulus magnitude rises for some time. Increases in growth per increase in stimulus eventually slow and at some point (A), the curve flattens and further increases in stimulus cease to cause more growth.

To summarize Overload: if you want to make the most efficient gains, training has to be challenging, and it has to get harder over time. Just being difficult does not, however, make a stimulus specific. To grow muscle, Overload training must still conform to the Specificity principle—it must be challenging in the dimensions that cause muscle growth.

Training Stimulators of Hypertrophy

Understanding the variables in our training that stimulate muscle growth is essential to creating a training program for hypertrophy. There are three candidate stimulators of hypertrophy at the cellular level that can be measured and correlated with muscle growth. The following occur in the muscle tissue itself, in response to training, and are predictive of hypertrophy:

- Tension
- Metabolite Accumulation
- Cell Swelling

While tension, metabolite accumulation, and cell swelling are the cellular level initiators of hypertrophic signal cascades, it is helpful to look at the training variables that produce them or that are themselves well correlated with growth. It is also helpful to assess other factors that may impact hypertrophy. Below is a list of the cellular and training level factors that are correlated with muscle growth. Many of these variables interact with one another and some even produce others. They can nonetheless be ranked in terms of their relative importance for hypertrophy. This ranking is based both on data that tease apart interacting elements to the extent possible and on practical program design:

1. Tension
2. Volume
3. Relative effort
4. Range of Motion (ROM)
5. Metabolite Accumulation

6. Cell Swelling
7. Mind-Muscle Connection
8. Movement Velocity
9. Muscle Damage

Again, the above list is *in order of the importance of these stimulators*. That is, the ones towards the top should be prioritized aspects of most hypertrophy programs. Let's take a deep dive into each of these stimulators of muscle growth.

Tension

Tension—force produced in the muscle, stimulates growth. Muscle cells have tension receptors—molecular machines that detect and measure force passing through the tissue. To the extent that they detect force, these receptors initiate downstream molecular cascades that activate muscle growth machinery[1]. The more tension detected, the more muscle growth is stimulated, across a large range of force values.

The importance of tension is evidenced by the considerable muscle loss seen in astronauts and people confined to hospital beds (whose muscles experience little to no tension)[2]. Even the tension produced by walking is a hypertrophy stimulus, just on such a small scale that it merely keeps you jacked enough to be able to walk. Likewise, activities of daily living produce enough tension to maintain the muscle needed for those activities. To grow bigger than "activities of daily living" muscles, you need "larger than daily force" stimuli presented regularly in training.

Different force levels are managed by different types of motor units in skeletal muscle. A motor unit is a group of muscle cells and the motor neuron that stimulates their contractions[3]. There can be anywhere from just a few to thousands of muscle cells associated with one motor neuron in a motor unit. Small motor units have fewer, smaller muscle cells that tend to be 'slower-twitch' and therefore weaker, but more fatigue resistant. Larger motor units have more, larger muscle cells that tend to be 'faster-twitch' and therefore stronger, but more quickly fatigued[4].

Henneman's Size Principle states that the more force needed to execute a motor task, the more and larger muscle fibers will be recruited for that task, so larger motor units tend to respond more to heavier loads[5,6]. If you curl a very light object, let's say a pencil, you will only activate a small fraction of your motor units, and most of them will be small motor units with slower-twitch cells. Repeated curling of the pencil will generate force in those activated muscles and lead to their growth. However, slower twitch muscles are smaller to start and less growth-prone. This means that just curling your pencil *does actually stimulate growth* in your biceps, but it's an absurdly tiny amount: tiny enough to be canceled out by the natural turnover rate of muscle tissue. Pencil curling will only keep you pick-up-a-pencil-jacked. If you curl a heavier object, let's say a 10lb dumbbell, more, larger motor units are required, putting more growth prone muscle fibers under tension. If you regularly train with 10lb dumbbells, you will almost certainly be more muscular than if you only train with a pencil.

The increase in force production across larger motor units that results from lifting heavier things causes exponential increases in muscle growth. In other words, while lifting a weight that's 10% of your 1RM (one rep maximum or the most you can lift for one repetition) might cause a tiny bit of growth per repetition, lifting a weight that's 70% of your 1RM (seven times heavier) causes *much more* than seven times the growth[7].

Because the most growth-responsive motor units only turn on with very large force requirements or under a few other special conditions, you have to lift somewhat heavy in order to create enough tension for good growth[8–11]. Tension also has its limits—lifting at the heaviest end of the loading range is not the best choice for growth either. Too heavy a load, despite producing a great deal of tension, accumulates a great deal of fatigue and prevents sufficient volume, our next important stimulator of hypertrophy[12].

Volume

Tension is the most causative stimulator of training-induced muscle growth, but if we take this idea to its limit without consideration of other factors, we might conclude that doing a 1RM lift should generate the most growth. Experience and data suggest that this is not likely the case[13]. Very low volume, high load programs tend to produce very little hypertrophy in beginner lifters, and often none at all in the intermediate and advanced. It turns out that this is because, although low rep heavy sets produce a very large amount of tension, the muscles' exposure to this tension is limited by the small number of reps possible under such heavy weight[12,14,15].

To maximize growth, muscles need a longer duration under the stress of tension than one repetition can provide, no matter how heavy the load. A great analogy to the relationship between tension, volume, and hypertrophy is the exposure of pale skin to the sun and the development of a suntan. The stronger the sun, the darker the eventual tan, just like the heavier the weight, the more growth it stimulates. If there is not enough sun or not enough load, no amount of exposure will generate a tan or muscle growth. Likewise, just a few seconds outside, even near the equator in the midday sun is not enough stimulus for notable changes in skin tone any more than one rep, no matter how heavy the weight is not enough stimulus for notable muscle growth. How much time you spend in the sun determines how much color change you will see, and in much the same way, the total time you spend lifting heavy weights will determine your hypertrophy response.

Notice that in this analogy, peak magnitude of exposure does absolutely still matter. After all, most people don't get a suntan by spending hours in only the light of the sunrise or sunset, just like you don't get very muscular by lifting 10% of your 1RM for hours on end. There is an ideal range of tension producing loads that allow for enough time experiencing that tension to promote best growth[13]. Within the effective range of tension values, volume probably makes the bigger difference. You can visualize the relationship of tension (approximated by the word “load” as load is what causes tension in resistance training) and time producing that tension (volume) by plotting a curve. Cellular mechano-receptors send signals in proportion to the load, but the duration of this signal output also determines how well the message is received and therefore how much muscle growth occurs.

You can get more growth by increasing the tension (via increasing the load), increasing the duration of tension application (the volume), or some combination of both. In simple terms, to cause more muscle growth, you either need to lift heavier (up to a point), do more total sets and reps (up to a point), or some combination of both.

Different fiber types probably respond better to different levels and different durations of tension. Some current research along with experience from athletes and coaches suggest that faster twitch muscle fibers are more responsive to heavier training and slower twitch fibers to lighter training[16,17]. This makes sense given that slower twitch fibers are more fatigue resistant and therefore need a greater duration of stimulus to activate growth processes fully. Heavier loads increase tension that can activate more fibers, but the heavier the weight, the less reps will be possible, and the shorter the duration of that tension. Therefore, the authors posit that loads on the lighter end will likely provide better stimulus to slow twitch fibers due to the high volume of reps possible, but limited stimulation to fast twitch fibers. Loads on the heavier end on the other hand, will likely better activate fast twitch fibers (due to the level of tension), but provide limited growth stimulation to slow twitch fibers[18,19].

The astute reader will notice that, though we have titled this section “volume,” we have actually described a concept known to many as “time applying tension.” Time applying tension is a useful way to think about growth stimulus, but it has distinct limitations that make the volume concept better suited to discussions of hypertrophy. Assessing volume as a proxy for time applying tension is more practical for hypertrophy training program design, as we will see in later sections discussing volume landmarks.

After looking at the relative effects of tension and volume, we can begin to see that for maximal hypertrophy a spectrum of tension and volume values is needed for best growth. The next stimulator of hypertrophy might in part explain the relationship between the last two:

Relative effort

Relative effort is a measure of how close to failure you are on a lift or how difficult the lift is for you with respect to your current capacity. Recall that Overload requires training to be sufficiently challenging—relative effort is a means of measuring the degree of challenge hypertrophy training is applying. At or very near muscular failure, nearly all motor units are active and producing force[20–22]. Relative effort is in part what allows a large range of tension and volume values to be effective for hypertrophy (along with different fiber type responses to stimuli)[23]. In simple terms, more volume can make up to some extent for less tension and visa-versa due to similarities in relative effort[13]. In other words, within a certain range, less volume can be made challenging enough to satisfy Overload with increased load and visa-versa.

A motor unit can be stimulated to grow either because of the amount of force required by the whole muscle is large, or because the volume is so great that some muscle fibers must take over for others when the latter fatigue. For example, your smaller, slower-twitch motor units might not need any help in lifting the first 20 reps of your 30RM, but the last 10 reps will see them fatigue so much that, to keep lifting, the biggest and most fast-twitch (and thus growth prone) motor units have to be turned on just to keep the reps coming[11,22]. Likewise, an extremely heavy load produces so much tension across so many fibers that even with lower reps, growth will be stimulated[8,9].

Range of Motion

If you were to build a training program solely on what we've covered so far, you could very logically plan exclusively isometric training. If tension is central and the time over which it is generated is of supreme importance, then why not grow by setting a bar to half-squat height, putting 110% of your squat 1RM on it, and pushing as hard as you can into it, thus remaining motionless but getting all the thus-far-discussed tenets of hypertrophy?

Isometric training *has* been extensively shown to produce robust hypertrophy in animal models and rehabilitation settings[24,25]. Unfortunately, animal models and rehab settings often differ greatly in outcome compares to healthy humans and the authors hypothesize that that is the case for isometric training as well. Direct experimental comparisons of partial ranges of motion and full ranges of motion (ROM) in humans almost always favor fuller ROMs for hypertrophy, which also suggests indirectly that isometrics are less stimulative[26]. This is probably especially true with more trained populations—with beginners likely getting some growth from isometric-only training, but the advanced very little. (Most of these ROM studies also equate for total work, which means the "time applying tension" is the same in both groups and that ROM is the variable associated with the differences). There are a few other reasons that isometric-only training is likely suboptimal:

> ***Different motor units activate during different portions along the range of motion of a movement[27–29].*** Some are activated through the whole range, some at the stretched position, some at the contracted position, and some at various points between. Isometric training would only stimulate a fraction of these at a time. To stimulate as many units as possible, as much of the entire ROM as possible should be trained.

Tension while stretching a muscle seems to be an independent growth stimulator in addition to tension itself[25,30–32]. By doing full ROM, you can stimulate growth via both tension in general and tension under stretch specifically. There is good reason to believe that stretch under tension also provides a different type of hypertrophy than tension without stretch (adding muscle in length, not just in width).

Concentric or eccentric training grow a roughly equivalent amount of muscle, but seem to stimulate that growth via somewhat different downstream pathways[33,34]. Thus isometric-only training probably doesn't stimulate either unique pathway to its fullest. The best way to perform both concentric and eccentric training and get the benefits of each is to do full ROM training.

These insights don't imply that partial ROM or isometric training approaches are totally worthless. In some cases, partial ranges can stimulate regions within a muscle or muscle group preferentially[35,36]. Even isometrics can preferentially target certain muscles or parts of muscles that full ROM training cannot.

Isometric contraction can have a role in full ROM training. For example, peak contraction in rowing movements. While a "touch and go" style of rowing is great for overall back hypertrophy, a special advantage to the scapular retractors (rhomboids and mid-traps) may be gained from a partial ROM with isometric contraction when the elbows behind the midline of the body (Figure 2.2). Such training requires lower weight, to allow you to hold a full retraction of the scapula for a second or more. Such a light weight *can* be done for the full ROM, but because this loading is vastly under-stimulative for the remainder of the movement, it might make more sense to just limit the row to the top half of the ROM, saving some effort and fatigue. While this dynamic describes a minority of training situations, it's worth understanding.

Figure 2.2: The Peak-Hold Row

A rowing movement limited to the top half of its full range of motion, with a pause at the peak contraction to target the scapular retractors.

Volume As it Relates to Tension and ROM

Volume can be defined as the product of the weight lifted, the range of motion through which it is lifted, and the number of total reps for which it is lifted. Because volume takes ROM into account (by integrating the distance the load travels across the movement), and because ROM is an important consideration for hypertrophy, using volume as the proxy for “amount of tension stimulus applied” is probably at least as good as just using time applying tension. In fact, because time applying tension only measures the “dose of tension applied” and volume measures the dose and the ROM, volume is probably the better measure, assuming most people use full ROM. In addition, volume has vastly more real-world applicability. Most people who train seriously already count their sets and reps regularly. Very few people, however, actually measure the duration of each set. If programming insight is given in terms of volume (sets and reps), it’s that much easier to utilize.

Going forward, we will use volume as a proxy for the amount of tension stimulus applied and not use time applying tension unless it is specifically warranted.

Metabolite Accumulation

Calcium is the first in a series of ions and molecules that are released with muscle contraction and called "metabolites"[37]. As muscles produce more and more force, they rely more and more on anaerobic energy systems, which, unlike aerobic systems, produce rapidly accumulating byproducts[38,39]. This process adds to the pool of metabolites in the muscle cell—some of which are acidic and irritate the muscles in which they are produced, which is where the "burn" feeling when lifting comes from. Research is now accumulating (no pun intended) in support of a direct role for some metabolites (lactate specifically) in triggering muscle growth[38,40–42].

Muscle growth is probably triggered in proportion to both the amount of metabolites present and the duration of their presence. While the growth from these pathways probably does not compare to that resulting from tension-mediated pathways, it does likely produce robust hypertrophy. In addition, it seems likely that tension-mediated growth pathways are boosted in the presence of certain metabolites, giving metabolites an indirect growth effect as well as a direct one[38]. Since more metabolites are produced closer to failure, this is more support for the importance of relative effort[38].

Cell Swelling

Direct research on cellular physiology has shown that the swelling of muscle cells actually itself stimulates muscle growth and that this might be especially true for faster-twitch muscle cells[43–46]. This means that "the pump" experience revered by bodybuilders through the ages is actually in some way a direct observation of stimulation of muscle growth. This does not mean a lack of pump during training means a lack of growth stimulus (lower rep heavy training does not produce much pump but can promote some growth), but it does mean that the pump can be sought in its own right. While the primary cause of the pump is likely the reactive hyperemia (wherein the muscle contraction triggers increased blood flow to that muscle), metabolite accumulation also triggers the pump effect—which means that much of the same kind of training that stimulates metabolite-dependent growth pathways will also likely cause pumps and thus stimulate cell swelling-mediated growth[47,48].

Mind-Muscle Connection

Mind-muscle connection usually refers to the simple awareness of your target muscle working during a movement—for example focusing on flexing and eccentrically loading the quads in a leg extension, feeling every sensation, and trying to contract every fiber rather than going through the motions[49–54]. For this book's purposes, we will use the term mind-muscle connection to refer to a more all-encompassing perception of effective stimulus. Because the purpose of training is to stimulate the muscles, perceptive feedback needs to correspond to the likelihood of a stimulus, not just muscle activation.

We can be sure that a target muscle is being stimulated in an exercise when it's being activated at near its maximal abilities. In heavier training the mind-muscle connection is characterized by the perception of high tension in the target muscle. The other end of the loading range (lighter weight and more reps) should elicit a painful burn from metabolite accumulation in the target muscle toward the end of each working set. In effect, our definition of the mind-muscle connection (which will persist in the rest of the book) can be seen as a measure of the application of the more important training stimulators. A good mind-muscle connection assures the lifter that tension, volume, and metabolite stimulators are being applied to the target muscle.

Movement Velocity

Movement velocity refers to the speed at which you complete your repetitions during training. Specifically, the amount of time spent on each of the three distinct phases of movement: the eccentric, the amortization phase (the transition between eccentric and concentric), and the concentric. Importantly, all of these phases need to be at least controlled. For safe execution and the continual stimulation of muscle activity, there is almost never a place for completely relaxing at the top or bottom of a lift, or of letting the weight drop in an eccentric. If maximum growth is your goal, you can forget dive-bombing your squats or chest-bouncing your benches. Within the bounds of controlled movement, there are various velocity options that can be taken advantage of for different purposes[55]. Controlled but explosive movement is likely more stimulative of faster fibers and slower movements might better stimulate smaller motor units. Benefits of various cadence options will be discussed in depth in the stimulus range discussion later in this chapter.

Muscle Damage

Whether it is the case that damage is causative of hypertrophy or just caused by the same things that cause growth is still unclear[46,56]. In either case, the correlational relationship between how much damage is done and how much growth is achieved seems to be an inverted U-curve (Figure 2.3). While training so little that you incur no damage is probably not stimulative enough for growth, training for maximum damage is also almost certainly a bad idea. Recovery and adaptation compete with each other to some extent because they dip into the same finite pool of resources[56,57]. If training is so damaging that recovery consumes nearly all resources, no actual adaptation (muscle growth) can occur!

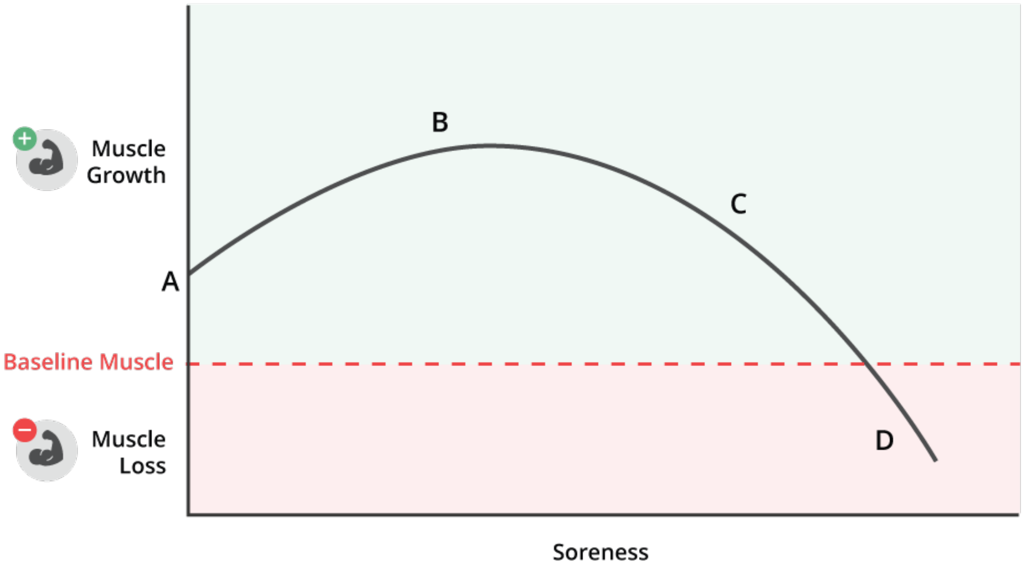

Figure 2.3: Relationship Between Soreness and Growth

Effective training does not always cause soreness (A), but training magnitudes resulting in some soreness are likely to lead to more growth (B). Because recovery and adaptation use overlapping resources, getting very sore might cause less optimal growth (C). Extensive soreness can be evidence that enough damage has occurred to cause muscle loss (D).

In any case, damage remains a decent proxy for stimulus effectiveness. If you experience no decrement of performance, don't get remotely tight, and have zero muscle soreness after a training session, you are probably not training hard enough for best gains. On the other hand, if you train so hard that you're crippled for a week, you're probably spending more resources on recovery and concomitantly less on actual muscle growth[57]. Training somewhere between experiencing some fatigue and tightness the day of training up to having DOMS that lasts a few days is likely best practice.

Summary of Hypertrophy Stimuli

By lifting heavy you activate direct tension-activated growth mechanisms and research has hinted these responses are amplified by metabolite production. Metabolites also likely trigger independent growth pathways of their own—and do more so as you approach closer proximity to failure. In addition, metabolite accumulation pulls water into muscle cells, contributing to cell swelling, which adds its own hypertrophy stimulus. This cell swelling effect is also produced by increased blood flow and fluid displacement effects from repeated contraction. Larger ranges of motion contribute to growth stimulus via stretch under tension and by prolonging the amount of time applying tension. The exact combination and ratios of the various hypertrophy stimuli that would cause best growth is not entirely clear. As we have seen, some of the stimulators of hypertrophy induce other stimuli, some co-vary with the same training practices, some boost the effectiveness of others, and so on, making the relationships between training, stimuli, and growth even more complex. Don't get overwhelmed by this—putting what we do know to effective use is actually

Effective Stimulus Ranges

On the graph below of the relationship between training stimulus and muscle growth, the point at which slowly increasing gains become quickly increasing gains (the first inflection on the graph) corresponds *roughly* to the stimulus threshold (Figure 2.4). The second inflection on the graph is where gains level off into slower returns and is roughly the point at which increasing the stimulus is not worth the effort. Stimulus increases from here are still technically "effective," but no more so, and even less so, than via a lower level of stimulus, and thus we do not tem them as being in the "effective stimulus range." The effective range for each stimulus therefore lies between the stimulus threshold and the inflection point at which more stimulus no longer increases growth[59].

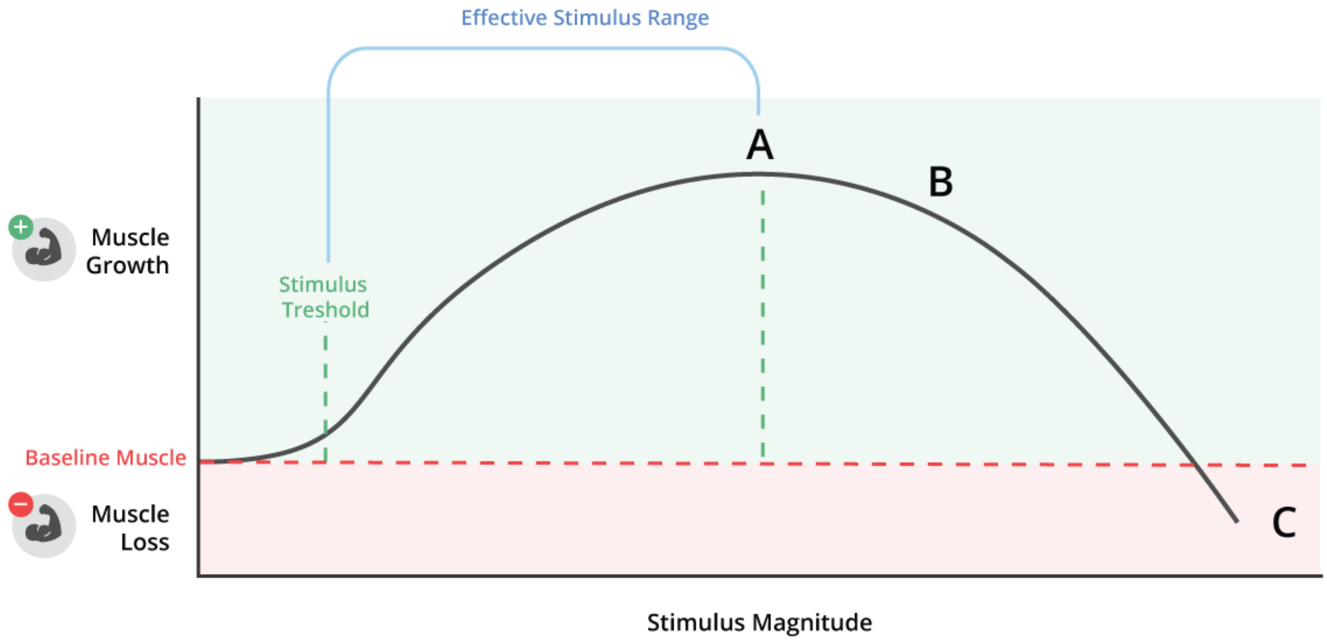

Figure 2.4: Extended Relationship Between Stimulus Magnitude and Growth

The stimulus magnitudes between the stimulus threshold and the point at which adding stimulus no longer increases muscle growth (A) represent the effective stimulus range. Beyond this range, increasing the magnitude of stimulus will result in incrementally less growth (B) and eventually muscle loss (C).

The effective ranges for mediators of hypertrophy that we can control directly; tension (as proxied by load or weight), volume, and relative effort are explored in our next section. The other stimulators of hypertrophy are not components of training, but rather factors that result from training (metabolites, cell swelling, etc.). These are difficult, if not impossible to measure directly in any practical way. Thus, when we consider effective ranges for these stimuli, we speak in terms of the training parameters that best produce them. We can identify a range of training parameters between the stimulus threshold and the point at which increases in growth per increase in stimulus slow, within which we can get our best hypertrophy results.

Relative Effort: Effective Stimulus Range

Although tension and volume are ranked slightly above relative effort in their importance for hypertrophy, relative effort helps set the bounds for effective tension and volume stimulus ranges, so we will discuss it first.

For now, we can measure a set's proximity to muscular failure as its repetitions in reserve or RIR. In other words, how many reps do you have left before you completely fail to produce the movement. The lower the RIR is, the closer to failure the training is. A 4 RIR means you have 4 reps in the tank until you can't lift the weight through its full range of motion anymore, and 0 RIR means the next attempted rep will fail, and so on.

As a set approaches muscular failure, faster twitch, larger, and more growth-prone motor units begin to activate more and generate a larger fraction of the total tension[22]. The last five or so reps of a set taken close to failure sees the vast majority of the tension produced by the biggest and most growth-prone motor units. This activation occurs in the last five reps approaching failure *no matter the load* within the stimulus range[11]. In other words, the last five reps of a 30 rep set to failure might require almost as much activation as the last five in a five rep set taken to failure. Because of this disproportionate contribution to the growth stimulus, reps of 5 RIR and lower have been termed "effective reps." To be clear, the technically correct way to envision them is as *"more effective reps,"* because the reps before them are also stimulative, just less so.

Growth increases in any given set of training as the RIR declines, though these jumps in growth get smaller as you approach 0 RIR—there are smaller differences between 1 RIR and 0 RIR than between 5 RIR and 4 RIR (Figure 2.5).

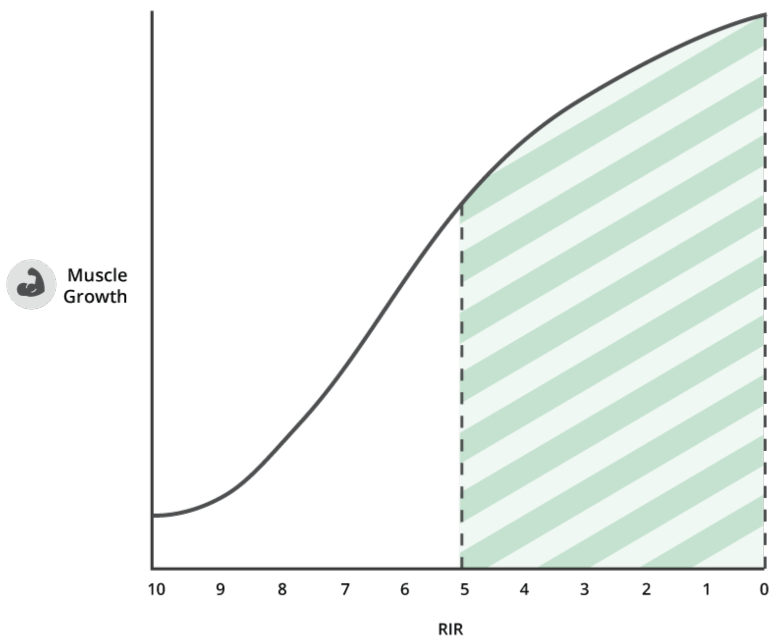

Figure 2.5: Relationship Between Effective Reps and Muscle Growth

Sets taken to 5 RIR or less stimulate more growth than sets with higher RIRs.

There are several reasons that lower RIR causes more growth. First, for weights under 85% of 1RM, only the near-failure reps will activate the biggest, most growth-prone motor units due to lower load and less tension[22]. The hilarious corollary to that observation is that *all reps* north of 85% are close to failure anyway, so either way you get there, failure proximity matters for growth[11,60]. Secondly, training close to failure increases a number of other factors that promote growth; it causes a greater accumulation of metabolites, more cell swelling, and is also likely to cause more muscle damage (though, again, whether the latter directly contributes to growth is still unclear)[46,56,61–63].

Thus, performing most, if not all, working sets in a program at 5 RIR or less is probably best practice. The temptation is to see Figure 2.5 and conclude that 0 RIR training should be the goal of every program, but what is missing from this graph is the element of fatigue. Fatigue will determine how much more training you can do across subsequent weeks and therefore how much more growth stimulus can be applied. If we take both stimulus and fatigue into account, we come to a different conclusion—averaging 2-3 RIR likely allows the best stimulus to fatigue ratio for long-term growth

(Figure 2.6). While one session at 0 RIR will cause more growth than one session at 5 RIR, the 0 RIR session will create vastly more fatigue[61,62]. This fatigue will limit your ability to progressively overload across subsequent weeks and therefore limit gains.

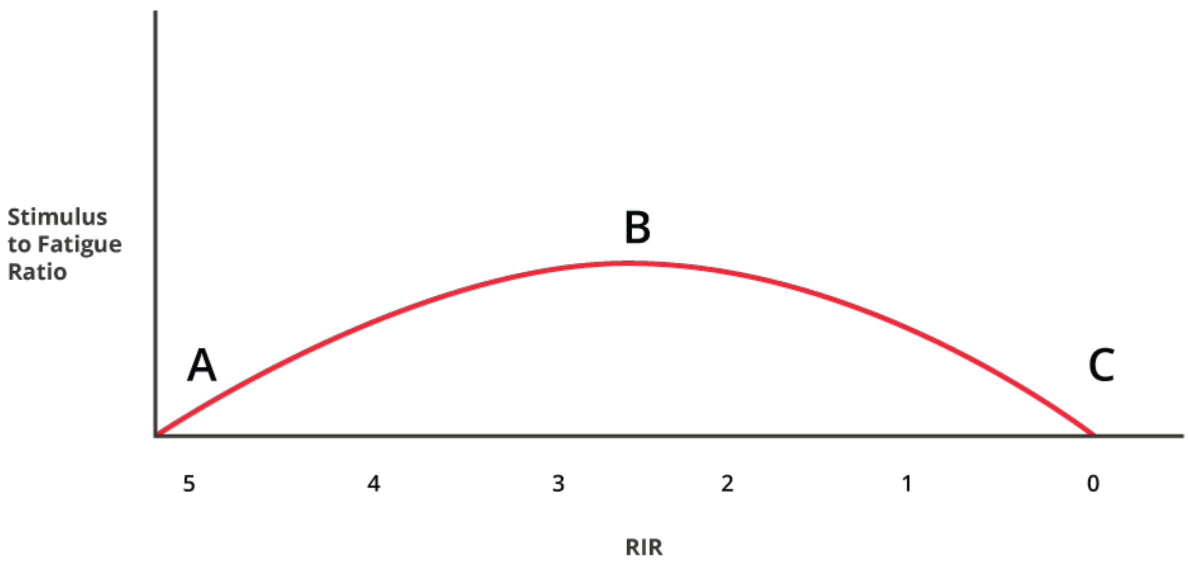

Figure 2.6: The Relationship Between RIR and the Ratio of Stimulus to Fatigue

At 5 RIR (A) stimulus and fatigue are both relatively low and growth is minimal. At 0 RIR (C) stimulus and fatigue are both very high and fatigue will inhibit subsequent training and progressive overload, limiting long-term growth. Between 2-3 RIR (B), the stimulus is relatively high and fatigue relatively low, maximizing stimulus to fatigue for the best gains over time.

This does not mean that you should only ever train at 2-3 RIR, but it probably means that your average RIR across weeks be set at around 2-3 RIR. We'll see exactly why in the section on progression, later in this chapter.

As mentioned, the effective stimulus range for relative effort (5-0 RIR) also contributes to initiating two other stimulators of hypertrophy, metabolite accumulation and cell swelling. While metabolites can be produced by high reps without proximity to failure, these do not promote growth effectively. As proximity to failure increases, metabolites accumulate much more efficiently and trigger growth pathways[11,22,60]. Cell swelling or a "good pump" is produced by the occlusion of venous outflow via the contraction of the muscle itself and is strongly associated with metabolite accumulation and so proximity to failure is also a factor in generating this hypertrophy stimulus[47].

Hypothetically, going to failure at any load (even something like 10% 1RM) could produce gains, but so many reps would be needed to approach failure with such light weight that fatigue accumulation would disproportionately prevent faster twitch fibers from being stimulated, making maximum growth very unlikely[64]. Our most important hypertrophy stimulus, tension, is required in adequate amounts for best growth.

Tension: Effective Stimulus Range

Without considering the proximity to failure (the relative effort variable), notable growth in healthy subjects is seen at weights above 60% 1RM (and especially above 75% 1RM). Thus, in older research, 60% 1RM was marked as the bottom of the hypertrophy stimulus threshold for tension because proximity to failure wasn't factored in[18]. When working in close proximity to failure, however, we can see robust growth starting at around 30% 1RM[7,13]. This is our tension stimulus threshold.

As we go heavier from around 30% 1RM to about 85% 1RM, each rep we do causes more growth[7]. North of 85%, as load increases, the amount of growth you get with more load decreases and trade-offs for added hypertrophy become less favorable. Fatigue and injury risk generated by loading greater than 85% 1RM increases exponentially[65]. Mind-muscle connection is a more minor concern, but paying attention to the target muscles is more difficult when you are struggling to lift a much heavier weight; this further tempers the benefit of lifting above 85% 1RM making it likely a good choice for the top end of our effective tension stimulus range.

Thus, so long as we remain in the 5-0 RIR relative effort stimulus range, 30% to 85% 1RM is our effective load (tension producing) stimulus range.

Volume: Effective Stimulus Range

In the tension stimulus range, we said that you generally get more growth stimulus as you move from 30% to 85% 1RM, but keep in mind that this is *per repetition* of weight lifted[7]. Because training is composed of working sets, it's also a good idea to compare working sets, not just reps, when assessing the volume stimulus.

Per-set volume and growth

Volume must be applied via separate sets rather than across one long set in most cases. Doing one long set would disproportionately stimulate the slowest, least growth prone fibers. Because the nervous system and faster twitch muscles tire quickly, splitting training into multiple working sets lets them recover for continued stimulation leading to more net growth stimulus than any one set could provide. Some have advocated counting effective reps in order to compare programs, but this might not be an accurate assessment. A 3 RIR set followed by a 2 RIR set might have five total effective reps, the same as one set taken to failure (0 RIR), which would lead us to conclude that either strategy would produce the same growth stimulus. The overwhelming direct research shows however, that two sets of 2-3 RIR actually confer about twice as much growth as one set taken to failure! This is probably because *the other reps in a set do contribute to growth*, even if less so.

By counting the number of *sets* done at 5 or less RIR, we get a more accurate proxy for growth stimulus than we would by counting only effective reps. When we perform a "close to failure" set, the number of repetitions we can perform is inversely proportional to the load used. If we use a 30% 1RM load, we can do something like 30+ reps in a single set. If we use 85% 1RM, we might only be able to do five or so reps. Although repetitions with the lighter load are less stimulative individually than those with a heavier load, the number of repetitions and therefore volume stimulus will be higher, so the effects largely cancel out. In other words, the amount of growth stimulus *per set* is very comparable for sets of anywhere from five to 30 reps so long as the

sets are close to failure. Slower-twitch muscle cells will perhaps grow a bit more from the lighter end of that range, and faster-twitch cells more from the heavier, but on average, we get very close to equating growth stimulus just by counting the number of “hard sets” (sets taken to within 5 -0 RIR) in a program, as Greg Nuckols and Nathan Jones have pointed out[66]. This revelation is incredibly important, because it can allow us to use the “working sets” proxy for growth stimulus and make volume comparisons between different program designs easier and more realistic[67].
can allow us to use the “working sets” proxy for growth stimulus and make volume comparisons between different program designs easier and more realistic[67].

Instead of using the number of hard sets as our proxy for growth stimulus, we could use the measure of ‘mathematical volume.” Mathematical volume is the calculation of sets x reps x weight x distance. Distance is relevant between different exercises and different individuals’ bodies, but not helpful when comparing programs. Sets x reps x weight can just be simplified to sets since, as we have seen, reps and weight more or less cancel each other out. So, we end up with sets again proving to be a fairly accurate and very convenient measure of volume. Please note that this relationship is not likely to apply outside of the tension stimulus range. Weights shy of 30% 1RM are probably under-stimulative rep for rep and weights greater than 85% 1RM often produce such low reps that increased tension stimulus can’t make up for the decrease in reps[67]. It’s also not even clear that there is much per-rep stimulus increase using loads above 85% 1RM.

From now on, when we discuss volume, we are referring to numbers of sets, with the implied assumption that they are sets done within the effective relative effort and load ranges—taken relatively close to failure between 30% and 85% 1RM.

Minimum Effective and Maximum Recoverable Volumes

The amount of sets that it will take to cause growth is termed the "Minimum Effective Volume" for hypertrophy, or MEV. This corresponds roughly to the "stimulus threshold" where gains increase rapidly with increases in volume.

Your MEV depends on a lot of things, but the biggest determinant by far is your training age. If you have never trained your legs in your life, just one set per week can grow your legs for weeks on end, as has been demonstrated in HIT (high intensity training) research[13]. Of course, the body adapts to stress, and as your legs grow more and more volume will be required to continue growing. MEVs vary person to person even at the same training age, but MEV increases for everyone across training age.

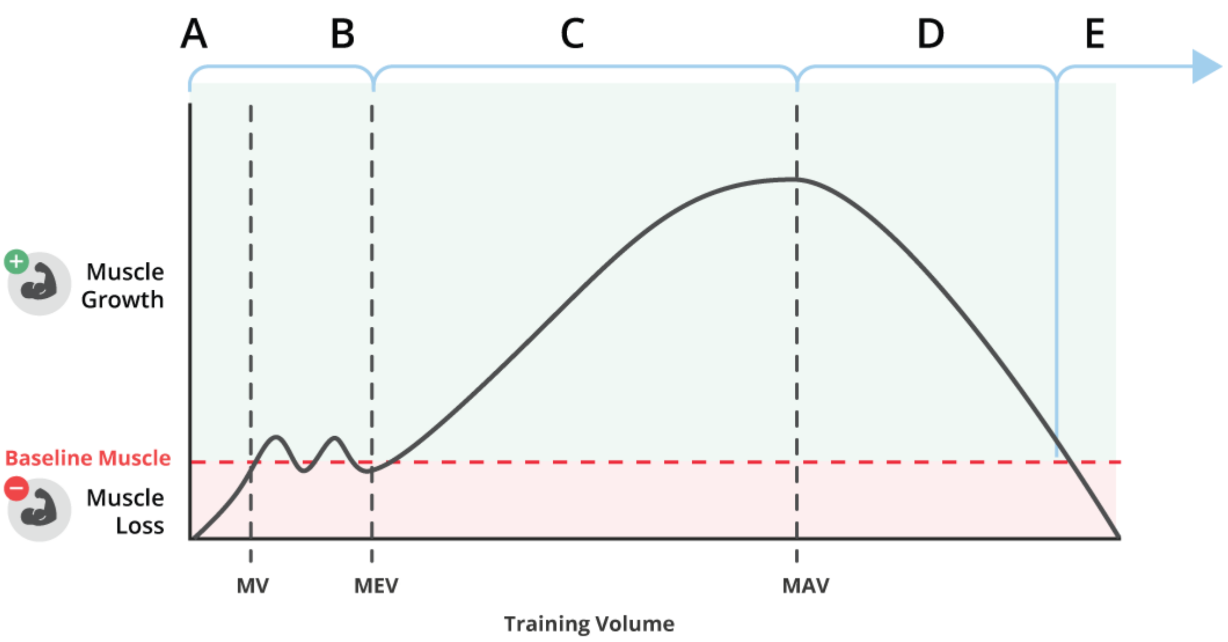

Figure 2.7: The Relationship Between Training Volume and Muscle Growth

Training below MV leads to muscle loss (A) while training at MV maintains baseline muscle (dashed line). Training between MV and MEV will result in no net growth (B). Training anywhere between MEV and MRV will cause gains (C+D), with any training session's effect having a theoretical peak at MAV (which shifts across the mesocycle). Beyond MAV, more volume results in incrementally less growth (D). MRV falls somewhere within (D) and growth will cease not long after surpassing it. At some point, too much training can lead to muscle loss (E).

Training with increasing volumes above MEV causes increasing muscle growth, up until the point that recovery ability becomes exhausted[13]. This latter point is the maximum recoverable volume (MRV). All potential gains come from training between MEV and MRV, and to take advantage of as much of this range as possible (as well as to adhere to the principle of progressive overload) a volume progression should probably begin somewhere near MEV and end somewhere near MRV (we will cover progression in more detail later). The relationship between training volume and muscle growth is illustrated in Figure 2.7.

Volume versus Loading

An important implication of the fact that roughly the same degree of muscle growth can be had anywhere within the tension stimulus range (30-85% 1RM) is that there is no need to program extremely heavy weights[7,13]. When sport scientists say that "volume is more important than load for muscle growth" they are highlighting the fact that (within the effective load range and between MEV and MRV) more sets lead to more growth. More load does not have the same relationship with growth[7,13,68]. This means that if you train above the effective 30-85% 1RM tension stimulus range, you are focusing on a variable that does not have a dependable relationship with muscle growth at the expense of one that has perhaps the most dependable relationship with muscle growth. The most effective hypertrophy training happens within the 30%-85% tension range. So, is volume more important than load? In the sense that load is needed to initiate tension, no. But once we limit our choices to only loads in the effective tension stimulus range (30% to 85% 1RM), set number is almost certainly more important than which load you choose within the effective range.

Rep Range for Mind-Muscle Connection

Rep range also dictates the effectiveness of the mind-muscle connection as a hypertrophy stimulus. For isolation exercises, such awareness probably pays valuable dividends, especially as training age progresses from beginner to advanced[52,69]. When trying to pay close attention to the working muscle, avoiding reps much higher than 20 is probably best practice, since overall fatigue from too many reps will start to prevent the focus required. On the other end, sets of fewer than 10 reps might be so heavy that trying to maintain awareness of individual muscles is either not possible or distracts from effectively moving the weight. This leaves us with a rep range of around 10-20 for best mind-muscle connection for most people.

Range of Motion: Effective Stimulus Range

Even ROM has its own stimulus range, as you might expect from theory alone. This range is bounded on the lower end by "just enough ROM" to get near-best muscle growth and on the higher end by the point at which extending the ROM further will yield no additional results. Not entirely quantifiable bounds, but let's walk through the theoretical idea and see how it can impact practical choices in training.

Minimum effective ROM can have two descriptions. The first being "take the targeted muscles through the majority of their range of motion." The second being "use a ROM that both provides notable stretch and takes the muscle either to its terminal end of flexion, (such that no large group of motor units is missed) or as far as it can safely go."

Practically, if you squat deeply enough to feel a notable stretch on your quads, your ROM is probably enough for near-optimal gains[25,30–32]. As much as it hurts us to put this in writing, you don't have to bury every squat 10 inches below parallel. Most lifters of average flexibility do have to descend at least to parallel to get a quad stretch and best gains. A good general rule is that, if you can move the limb further while still using the target muscle under load, it's probably wise to do so. For example, if you can safely bring the pulldown bar to your chest, but you stop at your chin, you might be missing out on small but significant growth in your lats.

There are some movements that limit ROM by virtue of the exercise itself, but these often have other benefits (such as better targeting specific parts of a muscle or different muscles in a muscle group). For example: the row versus the pullup. The row limits lat ROM compared to pullups by virtue of the movement, but this does not mean that rows should be left out of training programs. We should have *some* exercises to address the full ROMs our limbs are capable of performing, but they don't need to make up all or even most of the movements for the target muscles. We should however perform both pullups and rows to *their* fullest possible ROM in most cases.

It is also possible that exercises with incomplete ROM are ok to alternate with ones that cover the ROM on a monthly or multi-meso basis. For example, you might do squats without locking out in one meso, and leg extensions with a full lockout but no deep stretch in another meso, and still get close to maximum growth over many months of such a rotation. What you don't want to do is chronically ignore easily trained ROMs for no good reason.

What do you do if you are much more flexible than standard exercises allow? For example, if you can do lat pulldowns with free handles in each hand and descend to three inches below your chest, do you still do bar lat pulldowns that limit your ROM by those three inches? You certainly can, but, as mentioned above, every week, or maybe once every few mesocycles, attention to that extra ROM may be beneficial on the net balance.

On the upper end of the stimulative ROM range, too much ROM for good growth can occur for three reasons. The first being when extending ROM causes technique to break down. For example, "ass to grass" is a great way to squat, unless your lower back has to round excessively to get into that position. Your best squatting ROM in this case, is as low as you can go without excessively rounding your lower back. The second reason is if extended ROM causes you to rely on non-target muscles more than target muscles. Cable flyes, done very deeply with completely straight arms can get to a point where your biceps are doing most of the work and the pecs, having been stretched to the max already, aren't getting any added benefit. Lastly, if an exercise causes pain at extreme ROM. People's bodies are different and—even putting mobility aside—are capable of different ROMs based on anthropometry. If benching with a cambered bar really stretches out your pecs but hurts your shoulder, either cut the motion by enough ROM to prevent any shoulder pain or just switch back to regular barbell presses.

"Full ROM" really does mean something, but it should only be as full a ROM as is effective, safe, and logical in the long-term timescale of training, while conserving the intent of the exercise. In simple terms, do a ROM that gets you a good stretch, a good contraction, and don't sweat the details too much.

Movement Velocity: Effective Stimulus Range

Hypertrophy results seem fairly stable in the following durations: eccentric, amortization phase, and concentric durations of up to three seconds *each*, or up to nine total seconds per rep[55]. From a strictly theoretical perspective, larger forces are probably achieved with the following: a 2-3 second eccentric phase, a controlled "touch and go" amortization phase, and a relatively quick (but controlled) concentric phase. As reps approach failure, they may very well take a bit longer, and that's not a concern.

There is no reason to believe that pausing reps for a second or two is more hypertrophic than the "touch and go" method, but there may be some cases when paused amortization phases provide valuable benefit. For example, some safety is certainly added by pausing at the bottom of the squat. There may be some situations where this is worth the added time or where the lighter weight needed to do a slower movement provides some benefit for working around injury or focusing on technique development.

Explosive movement on the concentric phase has both advantages and disadvantages for hypertrophy. Explosive movement might enhance motor unit recruitment and thus stimulate more growth, but it is also likely more fatiguing per-rep than normal speed execution. It might also throw off technique in some cases, reducing safety (and working muscle awareness for some lifts). At the current time, it doesn't seem that explosive concentric movement offers enough benefit to warrant the risks for hypertrophy goals, but more research might shift this conclusion.

For the time being and until much more research on the topic becomes available, if you're in control of the weights and you're not taking more than three seconds on any of the concentric, pause, or eccentric phase, you're probably getting maximum or near-maximum effect[55].

Applying Hypertrophy Stimuli

Now that we have defined and described the main stimulators of hypertrophy and the ranges in which they are effective, we can move on to the training methods used to achieve those stimuli. Though there are certainly other ways to stimulate growth, the below training methods account for the vast majority of effective hypertrophy training:

- Straight sets
- Down sets
- Giant sets
- Supersets
- Myoreps
- Drop sets
- Occlusion training

Let's take a look at each of these methods and describe how they should be implemented in a typical hypertrophy training program.

Straight Sets

The most often used but least sexy hypertrophy training stimulus—straight sets—involve performing a set of reps (ideally within the effective stimulus ranges discussed earlier), resting until you are ready for another productive set, and repeating as needed to hit your target volume.

Programming Straight Sets

In straight sets, the tension and volume stimuli are being presented, but because the sets are taken to 5 RIR or less, all of the other stimuli are presented as well, though the tension and volume stimuli are probably the most contributory to gains here. Because they primarily target tension-based volume accumulation, straight sets have their place as the cornerstone of most hypertrophy training programs and can be used for weight gain, maintenance, and fat loss training. An average program will often be composed of roughly between ⅔ to ¾ (counting by total working sets done) straight sets, with the other training methods making up the rest.

Straight sets can be done in almost all cases, but should probably *not* be done after significant metabolite accumulation, for at least two reasons. First, straight sets, thanks to longer rest times, may actually lead to a reduction in metabolite accumulation by "washing out" previously accumulated metabolites. Secondly, the massive fatigue created by metabolite training techniques will reduce the tension and or per-set volume of straight sets done afterwards by a large margin, which highly reduces the efficiency of training. It's probably best in most programs to do straight sets first, and then do metabolite work afterwards.

Rest Between Straight Sets: Subjective Measures

Rest between sets functions to prepare muscles to undergo stimulative training again. The following are the factors limiting the effectiveness of subsequent sets:

1. Target muscle recovery
2. Synergist muscle recovery
3. Nervous system recovery
4. Cardiorespiratory system recovery

Constraint number one is the most straightforward. If the local muscle has not recovered enough to do a meaningful amount of work, the next set will be less productive. "A meaningful amount of work" means that the muscle can do at least five reps. (As discussed earlier, the last five reps before failure are the most effective, so if the set has less than five total reps, the hypertrophy stimulus is likely lower than it could be). In most cases, 10-20 seconds is enough time for local fatigue to dissipate and allow another set of at least five reps. However, we rarely rest that short a time between sets because local fatigue is not the only limiting factor.

The second constraint on rest times is the recovery of non-target, but synergistic muscles for the given exercise. If these haven't recovered sufficiently, they cannot support execution of the movement to best stimulate the target muscles. For example, if your quads are ready to do another set of squats, this hardly matters if your lower back musculature is not. If you start another set of squats in such a state, your lower back might round and limit your reps. Even if this happens after five reps, robust growth is not guaranteed because the five reps have to be the five last reps your *quads* can do, not the last five your lower back can muster. Before doing another set of an exercise, you have to make sure that synergist muscles are recovered enough that your target muscles can be the limiting factor.

The third factor dictating rest times is nervous system fatigue, which is accumulated by the brain, spinal cord, and peripheral nerves, and includes unconscious neural and psychological drive[64]. A lack of unconscious neural drive can feel like a limited ability to produce force in your muscles. You *want* to push hard with your quads, but there seems like a broken connection between your desire and your quads' cooperation. Psychological fatigue manifests as a lack of motivation to do another hard set. We've all been there, and you should probably feel this for at least a few seconds after each set if you are training hard enough. It takes between several seconds and several minutes for this type of fatigue to dissipate after your last set—longer for bigger stronger muscles. You might need four minutes between sets of deficit deadlifts, but only 15 seconds between sets of cable triceps pushdowns.

The fourth and final constraint on rest times is cardiorespiratory system recovery. After a hard set, breathing is often elevated[70]. If you start another working set before your breathing returns to mostly normal, you can expect degraded performance[71,72]. You don't want to be limited "by your lungs" and not your target muscles. Your cardiorespiratory system is no longer the limiting factor when your breathing returns roughly to normal and the time required for this will vary person to person.

In real life training, you can go through this checklist very easily between sets to see if you're recovered enough to go again. Below is an example checklist using chest training.

1. Are my pecs still burning from the last set?
2. Are my front delts and triceps ready to support my chest in another set?
3. Do I feel mentally and physically like I can push hard with my chest again?
4. Is my breathing more or less back to normal?

If you can answer on the affirmative end of the recovery spectrum for each of the above questions, then you're probably ready for another productive set!

You'll notice that we refer to a "recovery spectrum." This means that recovery between sets in a given workout is *not absolute*. There's no need for complete recovery in order to do another set—and in fact this might not be possible with hard, productive training as some fatigue accumulation in the target and non-target muscles, the central nervous system, and the cardiovascular system is expected.

Rest Between Straight Sets: Practical Guidelines

It might only take a minute to go from 50% to 90% recovered after an average set, but another two minutes to go from 90% to 95% and another 10 minutes to go from 95% to 99%! If we look at it from an efficiency perspective, doing ten "90% effective sets" in 30 minutes time is vastly more efficient than doing just a couple "99% effective sets" in the same timeframe. Because per-set hypertrophy is such a powerful modulator of growth, ten "good sets" will cause vastly more growth than two "almost perfect sets."

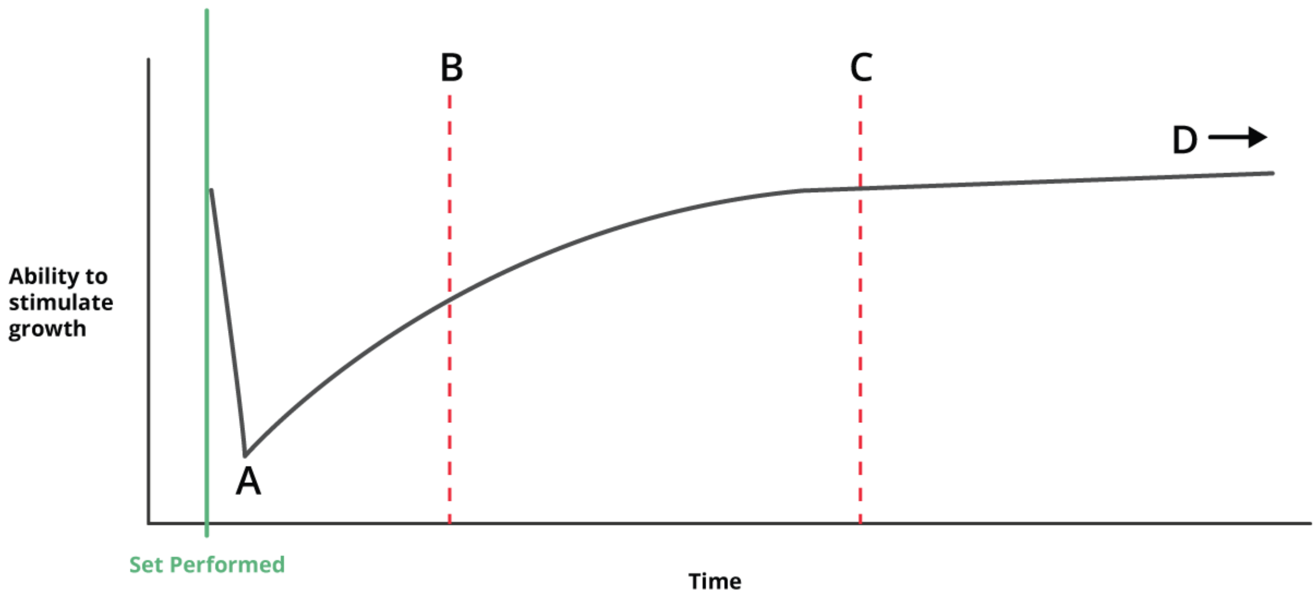

Figure 2.8: Post-Set Recovery Time Course

After a working set, ability to stimulate growth drops drastically (A) and returns to around 90% after a minute or so of rest (B). After another several minutes, ability to stimulate returns to around 95% (C). Recovering past this is time consuming for very little increase in ability to stimulate (D).

You can always rest longer and recover more between sets (short of resting so long that you cool down). But unless you have unlimited time on your hands and unlimited patience, it's almost certainly not worth chasing that dragon (Figure 2.8).

Most straight sets will have rest times of between 30 seconds and about four minutes. Thirty seconds for smaller, weaker muscles in smaller, weaker lifters with good cardiovascular fitness and up to four minutes in larger, stronger muscles in larger, stronger lifters with poorer cardiovascular fitness. Where your specific sets fall in rest times will depend only on when you can answer the four rest time constraint questions to give yourself the all-clear for another productive set.

Keeping rest times consistent is also important for tracking performance. If you take longer and longer rests times across a mesocycle, you may fool yourself into thinking performance is stable, when it would actually be getting worse with matched conditions (same rest times).

Down Sets

Down sets are straight sets done with an intentionally lighter load, after having done straight sets with a heavier load until productive training with that load could not continue. There's a lot of mystery in that definition, so let's clear some things up. First, the exact parameters of your down sets will depend on the sets that preceded them and therefore on the training program you have developed based on your needs analysis.

For example, let's say that you have five sets of bent-rows to do and you are targeting the 10-20 rep range. Your first three sets are 17,13, and 10 reps. For the next sets, you have two rules: one, you need to do two more sets. Two, you need to make sure that reps are still within the 10-20 range for those two sets. You're almost certainly too fatigued to another set with the same load and stay within that rep range (given that the last set saw reps at the bottom of that range), so you have to lower the load. How much you lower it will depend on how fatigued you get set to set, and a few other individual factors, but because the range is so large, there is plenty of room for error. You can either do one bigger drop to put both the 4th and 5th set into the 10-20 range at the same weight, or do two smaller drops, one for the 4th and then one for the 5th set, respectively. Either choice will be effective for hypertrophy. Another option is to have two different rep range targets. For example, doing six sets of bent rows, with the first three sets targeting the 5-10 rep range the second three targeting the 10-20 rep range is a fine option.

If you design your training around loading ranges and not rep ranges, it's completely fine to never do down sets. The one caveat to this is that if sets dip below five reps, the efficiency of the hypertrophy stimulus drops, and at that point, you're probably pushing the load too far ahead of the volume for best results and might need to consider adding down sets. In other words, make sure you're never cutting into the number of 5-0 RIR "effective reps" in any of your working sets.

While switching to another exercise instead of doing down sets is an option to continue stimulating the same target muscles, the benefit of down sets is that you are already warmed up for the given exercises and can save that time and energy for hypertrophy efforts.

Giant Sets

"Giant sets" (sometimes referred to as "marathon sets") refer to a series of sets done to reach a total rep goal, using a constant load and without regard to the number of reps per set or total sets. For example, you might choose the 20lb dumbbells for lateral raises, and set a goal of 50 reps. Then, with every set but the last being stopped at between 5-0 RIR, you do as many sets as it takes to sum up a total of 50 reps.

Giant sets have a few advantages in some situations. They make reaching your volume goals straightforward but more flexible, which comes in particularly handy when you have forced rest time inconsistencies—for example, if you often find yourself working in with others and waiting for equipment between sets. With giant sets this will not pose a problem since completing the requisite total reps is the goal and reps per set and rest times are less a focus.

Giant sets are also useful for training beginners. Beginners usually have trouble making accurate estimates of RIR and respond very well above 5 RIR anyway. Since you can end each set when form breaks down rather than according to proximity to failure assessment, lifts to be done with great form and adequate volume—just make sure total reps add up to your target. This also affords them more time practicing technique.

Giant sets can also provide an opportunity to focus on working muscle awareness. For example, you might feel your rhomboids, your teres major, your biceps, and even your forearms, but have trouble feeling your lats, the target muscle, in lat pulldowns. This will be easier to focus on when not assessing RIR. Giant sets free your mind up to focus on just working muscle awareness and rep counting (or just working muscle awareness if you have a lifting buddy to count for you).

Finally, giant sets are an option when you have little control over load progression. For example, if you do lateral raises with the 15 pounds and the next set of dumbbells are 20 pounds and then 25 pounds and so on—these are big jumps for this lift. If you tried to progress directly from 15 to 20 pounds, your reps per set will fall off by massive margins. Instead, you can do this giant set style by adding total reps over many sets each week while keeping the weight the same until you are ready to move up to the next option.

The big downside to giant sets is that it's very difficult to compare performance from week to week, which, as we'll see in the next chapter, is critical in assessing recovery. Whenever giant sets are programmed, very close attention should be paid to the other, non-giant set training approaches for that same muscle group.

Supersets

Supersets involve doing two sets of different exercises back to back without rest in between. There are two main types of supersets: non-overlapping and pre-exhaust.

Non-Overlapping Supersets

Non-overlapping supersets involve doing a straight set with an exercise for a given muscle followed immediately by a straight set with an exercise that targets that muscle's antagonist or an unrelated muscle. For example, doing a set of leg presses for the quads and then immediately doing a set of stiff-legged deadlifts for the hams. Alternatively, doing a set of lunges followed by a set of biceps curls. In both instances, different muscle groups are worked with each set and time is saved by not taking a break between the two sets.

Because they are so efficient, non-overlapping supersets are ideal for individuals with training time constraints[75,76]. Despite the back-to-back nature of these lifts, performance in the second set is generally still quite high[76–78]. Because the target muscles in these sets are non-overlapping, the cross-contamination of local fatigue is very low. In the case of using antagonist muscles, the antagonists limit force production of agonist movements to some extent, so when they fatigue, performance might *actually go up* in their counterparts. For example, if you tire out your lats before doing incline presses, they pull down on your upper arms less during inclines and thus your incline performance might actually improve. This is true up until systemic fatigue accumulates enough to inhibit performance. Because non-overlapping supersets can create quite a bit of systemic fatigue however, and have you switching between opposing movements, they are not conducive to the best working muscle awareness and are for that reason not the best idea if you are not time constrained. In addition, for bigger and stronger lifters, the systemic fatigue of back to back sets on compound movements can prove excessive and interfere with target muscle stimulation.

If you have limited time to train, non-overlapping supersets can be a huge benefit, especially if they are done with lots of compound lifts (rows supersetted to bench presses, for example).

Pre-Exhaust Supersets

In the pre-exhaust superset method, sets target overlapping muscle groups purposefully. You perform an *isolation movement* for a target muscle first (pre-exhausting it), and then, with minimal rest, perform a *compound* movement that involves that same muscle group. For example, you could do triceps pushdowns, and right after, perform push-ups with a close grip. The purpose of this method is to pre-fatigue the target muscle with the isolation movement so that it becomes the limiting factor in the compound movement. To put it another way, this method allows the target muscle to accumulate more “effective reps” in that second movement as it will be closer to failure from the pre-exhausting movement.

Sometimes a compound movement is limited by the early fatigue of a synergist muscle that is not the target muscle for that exercise. For example, if you have easily fatigable front delts or chest, you may never get a chance to feel your triceps much in close grip pressing because the chest and front delts fail far before the triceps are fully stimulated. But if you pre-exhaust the triceps with an isolation set, they can become the limiting factor in the close grip pressing and can be effectively stimulated with that compound movement.

This method also allows the target muscle to accumulate more metabolites than it would with just with the isolation movement alone. By bringing in other muscles to assist the pre-exhausted muscle during the compound movement, the target muscle is able to get more stimulus than if you just did straight sets, and metabolite accumulation gets that much more of a boost. For example, if you'd normally have about five reps of "near failure" metabolite-accumulating training per set of triceps pushdowns, you can add another five reps to that if you superset them with close-grip pushups. And because the triceps are so close to failure when you switch to pushups, the total rep number will be quite low and thus the majority of the reps for the pushups will be in the "effective reps" range for the triceps. The target muscle also gets a bigger pump than it would with just the isolation movement alone. The added volume of work and metabolite accumulation causes an impressive degree of cell swelling in the target muscle, and interestingly, because a normal rest is taken between the compound movement and the next superset start, blood has lots of time to perfuse the muscle, making this type of superset one of the best ways to maximize the pump and thus growth from cell swelling. Further, the burning and pumped pre-exhausted muscle is easier to feel during the compound movement, thus improving mind-muscle connection.

The rep range on the first (isolation) set of a pre-exhaust superset should be whatever pre-fatigues the local muscle without much systemic cost, while also summating a lot of metabolites. Usually, the 10-20 rep range is well suited for this. The loading for the second (compound) exercise in the superset should be light enough to allow for at least five reps to be completed, and preferably between 5 and 10 reps, as that allows more metabolite summation but limits the systemic fatigue accumulation of an excessive amount of lead-in reps.

On the second half (the compound set) of a pre-exhaust superset, systemic and synergist fatigue quickly climbs, but cannot catch up to local fatigue in the target muscle because that muscle *began the set nearly maximally fatigued*! After the compound set is over, rest time should check the usual straight set recovery boxes.

The downside of pre-exhaust supersets is that they fatigue the target muscle considerably, making them inappropriate for use at the beginning of a training session in many cases. Pre-exhaust supersets are best done in the 2-3 RIR or lower range for largest growth effects, as this maximizes the pre-fatiguing effects in the first exercise and the time of metabolite generation and failure proximity in the second. This type of superset can be used fairly regularly if needed, but is best saved for muscles that have been tough to target. Pre-exhaust supersets, in effect, are a way to train a muscle that's usually not responsive to compound training because it's not the limiting factor, by making it a limiting factor. And because it's two sets in one, this strategy is a great way to put high volumes into muscles that tend to have higher MEVs and MRVs, such as the side or rear delts, for example.

Myoreps

Myoreps are a variation on the older concept of rest-pause sets. In myoreps, the first set is typically in the 10-20 rep range, 0-2 RIR. Rest times are limited to just a few breaths between sets and subsequent sets should be around 5-10 reps with 0-2 RIR. You continue this pattern until you have completed all planned sets.

The purpose of these short rest periods is to maximize the ratio of "effective reps" to the total number of reps performed over all of the sets. This only has the desired effect if the limiting factor in each set is the fatigue of the target musculature (rather than any synergistic muscle or systemic factors). For example, cable biceps curls don't generate a lot of central fatigue, they don't generate a lot of cardiorespiratory fatigue, and they essentially have no real limiting synergists. Thus, when you're ready to do another set of 5-10 reps in the cable biceps curl, there is a very good chance that this next set will be limited mostly or exclusively by the biceps fatigue itself, which is exactly what we want. Doing 10-20 reps of squats or deadlifts, in contrast, might produce so much cardiorespiratory fatigue that your lungs take longer to recover than the target muscles. You might start your next set and get 5-10 reps, but have been limited by your breathing rather than your quads, rendering the subsequent set pretty useless for hypertrophy.

As a general rule, then, compound, large-muscle-mass exercises in which the lifter has to support himself against gravity produce a lot of central, cardiorespiratory, and synergist fatigue relative to local fatigue, and thus are poor choices for myoreps. On the other hand, isolation exercises, especially those without major synergists, are very good choices for myoreps.

The advantage of myoreps is twofold. First, they can create a high ratio of stimulus to fatigue in the faster fibers of the target muscle, because they allow for a much higher ratio of “effective reps” vs. “lead-in reps.” The second advantage is that such training usually leads to metabolite accumulation and a good pump. Sounds too good to be true! A method of training that can train the faster fibers, generate metabolites, and a decent pump—what an efficient way to push all the main growth stimulators at once. Indeed, it is, but while myoreps are efficient and effective, they do have some downsides.

Because they demand slightly more failure proximity on average than straight sets, myoreps are also painful and psychologically difficult to push through making them quite fatiguing, especially cumulatively over the weeks. The pain problem also has the potential to reduce working muscle awareness, which straight sets and high rep, short rest sets probably facilitate better. Secondly, myoreps don’t allow much volume to be accumulated outside of the 5-0 RIR spectrum. Although pre-5 RIR reps are not the most growth-promoting, they still have some effect and limiting them might prevent maximum growth for some of the slower fibers. Slower fibers do in fact grow (just not as much as faster fibers), so a program should not train *only* faster fibers and thus should not consist of only myoreps. Third, myoreps might not be quite as effective in promoting per-set growth as regular working sets. Though the intention is to target the faster fibers specifically, faster fibers are much more likely to be limited in their ability to generate force in high metabolite situations, which is exactly what myoreps end up creating. Because of this force deficit, slower fibers contribute a bit more to the total reps per set than you would originally predict, but the number of reps is so low, they get a bit shorted on the amount of volume they are exposed to. Thus, it's likely that while myoreps save a lot of training time, they are probably just a bit less growth promoting per-set than straight sets, which both let the faster fibers produce more force by letting them refresh between sets and give the slower fibers more work. Metabolite accumulation might make up for the difference somewhat, but a small deficit likely remains. Lastly, myoreps are simply incompatible with many of the most growth-promoting compound exercises, for which conventionally long rest times need to be taken so that the local musculature targeted is the limiting factor.

Myoreps are a useful tool, but are not magic, and need to be programmed in the context of their greater fatigue contribution. They should be using sparingly (probably once per session at most) and toward the end of any individual sessions after straight sets have been completed and should also generally be limited to isolation movements.

Drop Sets

Drop sets involve doing sets to 3 RIR or less, resting just long enough for the burn to fade, then reducing the weight before each subsequent set. Technically speaking, drop sets are essentially combinations of myoreps and down sets, so pretty much all of the rules for both apply. A good practice for drop sets is to set a minimum rep number for all sets and to drop the weight enough to stay just above that number. Your first set, as with myoreps, should be between 10 and 20 reps. After the first set, you rest just long enough for the burn to go away and then drop the weight so that you can get between 5 and 10 reps in that next set, repeating this for a chosen number of sets. If the reps ever drop below 5, the weight needs to come down further than planned in the next set, and if the reps come above 10 (for any but the first set), no drop is needed. In order to maximize growth, it's probably best to never to drop below 20% of your normal 1RM for the lift on the bottom end of your drop sets[7].

Drop sets do very much what myoreps do, but they probably target the slower fibers a bit more. This is because drop sets use a bit less time for recovery between each set but sacrifice load to do so. Because faster fibers recover more slowly and experience much bigger force production deficits under metabolite accumulation, they will experience less stimulus from drop sets. In addition, they are also more sensitive to tension than slower fibers, and tension decreases across drop sets. The best place for drop sets is at the ends of workouts when a good combination of pump and metabolite accumulation is desired, but a shorter rest than possible with myoreps is preferred. Please note that drop sets have all of the same limitations as myoreps and should not make up the majority of training volumes. Likewise, drop sets should be limited to mainly isolation movements.

Occlusion Training

Occlusion training is an interesting way to make the target muscle in an exercise more of a limiting factor. In occlusion training, this aim is achieved by occluding blood flow to the target muscle and thus preventing metabolites from escaping into the bloodstream as quickly—leading to better metabolite accumulation[79,80]. To do this, you can tie bands just below your knees for example, and do calf raises. This allows both high levels of metabolite summation in your calves and for the ability to recruit faster fibers with much lighter loads and lower volumes than normal[80]. This happens because the occlusion process causes so much local fatigue that faster fibers must contribute to the movement sooner[81–84]. It also allows for incredibly short rest times between sets—because the systemic disruption is so small, multiple sets can be done in rapid succession before systemic fatigue becomes limiting. In occlusion training, you essentially perform myoreps with an occluded muscle.

Though some advantages to this type of training are too speculative to mention, the one clear advantage is that occlusion training can give robust growth effects from *very* light weights taken close to failure, which means that loads as little as 20% 1RM can be used[80,82,84–87]. This makes occlusion training perfect for maintaining muscle when recovering from injury or in the depths of a contest diet. Secondly, it can be a great way to reduce rest times between sets and keep systemic fatigue accumulation low. However, because of the low total loads and especially because faster fibers so greatly fatigue from high metabolite exposures, occlusion sets are unlikely to result in as much growth as possible in the fastest fibers. Occlusion training is also limited to those muscles that can be effectively occluded—you cannot do much to stop blood flow to your back or abdominal muscles for example. When doing occlusion training, please follow all of the caveats for drop sets and myoreps, such as using this tool minimally and saving it for later in the training session.

	Myoreps	Drop Sets	Pre-Exhaust Supersets	Occlusion Sets
Method	Rest a bit between sets such that the muscle is the limiting factor and 5+ reps can be done	Rest a bit between sets until muscle is limiting factor and reduce load so that 5+ reps can be done	Pre-fatigue the target muscle using an isolation then continue to stimulate the muscle with a compound	Occlude bloodflow so that less load is required to stimulate max metabolites and pump
Rest Times	5 - 30s	2 - 5s	2 - 5s (1-3 minutes between each pairing)	5 - 30s
Load	10 - 20RM	10-20RM on first set, 20-30RM on last	10-20 sets on the isolation, 5-10 sets on the compound	20-30RM
Best Uses	Training smaller muscle groups in a time-efficient manner	Training smaller muscle groups very rapidly, with a more slower-twitch bias than myoreps	Targeting hard-to-isolate muscles by making them the limiting factors in compound moves	Using loads lighter than the normal stimulus range, especially when injured

Table 2.1: Summary of Advanced Metabolite Stimulus Modalities

The goal of metabolite training modalities is to maximize the number of effective reps and stimulate maximum metabolites and pump.

Summary

Though all of the above discussed training modalities can seem quite disparate, they share an identical primary goal. That being to impose tension, metabolites, and a pump on the target muscle and make the target muscle itself the limiting factor in rep performance. While low rep straight sets might target tension more, high rep straight sets might target the pump more, and short-rest sets like myoreps and drop sets might target metabolite summation more. *All* modalities target all three of the primary growth pathways to some extent, but some emphasize one more than another. You don't *need* to use all or even most of these options in your training. If you're well prepared for heavy training and have the time, straight sets are a great tool. If you're short on time and your joints and connective tissues are at the end of their ropes with heavy training, the other modalities can be great options, or a mix of modalities can be used to create an individualized training program that addresses weaknesses and limitations. Rotating through the modalities you haven't used in a while on occasion can also promote growth through novelty, which is something we'll explore in more depth in a later chapter.

Detecting and Comparing Stimuli

You don't need to assess every stimulus in your training for efficacy. If you choose a weight between 30% and 85% of your 1RM, it meets the criteria to stimulate growth without your feeling for the degree of heaviness during the lift[7,13]. Other variables are a bit tougher to sort out, especially when comparing different exercises, tempos, and training methods to one another. Without measuring long-term changes in muscle size or getting direct molecular signaling data (which would be cool, but is for now very impractical), how can we tell if one stimulus is better than another? While we can't discriminate stimulus magnitudes with 100% accuracy, we *can* qualitatively assess aspects of our experience that indicate effective stimuli.

Mind-Muscle Connection

An effective hypertrophy stimulus involves a good mind-muscle connection as defined in this chapter to include the perception of tension or the burn of metabolites accumulating. Effective stimuli feel a bit different depending on the rep range and therefore the load of the lift. For the heavier end of the hypertrophy stimulus range (5-10 reps), a good mind-muscle connection will often be perceived as a profound tension felt deep within the muscle, making the lifter acutely aware of the strain of the lift and the strength of the target muscle. On the other end of the load spectrum, in the 20-30 rep range, because of lighter loads, it can be hard to sense a lot of tension. In this range, better evidence of a good mind-muscle connection is the degree of burn in the target muscle as the set progresses. If you're targeting glutes with hip thrusts and the last several reps scorch your glutes front to back and side to side, it's safe to say that you've got a very good mind-muscle connection and are effectively stimulating them. But if you're doing rows for high reps and only your forearms get a burn, you probably are not providing a great stimulus for back hypertrophy. The 10-20 rep range should feel somewhere between the lightest and heaviest ranges. In this range, you'll feel a good deal of tension through the target muscle and expect some localized burn as well. The mind-muscle connection involves not just the feeling of the muscle working, but the feeling of the muscle *working close to its limits*.

The Pump

The more of a pump you get, the greater likelihood a robust stimulus was presented. As with mind-muscle connection, the location of the pump response tells you whether you are stimulating the target muscle. If you get a crazy pump from chest supported rows and a very underwhelming one from dumbbell rows, chest supported rows are likely stimulating more muscle growth.

Like any qualitative metric, pump assessment has its limitations. Heavier (5-10 rep) sets can be every bit as stimulative of growth as lighter ones, but they generally don't cause as big of pumps and this varies person to person. Faster-twitch folks tend to report larger pumps with sets of 5-10 reps, and actually quite underwhelming pumps with higher rep sets. In any case, although pump should not be used alone to assess stimulus, in combination with the other metrics, described here, it is useful information.

Muscle Disruption

When we say "muscle disruption", we are referring not only to delayed onset muscle soreness (DOMS), but also to any perception of local fatigue, perturbation, or soreness in the target muscles at any time after the training session (including immediately after). Local fatigue is evidenced by decrements in target muscle performance. For example, if you trained your pecs with a load and volume you thought was "hard," but then you hit a dumbbell flye PR right after, you may not have trained them as hard as you thought. If you do a very stimulative chest workout you would expect a decrease in performance for lifts that use the same muscles (like dumbbell flyes) right after. It Is worth mentioning that local fatigue can also be detected toward the end of a set, not just after multiple sets. If during a working set, your target muscle feels like it is losing the ability to generate high-force contractions, that is a very good sign of an effective stimulus. If you do a whole set and never feel your muscles getting tired or slowing down, it is likely you too far from failure for best stimulus. The term "perturbation" here means that something about a muscle's stretching and contraction feels off, it feels weak, or motor coordination is off—like the struggle of walking smoothly downstairs after high volume quad training, for example, or trying to print neatly with a pen after a biceps workout. Soreness can commence between sets of a session, right after, or with a delay (DOMS), but muscle soreness doesn't necessarily mean growth and soreness is not mandatory for growth—though it does confirm that you stimulated the target muscle.

None of these measures are by themselves guarantee of a robust stimulus. Nor is missing any one of them a guarantee that no good stimulus was provided. You can feel nothing special in your quads and have them grow for years just by getting stronger for volume. You can get big hamstrings without ever feeling much of a pump, and you can get lots of local fatigue and perturbation from doing distance running, but that will hardly get you bigger. The biggest utility of these measures comes from their combination into a single index for a movement, one that we term the Raw Stimulus Magnitude.

Raw Stimulus Magnitude (RSM)

The RSM is the amount of muscle growth stimulus any given training generates, and it is very well proxied by some combination of mind-muscle connection, pump, and disruption. If training gives you a massive mind-muscle connection and sensations of large effort, a big pump, and a large degree of disruption, all in the target muscle, you are very likely to be imposing a very effective stimulus. At this point, you have the "training hard enough" part covered and other factors (such as how often you impose this stimulus, your diet, your genetics, and your recovery) will be most determinative of your results.

Quantifying RSM

The Mind-Muscle Connection

The combination of intense tension perception and metabolite burn in the target muscle lets us know we're targeting the intended muscles successfully in training. It's important to note that for this metric (and most of the others), it can take time to develop the mind-muscle connection and sometimes movements that start out better get outpaced by movements that were initially a bit more awkward. Before you abandon any exercise give it a fair shot with at least a mesocycle of consistent training during which you try to modify the technique to generate the best mind-muscle connection possible. You can rank mind-muscle connection as follows:

On a scale of 0-3 how much did the training challenge your target muscles?

0: You felt barely aware of your target muscles during the exercise
1: You felt like your target muscles worked, but mildly
2: You felt a good amount of tension and or burn in the target muscles
3: You felt tension and burn close to the limit in your target muscles

The Pump

The more cell swelling caused per set of any exercise, technique, or program setup, the more likely growth is. You can rank pump as follows:

On a scale of 0-3 how much pump did you experience in the target muscles?

0: You got no pump at all in the target muscles
1: You got a very mild pump in the target muscles
2: You got a decent pump in the target muscles
3: You got close to maximal pump in the target muscles

Muscle Disruption

The more training disrupts your target muscles with minimal volume, the more stimulative of growth it is. You can rank disruption as follows:

On a scale of 0-3 how much did the training disrupt your target muscles?

0: You got no pump at all in the target muscles
1: You got a very mild pump in the target muscles
2: You got a decent pump in the target muscles
3: You got close to maximal pump in the target muscles

By adding these scores together, you can assign a numerical value to any training stimulus and make relative comparisons. Importantly, the RSM is always and everywhere a per-user index. Someone else might have a low RSM for the very same exercise or training parameter you have a high RSM for, which is why Individualization is its own training principle and gets its own chapter later on as well! Below are five of the most common ways the RSM can be used to inform training practices.

Calibrating Volume

Comparing the RSMs of different volumes of training can help you calibrate the amount of training needed for best gains. For example, if you do two sets of an exercise in a session, you might find that your mind-muscle connection and sensations of effort were better in the second set than in the first, making it possible that it would have been still better in the third set. Maybe you didn't get much of a pump, and you hardly felt any fatigue, perturbation, or soreness after the session. The next time you come into the gym, you do three sets of the same exercise, and you get much more of a stimulus along each parameter.

It is worth mentioning that while RSM use can ensure your stimulus is at least within the effective stimulus range, it might not detect if too much stimulus is being presented, so we'll have to use other measures to make sure we do not exceed effective training volume. We will discuss these in-depth in the fatigue management chapter.

Comparing Exercises

If you equate set volume, you can use RSM scores to determine which exercise choices are more effective for you. A lower RSM score doesn't mean you stop using those exercises entirely, but all else being equal, you should use your most stimulative exercises more often. Mind you, we can't conclude what the "best" exercise is because we don't yet know how relatively fatiguing each exercise is, a factor that will greatly influence program design. This is why this measure is termed "raw" stimulus magnitude and not just "stimulus magnitude." We will explore relative fatigue and its use in exercise choice and program design in the next chapter.

Comparing Tempos

You can use RSM to compare the different execution parameters of exercises. For example, you can try slow eccentric leg extensions for a few sessions and see how they score on your RSM index compared to regular speed leg extensions.

Comparing Rep Ranges

For individual muscle groups and even individual exercises or tempos, some repetition ranges will be more stimulative than others, and you can use the RSM index to figure out which. This doesn't mean that once you figure out that your quads get the best stimulus in the 5-10 range, you do only that range and no others, but it might mean that you do a bit more of your weekly quad volume in the 5-10 range and a bit less in the 10-20 and 20-30 range. Again, our discussion on fatigue generation in the next chapter will help us narrow some of these factors down further.

Comparing Training Methods

For different muscles and exercises, some training methods might be more stimulative than others. You might find that cable triceps extensions have a higher RSM if you use supersets compared to straight sets. You might also find that supersets of squats (with anything else) have lower RSMs than doing straight sets, and you can use this insight to write your program.

Further, within-training assessments provide an opportunity to improve the training stimulus at a range of timescales. After just one rep, you can potentially adjust your technique based on a lower than expected perception of tension in the target muscle. After just one set, you can alter your technique to increase the end-set burn in the target muscle for the next set. After several sets, you can evaluate the pump and introduce changes to enhance it if necessary. After the session, you can gauge the degree of perturbation by assessing the decline in target muscle strength and any changes in your perception of its mobility and movement sensation. Lastly, a day or two after the session, you can infer stimulus from the degree of soreness developed. At every timescale, assessment of RSM can allow you to make your training better.

If that all sounds complicated, just remember this. Train in such a way that causes robust mind-muscle connection, gives you good pumps, and beats your muscles up to the recommended extent. If your training fails to check most of those boxes, doing more training, using different exercises, tempos, or training methods is probably a good idea for best growth. Now, we just have to make sure the training we're doing *continues to cause* muscle growth beyond a single session.

The Progression Component of Overload

You will recall from the beginning of the chapter that the principle of Overload dictates that training must be both challenging enough to reach a threshold that will cause adaptation and must become progressively more challenging over time to support continued adaptation. Now that we have addressed the first component of overload, **acute overload** (the threshold component), it's time to address **progressive overload**. The quintessential element of progression is the need for *more* stimulus over time. Progression makes sure that we stay within an effective stimulus range as we adapt and improve, and our stimulus threshold gets higher. It also allows us to move from MEV to MRV in order to maximize the weeks of stimulative training we can do before needing to deload and drop fatigue.

First, we will go over theoretical progression of the cellular level stimulators of hypertrophy: tension, metabolites, and cell swelling—your training modality progressions should be designed to best elicit these variables across weeks of training.

Training for Tension Progression

Tension progression, or "giving the system more and more exposure to tension" can mean changes in load (which directly add tension), or changes in volume (which add time applying tension even if load remains the same).

Just adding sets is a fine way to progress, but if that were the only progression we used, we would run some problems: First, if our original program were well designed and addressed all of the pertinent loading ranges from 30% to 85%, as we got stronger, our old 30% 1RMs would turn into 25% and keep falling, which would start to reduce the effectiveness of our training. Secondly, the greatest loads would fall as well, so what used to be our 80% 1RMs became our 75% and wouldn't target our larger fibers as well. If you let this process go on for a comically absurd amount of time, you would eventually see all of your loads drop to below 30% 1RM and no longer get much growth stimulus from any volume. Lastly, if we didn't at least add reps, we'd fall further and further away from the 5-0 RIR range more and more as strength and endurance improved over time. Thus, we have to add at least reps in the short term (weeks) and load in the medium term (months) to progress at best rates.

So long as your reps stay within their target ranges, you can progress via reps and sets every week for as long as that lasts. Once maintaining your 5-0 RIR pushes your reps above the target range, you can increase the weight to push them back down. Or you can just purposefully progress in load slowly and keep reps about the same, at which point staying within your rep ranges becomes essentially automatic, making program design easier.

Tension progression requires some load progression, especially in the longer term. To keep loads heavy enough to give us exposure to the full tension spectrum of hypertrophy, we probably have to increase them at least every month or so, but can conveniently do it every week or so in most cases. Thus, we have our first real-world progression tip: add some weight to the bar just about every week.

Since our sensitivity to volume also adapts—and in many cases much faster than our rep strength, load alone might not be enough to supply all of the needed tension progression over the course of a mesocycle. If you start your program at 10 sets per muscle group per week, you might get a good minimal, just-above-MEV starting stimulus. But if 10 sets really is around your MEV, a few weeks of 10 sets per week will leave you with below MEV stimulus and no further gains. The solution is not to increase load more than usual, because this will throw off loading ranges. 85% loads will become 90% loads, and 30% loads will become 35% loads, leaving gaps in our training. In fact, to provide as much stimulus as is needed to move through the volume stimulus range, we might have to double our loads, which of course throws our training into some combination of hilarious and impossible.

Because volume adaptation occurs faster than strength increases (in the short term), most individuals can benefit from *both* load and set progressions week to week. You'd start a training plan at around your MEV, and then, as recovery dictated, add sets until you hit your MRV. At the same time, you would add load in small increments, progressing on two variables at the same time. We'll discuss exactly how to add sets in the next section on progression recommendations for each type of training method.

Training for Metabolite and Cell Swelling Progression

First, since volume is one of the main training factors in the production of metabolites and cell swelling, just progressing in volume will facilitate some progression in these stimulators. We can further this progression with relative effort, another facilitator of metabolites and cell swelling. Thus, by progressing through volume and RIR across weeks we can accumulate more and more metabolites and cell swelling as well. You could you just maintain around 2 RIR across your mesocycle, but then you'd miss out on the benefits of occasionally pushing closer to failure. As with any simulator of hypertrophy starting on the lower end and finishing on the higher end of the effective range will get us the most growth, so going from 4 or 5 RIR all the way to 1 or 0 RIR progressively is usually the most effective approach.

There are at least two practical benefits that arise from prioritizing this descending RIR method. First of all, you incrementally tax your faster fibers as the mesocycle progresses, without taxing them too heavily too soon. This allows for good growth and also allows you to train for longer—since your faster fibers recover more slowly. Starting your mesocycle around 4 or 5 RIR also gives your slower and intermediate fibers more time exposed to stimulus. RIR progression is also fairly easy to achieve if you are progressing in volume and tension. Because fatigue sums up over the course of your mesocycle progression, it becomes more and more difficult to match your repetitions at a heavier load or to increase them with the same load. You end up having to push each set harder to reach your load or rep progression goals, and your RIRs will automatically fall as the mesocycle unfolds.

A. Leg Press in Week 1

Sets	Load	Reps	RIR
3	315	15,12,10	3

B. Options for Leg Press Stimulus Progression in Week 2

Variable Changed	Sets	Load	Reps	RIR
Load	3	**335**	15,12,10	2
Reps	3	315	**17,14,12**	2
Load + Reps	3	**325**	**16,13,11**	2
Load + Sets	**4**	**335**	15,12,10,8	2
Reps + Sets	**4**	315	**17,14,12,10**	2
All 3	**4**	**325**	**16,13,11,9**	2

Figure 2.9: Example Stimulus Progression Options

Example sets, load, reps, and RIR for leg press in week 1 of training (A). There are many options for stimulus progression from week 1 to week 2; increased load, reps, sets, or a combination of these (B). So long as volume and RIR progress appropriately the program will provide progressive overload irrespective of which variable(s) are increased.

This doesn't mean that there is one perfect way of setting up progressions. Extreme deviations from load, set, or RIR progressions are probably suboptimal, but there is a lot of room for individual variation within those ranges. Fundamentally, effective overload progression requires you stay within effective stimulus ranges for tension, relative effort, and volume. As long as you do this, there is a spectrum of progression options, and any of these will be very effective (Figure 2.9). In the following section, each example of load, rep, and set progression is just one of many ways in which to progress through a hypertrophy mesocycle.

Practical Application of Progressive Overload

Now that we have theory all sorted out, let's take a look at the practical application of progressive overload using each of our training methods over the course of a typical hypertrophy mesocycle.

Straight Set Progression

As discussed, progressing across some combination of load, sets, reps, and proximity to failure, with a focus on volume is probably best. That being said there are still quite a few options within that description for straight set progression.

Load Progression

One simple and effective option for load progression is just to increase as much as needed to stay within target RIRs, while keeping your reps similar. For example, if you plan four weeks of progression, you might target 4,3,2,1 RIR across weeks one, two, three, and four of your progression respectively. To keep reps similar, but get closer to failure each week, adding weight weekly might be needed. How much weight that ends up being depends on how fast you are gaining fitness and fatigue. If you are a genetically gifted beginner, you might be gaining strength and not accumulating much fatigue, so you might be able to add more weight every week. On the other hand, if you're a less genetically gifted, advanced lifter, you might accumulate fatigue much faster than strength and only able to add minimal weight every week or even every other week.

The benefit of the load progression strategy is that it can be autoregulated—if you thought you could only get away with adding 5lb on the leg press, but the first set was much higher than target RIR for your rep range you might add another 5lb to subsequent sets. Alternatively, you could keep the initial weight but go up by 10lb on leg press the following week. Or you could leave both the same, but be a bit more aggressive in weight addition for other exercises that target the same muscle group that session or that week.

A very important recommendation is to almost always err on the lighter side of load progression. If you under-add weight, you can almost always make up for it by making other exercises heavier or progressing faster in later weeks. But if you over-add weight, you might accumulate so much fatigue that you have to cut your progression short or take a series of unplanned recovery sessions, limiting your total gains for the mesocycle.

Rep Progression

If you choose to progress in reps rather than load, you will still be guided by the RIR roadmap—without load additions, adding reps will likely be needed to progress in proximity to failure across weeks. For rep progression, it's important to always keep your rep range targets in the back of your mind. For example, if you set your rep range as 10-20, and by week three you're doing 20 reps in your first set, you should probably consider adding weight in the fourth week, to prevent leaving your target rep range that week.

Rep progressions are also very useful when available weight increments are too large. For example, let's say you're lateral raising 15lb dumbbells with a 10-20 rep target range. If you average around 13 reps per set in week one and the next dumbbells up are 20lb, increasing weight in week two will almost definitely push you below 10 reps (and out of your target range). Instead of making such a large weight jump, you can increase reps with the 15lb dumbbells, maybe averaging 15 reps per set in week two and 17 in week three and so on. Once you break the 20 rep ceiling, you can go up to the 20lb dumbbells and will probably be able to get an average of around 10 reps with that weight by then. It might take several mesocycles to go from the 15s to the 20s, but it's load progress over time with the constraint of rep ranges, so it checks all the boxes of progression.

While rep progression and load progression are often interchangeable, sometimes one has distinct net benefits over the other. Especially for well-trained lifters in the lower rep ranges. When weight is extremely heavy, adding reps across an accumulation can be a larger feat than adding a very small fraction of weight to the bar—another full range of motion rep with extremely heavy weight can be much more taxing than adding say, 2.5lb to the given reps. Rep progressing from five to 10 reps for example also rather drastically changes the very nature of the stimulus, as the ratio of faster fiber to total fiber contribution is much higher for a set of five than it is for a set of 10. For sets in the higher rep ranges, load and rep additions are, within a wide margin, likely to be more equivalently effective methods for progression.

Set Progression

Sets are probably the best proxy for volume, and this is where MEV and MRV come into play. Starting your training at MEV will allow for effective training across a longer progression, but in order to start there, we must know how to find MEV. The following is a handy method for estimating MEV:

The “RP MEV Stimulus Estimator Algorithm”:

Do a number of sets you think is close to your MEV, erring on the lower side, then evaluate by assessing metrics for mind-muscle connection, pump, and disruption:

a. **On a scale of 0-3 how much did the session challenge your target muscles?**

   0: You felt barely aware of your target muscles during the exercise
   1: You felt like your target muscles worked, but mildly
   2: You felt a good amount of tension and or burn in the target muscles
   3: You felt tension and burn close to the limit in your target muscles

b. **On a scale of 0-3 how much pump did you experience in the target muscles?**

   0: You got no pump at all in the target muscles
   1: You got a very mild pump in the target muscles
   2: You got a decent pump in the target muscles
   3: You got close to maximal pump in the target muscles

c. **On a scale of 0-3 how much did the session disrupt your target muscles?**

   0: You had no fatigue, perturbation, or soreness in the target muscles
   1: You had some weakness and stiffness after the session in the target muscles, but recovered by the next day
   2: You had some weakness and stiffness in the target muscles after the session- and had some soreness the following day
   3: You got much weaker and felt perturbation in the target muscles right after the session and also had soreness for a few days or more

Add up the scores for each metric to total between 0 - 9.

TOTAL SCORE:	0 - 1	2 - 3	4 - 6	7 - 9
PROXIMITY TO MEV	Stimulus likely below MEV	Stimulus likely at or below MEV	Stimulus likely at or just above MEV (a great place to start your mesocycle)	Stimulus likely between MAV and MRV, possibly exceeding MRV
RECOMMENDATION	Increase volume the following week by two to four sets		Progress normally (see next section)	Drop volume the following week (see next section)

Table 2.2: RP MEV Stimulus Estimator Algorithm

As you can see, a score of 4-6 means that you're probably at or just above your MEV and so in a good place to start a mesocycle. Outside of this, the recommendations in the table can help you course correct for a productive mesocycle.

Once you get through your first week at MEV, you can look back on it and decide how to progress in sets using the RP "Set Progression Algorithm."

The "RP Set Progression Algorithm":

a. **On a scale of 0-3 how sore did you get in the target muscles?**

0: You did not get at all sore in the target muscles
1: You got stiff for a few hours after training and had mild soreness in the target muscles that resolved by next session targeting the same muscles
2: You got DOMS in the target muscles that resolved just in time for the next session targeting the same muscles
3: You got DOMS in the target muscles that remained for the next session targeting the same muscles

b. **On a scale of 0-3 how was your performance?**

0: You hit your target reps, but either had to do 2 more reps than planned to hit target RIR or you hit your target reps at 2 or more reps before target RIR

1: You hit your target reps, but either had to do 0-1 more reps than planned to hit target RIR or you hit your target reps at 1 rep before target RIR

2: You hit your target reps after your target RIR

3: You could not match last week's reps at any RIR

Note that in the above description, "target reps" refer to the goal reps for that week. If you are progressing via weight and you curled 60lb for 10,8,6 reps last week, your goal this week at 65lb should be 10,8,6 again. If you are progressing on reps the target reps might be 11,9,7 with 60lb.

Also note, these apply to the average of all sets in an exercise, so if you had a few amazing sets and a few very tough sets, for example, you would average those results when choosing your score.

For week one of a mesocycle score performance as 1-2.

Note that no matter how little soreness you are experiencing, if you score a 2 or higher on (lack of) performance you should not add sets and if you score a 3, you should employ recovery strategies (to be discussed in the fatigue management chapter).

		Performance Score ↓			
		0	1	2	3
Soreness Sore →	0	Add 1 - 3 sets	Add 0 - 2 sets	Do not add sets	Employ recovery sessions (see Fatigue Management Chapter)
	1	Add 1 - 2 sets	Add 0 - 1 sets	Do not add sets	Employ recovery sessions (see Fatigue Management Chapter)
	2	Do not add sets	Do not add sets	Do not add sets	Employ recovery sessions (see Fatigue Management Chapter)
	3	Do not add sets	Do not add sets	Do not add sets	Employ recovery sessions (see Fatigue Management Chapter)

Table 2.3: RP Set Progression Algorithm

If this all sounds overly complicated, you can just think of it like this:

- If you are recovering ahead of schedule, add sets
- If you are recovering from soreness just on time or even a bit late but still meeting performance targets, don't add sets
- If you're under-recovering and failing to meet performance targets, you need to employ fatigue management strategies (covered in the next chapter)

So, in order to achieve progressive overload across straight set training, you find your MEV (using our MEV estimator), then start from MEV and add sets in proportion to your recovery (using our progression algorithm). Because your body adapts faster to volume than to weight increases in most cases, you'll usually find that you can add quite a few sets over the course of your mesocycles even if you cannot increase weight weekly. As with load, because of the way cumulative fatigue is summed, it's almost always better to low-ball the volume at the beginning of the program rather than get too ambitious too soon. You can always add more sets, but reducing excessive fatigue means stopping or heavily modifying the program, which highly interferes with results.

Relative Effort Progression

You can progress through RIR as described earlier (working from 4-5 RIR in the first week up to 0-1 RIR in your last). If you undershoot your load progression, your volume progression will have to be sped up to keep RIR progression in check. If you progress too little in volume, you will hold less fatigue and be able to progress more in load and or reps. The good news is that if you simply honestly target load/rep progressions and honestly rate volume progressions, then both occur at the needed rates to follow your RIR, and there is no ambiguity.

Problems can arise if you attempt to purposefully increase loads too aggressively and thus increase volumes too little. Because the magnitude of loading (with close proximity to failure) is not very impactful on muscle growth, but the degree of volume is, rushing to lift more weight or more reps by keeping set volumes low will not yield the best muscle growth results. You will end up hitting great performances at the end of your mesocycle, but you will have gained less muscle. Try to hit the same RIRs as last week or one RIR lower, be as honest as you can, and using the Set Progression Algorithm will allow you to allot the needed volume.

Down Sets Progression

Down set progression operates very much like straight set progression, since down sets are just lighter straight sets. The more complex part of down set progression is deciding when to add down sets versus straight sets or both. You should have planned percentages of training dedicated to specific loading ranges or rep ranges (the latter being an easy proxy for the former). Specifically, your plan should call for some percentage of your volume being dedicated to the 5-10 rep range, the 10-20 rep range, and the 20-30 rep range. We will cover the details of how to arrive at the percentages you will use for any given program later, but for now let's just assume it's 33% for each category as an example. If you are adding sets to a program as the weeks go by and you're sticking to a certain RIR target per week, it's very likely that your added sets will be, on average, of lower repetitions than the sets you were doing in the week before. For example, if your leg press work has a target rep range of 10-20 and in week two you get 16,14,12, and 10 reps, an added fifth set in week three will likely be under 10 reps. To maintain your rep range target then, in week three your fifth, added set, needs to be a drop set so that at least 10 reps can be completed.

If your program prescribes loading ranges instead, you can just add sets to each loading condition. For example, if your program calls for equivalent sets in the 70%-85% range and the 55%-70% range, and you did four sets in each range last week, you can add one set to each loading range.

Pretty straightforward if your program starts with equivalent numbers of sets in different loading ranges. You just add sets to each range to keep the balance. If you have three loading ranges (let's say, a 20-30, 10-20, and 5-10 rep range) and 9 sets (3 each) total when the program starts, you'd progress until the program ended with something like 18 sets (6 in each range). However, there are at least two more advanced ways of progressing sets and down sets that we'd like to mention.

The first advanced progression scheme progresses across some rep ranges or loading ranges while keeping others constant. For example, if you want to develop your intermediate and slower twitch fibers more (or perhaps focus on metabolite and muscle pump-mediated adaptations) for a mesocycle, you might keep your 5-10 rep range work at maintenance volume and not progress there. If your program starts with eight total sets, two of them in the 5-10 range and the other six split between the 10-20 and 20-30 ranges, you might only add sets to the 10-20 and 20-30 rep ranges maintaining just two sets of 5-10 reps. In this way adaptations to 5-10 rep ranges are maintained while progressive overload is applied to the other rep ranges in order to produce adaptation.

The second advanced progression scheme adds sets to rep ranges in an autoregulated manner. What drives these autoregulated choices are the degree of perceived stimulus and the degree of fatigue generated. For example, let's say that a session has two exercises for the quads: a high bar squat and a hack squat. We start week one with three sets of each, and, as usual, gauge how fatiguing and how stimulative it was. Maybe squats felt pretty tough, the technique was a bit shaky, and your mind-muscle connection was fairly low. On the other hand, maybe hack squats felt super crisp and generated a big pump for what felt like very little effort. When adding two sets to this session next week, you might be better served adding both to the hack squat. First, by adding sets to the exercise that seems to have the better ratio of stimulus (detected via the pump and crispness of technique in the hack squats) to fatigue (perceived via ease of effort in the hack squats), the added sets will likely yield more growth for less cost. Second, leaving squats at the same set number prevents the accumulation of more exercise-specific fatigue. The following week we may start to feel better in the squat, making that exercise a candidate for set addition later on. In fact, this is what often ends up happening; adding so many sets to one exercise and not the other creates too much exercise specific fatigue for the higher volume movement. Weeks later into our original example we might be doing three sets of squats and six sets of hack squats, find that squats are feeling crisp, technical, and high in mind-muscle connection, while hack squats feel stale, under-stimulative, and fatiguing. In that case, we might add sets to squats for a bit until the balance is restored and additions to the hack squat resume. In very simple terms, this advanced method basically adds sets to exercises that seem the most effective and least fatiguing in order to maximize results.

This method can be used across rep and loading ranges too. If heavy work is just not feeling great but light work is moving along, adding more sets to the light work and fewer to the heavy might not be a terrible idea. This might mean that some weeks you add more straight sets, and some you add more downs sets and so on. In any case, try to remain as objective as possible when autoregulating your progression. You might not *want* to add sets to the 5-10 rep range but if it is more stimulative, you have to add the sets where they are most effective. In much the same way, you might hate bent rows, but, stimulus-wise, they love you, which means you need to bite the bullet and add them in, perhaps at the expense of the cable rows you'd rather add because they are easier and less stressful.

Giant Set Progression

Giant set progression is an interesting topic because, unlike the performance-based progressions listed so far, you can keep pushing giant sets to absurdly high total rep numbers. When you aren't tracking RIR and comparing it to expected values, it's very tough to determine whether or not to progress—the risk is that you'll just keep adding reps and cranking up the volume well beyond your ability to recover. This is precisely why giant-set-only programs are probably a bad idea. Another problem with giant sets is underdosing (you're choosing to start with a certain number of total reps, so how do you know if it's the right number?).

To manage giant set progression, you have to find a way to track. We suggest first tracking your performance and perception of effort on other sets (especially straight sets) for the same muscle group. If your performance is down on the straight sets, don't add any reps to the giant sets targeting that same muscle group. If performance is good and perceived work is low on the other hand, adding reps is probably a good idea. Secondly, try to track effort and pump developed from giant sets. Manage this in the same way as previously described—add reps if you are on the lower end of effort and pump and refrain if the giant sets feel like a huge effort and are giving you a crazy pump. Finally, when adding reps, add in proportions needed to achieve a good, but manageable pump and a high, but not crippling perception of effort.

The number of reps you start with and add will depend on different factors. If you're doing an exercise you haven't done in a while, starting very low (perhaps 20 total reps for lunges, for example) might be the best idea. Your muscles might adapt very quickly to the novelty of the movement, and you could be adding 10-20 reps every week for several weeks. For a movement you're quite used to, on the other hand, starting with higher reps but adding 5 reps per week or even every other week might be the most you can benefit from.

After training for some years, you'll start to get a good feel of the total range of reps you benefit from in a given exercise done in giant sets. For example, you know that within the context of a normal shoulder program, perhaps 60 total lateral raises at 20lb is about all you can handle, and that anything shy of 40 total reps just doesn't move the pump, soreness, or effort perception needle. Thus, you might start at 40 total reps in week one, and progress with 60 reps in mind as goal, perhaps ending up with 55-65 reps on the last week depending on how fitness and fatigue inform your autoregulation.

We'll just leave you with one last bit of practical advice on the use of giant sets; it's very easy to bite off more than your recovery abilities can chew, so we recommend starting very low in total reps and moving up slowly until you have a feel for your high and low volume ends.

Superset Progression

Pre-exhaust supersets

It doesn't matter whether you add load to the isolation movement, the compound movement, or both, *so long as both sets* are within the target rep range and target proximity to failure. Target rep ranges are a bit tougher to nail down, both because of pre-fatigue on the isolation movement and because of the position of the superset later in the workout. Both of these factors can reduce reps at 30% 1RM considerably.

Thus, as a general rule, pushing reps on either the isolation or the compound movement past 20 or so can often mean that load is too low.

What probably works well is to start with weights of 30% 1RM at lowest on each movement and then progressing from there. Generally speaking, the isolation should be between 10-30 reps (or 10-20 reps if the movement is performed with already-fatigued muscles), and the compound set after should be 5-20 reps. That 20 rep top cap on compounds is very much a super high-end figure, because if you truly pre-exhausted the target muscle with an isolation movement and didn't spend more than a few seconds in transition between the two movements, you probably *shouldn't be able to* do 20 reps on the compound movement. If compound reps are on the higher end of the 10-20 range, consider going closer to failure on the isolation exercise, resting less between the isolation and compound movements, increasing load on the compound, or some combination of all three.

And as long as your reps are between 10-30 for the isolation and 5-20 for the compound, increasing weights to keep your reps stable within those ranges is likely an effective load progression for supersets. Volume progressions should follow the same logic and pattern as for all other training methods; if it's too little stimulation, add sets, if it's plenty, don't.

Non-overlapping Supersets

Because target muscles do not overlap, progression on non-overlapping supersets can be treated like straight set progressions.

Myorep Progression

Because myoreps have a distinct RIR goal for each set, performance tracking can inform progression. In other words, if your last week's reps matched this week with a higher RIR (less effort) than expected, more volume is probably in order. If you struggled to match your reps from last week with the same RIR, holding off on adding volume is probably best. Because psychological and precise timing factors can introduce some variability to the number of reps performed in each "mini set" of a myorep set, taking the average of the reps over the whole set and using that to compare week to week performance might be preferred. For example, if in week one your myoreps were 17,7,5 reps, respectively and week two myoreps are 16,7,6 reps, although there are minor rep differences, the average is identical across weeks.

If you are new to myorep training, starting with two myorep sets can be a very good idea. You can autoregulate progression from there, as mentioned, starting low is a better choice than starting high if best hypertrophy is your goal. Once you have gained experience performing myoreps, you'll get a good feel for the number of sets you need to start with.

Drop Set Progression

Drop set progression is almost identical to myorep progression, since drop sets really are just myoreps and down sets combined, but there are two things to keep in mind with drop sets. First, count your reps! You can't just do reps on reps to "burn in the details", you need to track performance week to week in order to make informed progression decisions and continue progress. Second, track load—there is the temptation to just drop the load by arbitrary amounts, but drops should be planned for, executed, and replicated each week. This is true for any metabolite technique because the physiology adapts very quickly. If you don't track, your drop sets could become less and less effective.

Occlusion Training Progression

In most cases, treating occlusion training like you'd treat the progression for straight sets is best. When using this method to return to training after injury, a giant-set approach to progression is probably safer—while less effective under normal conditions, this method preferable for transitioning from injury. In this case, giant set progressions can be used until low RIRs are well tolerated again upon which starting straight set progression is recommended.

Sample Progression

Below is an example progression in sets, reps, weight, and RIR. Please note that this is just one example of an effective progression and many other variations within the progression parameters discussed thus far would be equally effective.

	Week 1				Week 2			Week 3			Week 4			Deload			
Monday	Sets	First Set Rep Range	Weight	Total Reps	Sets	Weight	Total Reps	Sets	Weight	Total Reps	Sets	Weight	Total Reps	Sets	Rep Range	Weight	Total Reps
Weighted Dips	Giant	5 - 10	25	20	Giant	25	25	Giant	25	30	Giant	25	35	Giant	2 - 5	0	10
Wednesday	Sets	First Set Rep Range	Weight	RIR	Sets	Weight	RIR	Sets	Weight	RIR	Sets	Weight	RIR	Sets	Rep Range	Weight	RIR
JM Presses	3	10 - 20	125	3	4	130	2	4	135	1	5	140	0	2	5 - 10	125	5+
Wednesday	Sets	First Set Rep Range	Weight	RIR	Sets	Weight	RIR	Sets	Weight	RIR	Sets	Weight	RIR	Sets	Rep Range	Weight	RIR
Skull Crushers Superset to Close Grip Bench	3	10 - 20 / 5 - 10	90	3	4	95	2	4	100	1	5	105	0	2	5 - 10	45	5+
Saturday	Sets	First Set Rep Range	Weight	RIR	Sets	Weight	RIR	Sets	Weight	RIR	Sets	Weight	RIR	Sets	Rep Range	Weight	RIR
Cable Pushdown Drop Set	2	20 - 30	80	3	3	80	2	4	85	1	5	85	0	2	15 - 10	40	5+

Table 2.4: Sample progression

Under-Application of Overload

Excessively short rest between sets

The best path to hypertrophy is to make sure that the local musculature is being challenged sufficiently. In other words, 5 RIR or less. Now, that's 5 RIR *at the local level*, not just five reps from psychological, cardiovascular, or synergist muscle failure or five reps from "I don't want to do this anymore". Distance from failure should refer to how close the *target muscle* is to failure. Not resting long enough can make it more likely that you stop the next set due to being out of breath. This limits exposure of the target muscle to its best growth stimulus. Use the information in this chapter to determine rest times and make sure the target muscle is the limiting factor.

In some cases, systemic factors will still be limiting with *any* amount of rest time. If you are in very poor cardio shape this can prevent you from completing high reps that would make the target muscle the limiting factor. A large degree of CNS fatigue from other life stressors, such as work, or relationships can also impose limits that reduce the stimulus you are able to apply to the target muscle[88]. In these cases, resolving such issues is your first priority. This can be done either by taking the time to improve your cardiorespiratory abilities, making a point to reduce stress in your life, and by modifying exercises in the meantime—choosing less systemically fatiguing options or more directly targeting movements.

Junk Volume

In hypertrophy training, junk volume has a simple definition: training volume that adds fatigue but does not contribute to muscle growth. Junk volume not only takes resources away from effective training, it uses resources for recovery alone instead of growth and recovery. This waste of resources should be avoided—unless you like doing stuff that makes you tired but doesn't get you any more muscular. Junk volume usually comes from volume without sufficient Specificity, tension, or relative effort.

Insufficient Specificity can fail to provide Overload if a target muscle is being used, but not in a way that best elicits growth. For example, doing push-up plank holds for hypertrophy of your chest. The isometric-only contraction of your chest is going to be very fatiguing to those muscles, but not cause nearly optimal hypertrophy. The less your training is specific to muscle growth, the less muscle growth your program will be able to generate.

Insufficient tension can occur when weights significantly lower than 30% 1RM are being lifted. Even if taken to muscular failure, such weights produce minimal stimulus for the first 30, 40, or 50+ reps. Such high rep sets also produce a great deal of fatigue, taking resources and limiting muscle unit activation. The most common presentation of this source of junk volume occurs in very long sessions, where your 30RM in curls, for example, could have presented enough tension for optimal growth when you were fresh, but 20 sets of back and biceps training later, your "fatigued 30RM" weight is actually your 50RM and way too low to cause the most robust growth. At that point, you're just spinning your wheels instead of training, and are better off cutting the session short and coming back later that day or moving curls to another session to properly apply adequate tension in a more rested state.

Lastly, insufficient relative effort is a possible source of junk volume. With heavier weights, enough tension is produced in every rep to present a robust growth stimulus no matter how far from failure you are. With lighter weight and higher reps, getting close to failure makes a large difference in growth stimulus. If you don't push to 5 RIR or less on higher rep sets, you're leaving lots of growth in the tank.

In summary, if your training isn't specific to muscle growth, is not heavy enough, or is not coming close to local muscular failure, it's not going to be optimal. If you ever need a reminder of the theoretical downside of junk volume, imagine using the act of walking 10 miles per day to grow your legs. Long walks supply high volume training to your leg muscles, but this training is not specific to hypertrophy, sufficiently heavy, or remotely close to failure—but it does generate quite a bit of fatigue. You wouldn't try to walk for muscle growth, so it pays to be mindful of less extreme but nonetheless notable forms of junk volume training.

Overvaluing the mind-muscle connection

The mind-muscle connection is an effective tool for generating more growth from a given set, but it does not compare to the more important training variables. More volume, more load, or going closer to failure, will all produce much more growth stimulus. The prototypical folly in overvaluing the mind-muscle connection is illustrated by the statement "I don't count reps or weight; I just go by feel and make sure the muscles are working." Making sure the muscles are working is all well and good, but if you aren't keeping track of load, volume, and relative effort your growth will be limited.

Ignoring exercise order

The most common real-life example of this mistake is the failure to train prioritized muscle groups earlier in a session. Vast numbers of bodybuilders crave better rear-delt development, but huge fractions of those same bodybuilders have shoulder sessions that begin with presses, transition to side lateral raises, and end with rear delt work. How can you expect to grow your rear delts best if you always give them the short end of the stick?

If only local muscular fatigue rose across a session, later sets would generate bigger pumps, more metabolites and more growth, but central fatigue rises across a training session as well. This means that beyond a certain point (probably around eight sets or so) the ability to push any of your muscles begins to decline. Because central fatigue affects all muscles in the body, this is especially problematic for combining the training of multiple muscles in one session and speaks to the need for careful program design with respect to exercise order. For example, if you're training quads before training your chest, let's say with eight sets for each muscle group in a single session, you are nearly assured of getting a great quad stimulus. After eight grueling sets of quads, your chest is fine, but your central ability to train anything else, your chest included, is severely reduced. In order to prevent this problem from occurring in your program, go through your needs analysis, and place the prioritized muscle training toward the beginning of sessions. If you want to develop your muscles relatively equally for the time being, you can rotate their order across your training days.

Mistaking preference for stimulus

Compound, large muscle movements are often effective and efficient at building muscle, but also just plain difficult and tempting to skip. If you do include them, you might preferentially add volume to lifts you like doing better, even if they are not as stimulative. Now, you should very much want to add more sets to the exercises that feel like they are the least taxing in order to keep fatigue controlled, but that has to be weighed against the perceived stimulus magnitude of the exercise as well. If you know that you get a bigger pump from barbell rows than you get from cable rows, you must focus on adding a decent fraction of your volume to the barbell rows (even if you'd rather do most of your workout sitting down on a rowing bench, comforted by the smooth gliding of cables).

Directly insufficient stimulus

If you underdose tension, volume, or failure proximity significantly, it will directly impact your gains. Let's take a look at some common examples of each.

Underdosing tension is usually done by those who prefer the drudgery of reps to the oppression of heavy weight. If all of your working sets are always between 30% 1RM and 70% 1RM, that's all in the effective stimulus range, but skipping 70% 1RM to 85% 1RM loads means you are missing out on a fraction of growth, specifically for your most growth-prone muscle fibers. Short of injury or risk management in special situations, most lifters aiming for best growth should train heavy, light, and everything in between within the effective stimulus range.

Underdosing volume is incredibly common. (You might expect this sentiment from the authors that coined the volume landmark terms, but it's nonetheless true!) As has been borne out by numerous recent studies, many people train with considerably less volume than they could benefit from, often by as much as a factor of three[89–92]. Stock programs or DIY programs that have 5-15 working sets per muscle group per week is fine for many, but for others, such volumes may be at the very bottom of their stimulus ranges, leading them to miss out on a great deal of growth. Once-per-week-per-muscle group training also often leads to underdosing volume. Especially for smaller lifters who recover more easily. Even a once-weekly 20 set workout for a muscle group might be only half of someone's weekly MRV. Because adding any sets to that single workout is likely catabolic (due to the excessive damage caused by high single session volumes), the only effective way to add volume in such cases would be to increase frequency (add another weekly session), a practice that the dogma of "one muscle group per week" training often prohibits[57,93–95].

There are a few classic experiments which illustrate the problem of underdosing relative effort. In one study, beginner lifters were under-estimating their reps from failure by 10 or more reps—they could push through 10 or more reps when encouraged by someone else compared to guessing their own failure proximity[96]. That means they may have done 10 reps when they could have done 20+, leaving them pretty far away from their effective 0-5 RIR zone. Even though beginners can get more growth further from failure than more advanced lifters, that is still a lot of lost effective training. Luckily, the research does show that the more experienced lifters rate RIR much better on average[97]. It is nonetheless something to be aware of and assess, especially on high rep sets or metabolite techniques where the pain makes you want to stop long before failure. For those of you who coach, make sure you help your clients understand what proximity to failure feels like and learn to push themselves sufficiently. In the next chapter, we'll look at the opposite problem of going too close to failure too often.

Limiting ROM

By doing partial ROM moves, you might be able to hit some motor units harder because the partials emphasize some muscle units that the full ROM versions of an exercise don't. Although this might be the case, choosing 2-3 biomechanically different exercises for the same muscle group probably does that about as well as you need.

A big problem with using partials is lack of safety. When you can control a weight in its full ROM, you are prepared to handle it during all parts of the lift. With partial ROMs, the weights are often so heavy that controlling them within even a slightly bigger than planned ROM is not guaranteed. For example, if you are used to lowering the incline bench to three inches above your chest and you accidentally drop one inch further during the later reps of the set, that can mean instant failure and movement of the barbell through a ROM that you don't have the connective tissue buildup to withstand. This can spell a much higher chance of injury. Doing partial ROMs is not only potentially injurious, but it's also a big problem for tracking performance and so for presenting progressive overload. Slight changes in ROM (due to the difficulty in limiting ROM precisely) with every rep, set, and week of training, can prevent you from telling if you're getting stronger over time.

If flexibility is limiting your ROM, there are some things you can do that will help the situation in both the short and long-term: First of all, you can improve your ROM by improving your technique. For example, to increase ROM on the squat you can adjust foot angle, stance width, push your knees over your toes more, arch your back harder, or make other technical changes that might improve your safe range of motion. Practicing these over weeks and months and figuring out which combination of changes results in the most ROM and the most utilization of the target muscle can make the movement more effective. Secondly, you can get to the end of your current ROM and pause there for a second or so on most sets. Pushing the ROM like this while maintaining good technique will slowly improve flexibility over time (though weight may need to be decreased to add this pause). The great news is that ROM expansion is also likely to actually make your muscle bellies a bit longer by promoting sarcomere growth in series, so you have every reason to give expanding your ROM a shot if it's lacking[98,99].

Over-Application of Overload

There can be too much of a good thing—excessive stimulus can impede optimal hypertrophy via a number of mechanisms, the primary one being the accumulation of excessive fatigue. We will explore fatigue deeply in the next chapter, but for now we will present other mistakes related to over-applying Overload.

Heavier-Is-Better Thinking

We have already discussed how training in *excess* of 85% 1RM on a consistent basis is not optimal for muscle growth, but a related problem is doing most of your training close to that upper 85% end. While you are still *within* the 30%-85% 1RM effective stimulus range, constantly biasing training toward the heavy end is not optimal.

Per repetition heavier training does provide a better hypertrophy stimulus on an absolute scale[7]. However, when training within effective stimulus ranges for load and volume, so long as the RIR is equated, heavier training is theoretically no more beneficial than lighter training. In fact, there are distinct benefits to each part of the effective stimulus range. No muscles are purely fast or slow twitch, so even the faster twitch dominant muscles need *some* lighter work. Thus, "as heavy as possible at all times" training doesn't make sense for best growth. Another problem is that chronically heavy training takes a toll on joints and increases injury risk over time[65].

Heavier is better is an overapplication of tension overload, but often leads to the underapplication of ROM as well. Some have proposed that restricted ROM increases the forces being produced, but the problem with this logic is that limiting joint angles might simply let you load more external weight on the bar and not actually produce much larger forces within your muscles. If you can half-squat 150kg but only full-squat 100kg, the sticking point of both movements probably sees about the same intra-muscular forces, thus giving no major hypertrophy advantage to the half squats but increasing risk. It's tempting to go heavier for ego-related reasons, but it won't be the most productive way to gain muscle over the long-term.

Over-Prioritizing Specific Aspects of Progression

You can only add so much of each stimulus week to week because recovery ability limits weekly progression. You might be able to add 5lb, 1 rep, and 1 set to an exercise each week; or 2.5lb, 2 reps, and 1 set; or 0lb, 2 reps, and 2 sets, etc. Each progression variable comes at the expense of the others. So, shouldn't we just progress using the stimulus that has the greatest effect on muscle growth? The problem with this is that adding sets every week without adding reps or weight would eventually mean that the first few sets of a session would fall short of 0-5 RIR (as you became capable of more reps, but were not adding them in order to add sets). For example, if you start with one set of 10 at 3 RIR and next week add only another set of 10 at the same weight, that first set might now be 4 RIR because you've had a week to adapt to it. The second set might still be 3 RIR, but next week, the first set might be 5 RIR or higher. If you train like this for 4-6 weeks, many of your sets will simply be below the RIR hypertrophy range and growth will necessarily suffer. Even progressing on both sets *and* reps without progressing on load is a problem. Imagine you add reps each week as well as sets to keep RIR in the 5-0 range while increasing sets. That's a fine fix, but then over time, you won't be able to stay within the full spectrum of loading ranges because your weights will be too light as you gain fitness.

Over-prioritizing load progression is also detrimental. If you add too much weight to the bar each week you might not recover enough to add reps or sets if you want to. Giving up the ability to add sets (and thus get best results) is a great way to get stronger, but it's not the best way to promote hypertrophy. This strategy needlessly cuts total volume in favor of heavier weights, where the former is much more impactful on growth in the mesocycle timeframe[13,100].

Adding a combination of sets, weight, and (if/when needed) reps is the most effective option, and thus the superior choice if hypertrophy really is your number one goal.

"Beyond Failure" Training

In the technical sense, training beyond failure usually means beyond concentric failure. In other words, when you cannot lift the weight through the concentric portion your spotter assists you, but usually lets you do the eccentric alone for a few reps. Such training is often taken to eccentric failure, which is an inability to control even the eccentric contraction. If you wanted the most stimulus possible out of a single set, going all the way to eccentric failure is definitely a great option, but this generates a massive amount of extra fatigue that can negatively impact both growth (by using up resources for recovery) and prevent progressive overload across a full mesocycle, making optimal gains impossible. The other problem with this kind of training is tracking. How many reps did you do if you went beyond failure? If you do 13 reps this week but you did 14 last week, did you experience a reduction in performance, or did your training partner simply help less this week? Not being able to track impedes your ability to progress logically even if fatigue were not a factor.

Since the fundamental concept of going beyond failure is to do more work, why not just do another one or two sets instead of being assisted beyond failure once? Doing two sets beyond failure will stimulate more growth than doing two sets to 0 RIR. But three to four sets to 0 RIR will likely surpass the growth stimulus from two sets beyond failure. It solves the tracking problems, it's safer, and it fatigues you less. It even offers a higher mind-muscle connection, since that almost always falls off when you go beyond failure.

People with limited time in the gym might consider going beyond failure, since fatigue accumulation is not a realistic concern for them, while efficiency is. Though even in these cases supersets and higher frequency training might be a better choice. Unfortunately, beyond-failure training in the real world is often used by those interested in max muscle growth and willing to spend hours in the gym, to their detriment.

You can certainly do beyond-failure training on occasion. On safe exercises that don't expose you to potential injury risk if you lose control of the eccentric, at the end of a mesocycle, or just for the joy of pushing yourself that hard now and then. In fact, it might be in some unique way more stimulative of a small amount of muscle growth in a way that simply adding more submaximal sets cannot be. But if it occurs regularly in your training, especially in any microcycles aside from right before a deload, it is probably holding you back from better gains.

CHAPTER 2

Summary

Training that is considered overloading must:

- Be sufficiently close to the body system's peak output to be stimulative of adaptations
- Must be increasingly challenging over time to remain stimulative of adaptations

For any given stimulus, very little stimulus results in very little growth. Then at somewhere around the stimulus threshold, increases in stimulus skyrocket growth. From there, more stimulus yields incrementally more growth, but growth increases per stimulus increase slow considerably. Finally, at some point, more stimulus causes *less* hypertrophy to occur and eventually results in muscle *loss*.

Stimulators of Hypertrophy

Fundamentally, the core cellular stimulators of hypertrophy are tension, metabolite accumulation, and cell swelling.

The following list includes both these cellular stimulators and the training stimuli that produce them in order of importance for growth.

1. Tension
2. Volume

3. Relative effort
4. Range of Motion (ROM)
5. Metabolite Accumulation
6. Cell Swelling
7. Mind-Muscle Connection
8. Movement Velocity
9. Muscle Damage

Effective Stimulus Ranges

Relative Effort

Although tension and volume are ranked above relative effort in their importance for muscle growth, the relative effort effective stimulus range sets the bounds for the range of tension and volume values that can be effective for hypertrophy. Recall that Overload requires the body system to be pushed to near its limits for best adaptation and relative effort is a measure of how close to these limits the lift takes you. The effective range for relative effort is 5-0 RIR.

Tension

Loads between 30% and 85% of 1RM produce the best tension ranges for growth.

Volume

Training between MEV and MRV is best for growth. In the average intermediate lifter this is between 2 and 12 sets per muscle group per session, and between 2 and 4 sessions a week. There is a great deal of individual variation and large differences between beginners and advanced lifters however and determining individual approximate MEV and MRVs will make training most productive. You can use the MEV Stimulus Estimator Algorithm to find your MEV.

Range of Motion (ROM)
Training should be done with the largest ROM that is safe and provides best stimulus to target muscle while keeping it the limiting factor in the exercise.

Metabolite Accumulation and Cell Swelling
Training that presents MEV-MRV volumes at RIRs of 5 or less sums enough metabolites and causes enough cell swelling for best growth.

Mind-Muscle Connection
A purposeful focus on the mind-muscle connection can yield small additional growth benefits.

Movement Velocity
As long as a movement is controlled and takes at maximum around nine seconds to complete, it will provide a hypertrophy stimulus (assuming other parameters are optimized for hypertrophy).

Muscle Damage
Though this variable might not cause growth, it is correlated with factors that do. If your program causes no detectable damage, it's probably too easy, and if it causes overlapping, debilitating soreness every week, it's probably too hard for best gains.

A very simple way to sum up the entire Overload principle's implications for hypertrophy stimuli is as follows: *"Do multiple sets of 5-30 controlled, full-ROM reps that take three to nine seconds per rep. Take them close to failure (5-0 RIR in most cases), where the target muscle is the limiting factor, and repeat this approach as often as you are recovered enough to do so."*

Applying Hypertrophy Stimuli

Training options to impose the above stimuli, include:

- Straight sets
- Down sets
- Controlled eccentrics and pauses
- Giant sets
- Myoreps
- Drop sets
- Supersets
- Occlusion training

Rest Between Sets

Another productive set can be completed once target muscles, synergist muscles, central nervous system, and cardiovascular systems have recovered sufficiently. For straight sets this is generally possible at between 30 seconds and four minutes. The following checklist should be applied to each rest interval between sets before beginning the next set:

1. Has the target muscle recovered to do at least 5 reps on the next set?
2. Have synergist muscles recovered enough to remove them as limiting factors to target muscle performance?
3. Has the nervous system recovered enough to remove it as a limiting factor to target muscle performance?
4. Has the cardiorespiratory system recovered enough to remove it as a limiting factor to target muscle performance?

Raw Stimulus Magnitude

The Raw Stimulus Magnitude (RSM) of any training input can be proxied by mind-muscle connection, pump, and disruption to the local muscle.

Progression

The goal of effective hypertrophy training is to progress across RIR over the weeks of an accumulation phase, from 5-4 RIR at the start to 1-0 RIR in the last week before deloading. In order to hit the target RIRs each week to stay on this track, you can adjust load and or reps. Add more load and or reps if your last week's RIRs were on the higher end, and less load and reps if they were on the lower end.

Start your session volumes at around your MEV (about 2-4 sets per session per muscle group in many cases) and add sets via the Set Progression Algorithm. This generally means adding 2+ sets per session per week if your soreness is low and performance is rising, adding 0-1 sets per session per week if your soreness is significant and your performance is stable, and considering a recovery session, half-week, or deload if your performance falls week to week.

The Overload principle is the second most important to your program's effect, after the Specificity principle. That is, once you're training your target muscles in a growth-promoting way, your number two job is to train *hard* along the described parameters in this chapter and keep pushing your limits across the mesocycle until deload. If you don't overload appropriately, none of the other training science will get you anywhere close to your best gains.

CHAPTER 2

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CHAPTER 3

Fatigue Management

So far in our discussion, we have assessed the two most important training principles: Specificity and Overload. These two principles alone will get you up to a few months of great training, but progress will end there if you do not begin to manage fatigue. The intended outcome of overload training is muscle growth, but the side effect of such disruptive training is fatigue, which at some point inhibits growth. Fatigue is the energy depletion, disruption, and wear and tear that accumulates across a training program until it is unproductively high.

The Principle of Fatigue Management: Progressive overload produces both adaptation and fatigue. In order to make continued progress in training, planned and autoregulated strategies for alleviating fatigue along various timescales are required.

You can minimize fatigue via non-training interventions—by sleeping and eating well—but the impact of these has limits. If you are training more than you can recover from under any conditions, growth will be compromised. Our "Recovering from Training" book covers training and non-training fatigue management strategies in detail, but this chapter will delve into the most important step in fatigue management—organizing training to prevent gains-killing levels of fatigue from accumulating[1].

For an analogy of fatigue management importance, imagine cooking delicious meals as akin to generating muscle growth. When a kitchen first opens, it is productive, the raw ingredients are plentiful, the counters, pans, and other tools are clean. At some point, “fatigue” starts to show. Pans and tools get dirty, some ingredients start to run out. You can still make decent food under such conditions, but it won’t be the best. Give the restaurant a few more days and no clean dishes or silverware will be left, nearly all food ingredient items will be gone or very low, and no more delicious meals can be made. Routine cleaning must be done to keep a kitchen clean and stocked and able to pump out delicious meals. Similarly, routine periods of fatigue alleviation must be used for any training program to continue to pump out good growth.

Strategies for preventing fatigue can include managing accumulating fatigue within the mesocycle by rotating muscle groups and exercises and taking recovery sessions and rest days—similar to having weekly orders and day to day clean-as-you-go policies in the kitchen. Every month or so you might deload your training for a whole week of “deep recovery” so that you can clean the slate for another few months of productive training—similarly, a kitchen might do a deep clean and inventory every month or so to make sure they keep up with maintenance for continued productivity.

The necessity of fatigue

Unfortunately, stimuli within the effective ranges for hypertrophy must be disruptive enough to cause adaptation and anything that disrupts enough to initiate change will almost always also induce fatigue. Fatigue is a necessary side effect of proper training and good growth will not come without it. The key is monitoring and managing fatigue so that you get your best training without pushing yourself into lack of progress or injury[2].

It is possible, and advisable in most cases, to maximize the ratio of stimulus to fatigue for any training. Good program design first seeks the most muscle growth with the least fatigue possible and then aims to bring inevitable accumulating fatigue down occasionally to allow continued progress.

Types of Fatigue

Fatigue includes physical disruption and the depletion of both physical and psychological resources; it can be caused by training or other aspects of life, but either way, it eventually interferes with muscle growth. There are several ways to classify fatigue.

Local fatigue

Local fatigue is indicated by disruption in the muscles and other structures that are directly used by the training in question and will not usually interfere much with the training of other muscles. For example, even if your biceps are very (locally) fatigued from many sets of curls, training your legs with squats right after will not likely be impacted.

While disruption in the target muscles indicates local fatigue, it is also a sign that effective training has taken place. Disruption refers to anything from mild weakness or a feeling of having perturbed the target muscle all the way to DOMS (delayed onset muscle soreness) peaking three days after training and lasting more than a week. Wherever on this spectrum you fall after training, an effective session will certainly leave you with *some* disruption. Just how much disruption is ok is an important question that this chapter should help you answer.

Connective tissue and joint disruption are other indicators of local fatigue, but are less directly indicative of effective training on their own. They include acute perturbation or pain in the joints and connective tissues that *occurs* during training, after the training session, or that accumulates over many sessions. Joint and connective tissues take much longer to heal than muscles, so keeping this disruption in check is very important[3]. If these tissues get too disrupted, you might have to lay off *all* training for a muscle group or even body part (for example, not just skip quads but all leg training if your knees are too beat up). This can result in a costly loss of productive training. Excessive joint and connective tissue disruption can lead to chronic degradation or inflammation (such as tendonitis) and may take months or years to mitigate[4].

Local fatigue also seems to reduce mind-muscle connection, specifically the kinesthetic perception aspect (the ability to acutely feel the targeted muscle). Degraded mind-muscle connection and local fatigue also impede smooth technique. You might notice that you are moving your elbows too far back when benching and need to remind yourself to correct that more often. Or your upright rows might start to look different from rep to rep—sometimes too high, or too low, or too close or too far from your body. This can take tension off of the targeted muscles and further reduce the mind-muscle connection and stimulative effect.

Systemic fatigue

Systemic fatigue impacts the whole body irrespective of where or how it was generated—it can manifest in the cardiovascular system, cognitive abilities, force production, coordination, and so on. Systemic fatigue is the summation of all physical and psychological stressors, so non-hypertrophy related exercise or non-exercise physical activity can contribute as well. This means that for example, fatigue from marathon training can impact *upper body* gains even though you mainly use your legs for running. Psychological stress also increases systemic fatigue and that can affect your rate of muscle growth. In fact, the symptoms of physically based systemic fatigue and psychologically based fatigue are often indistinguishable.

A lack of motivation and desire to train can indicate systemic fatigue is rising[5]. This of course occurs to some extent acutely, as getting tired within one session certainly reduces training desire and everyone has times when they don't want to train. But a lack of desire to train caused by systemic fatigue is a bit more insidious. If you are normally very dedicated and train whether or not you feel like it, but you suddenly lose interest and stop caring about training, fatigue management might be in order. Continued fatigue accumulation might result in feelings of helplessness, powerlessness, and general malaise—at this point, fatigue reduction is probably overdue[5]. If a reduction does not occur, immune system function might suffer[5–7]. You can always get sick without being overly fatigued, but if your training desire is low, you are constantly sore, *and* you get sick, there is a good chance that you are very systemically fatigued. Illness also directly impedes muscle growth and prevents overload (and sometimes any) training. If you often get sick at the end of accumulation phases, you should likely consider some program changes.

Axial fatigue

Axial fatigue results from loading weight onto the spine and is an interesting intersection between local and systemic fatigue. Technically it is a type of local fatigue produced in the muscles used to erect the body—but, although local, axial fatigue can have a spill-over effect that behaves a lot like systemic fatigue. Because the erector muscles are needed for so many lifting movements, axial fatigue can become the limiting factor for the training of multiple muscle groups. If you do bent over rows and tax your erectors, subsequent squats will be degraded, even though the primary muscles used in squatting have nothing to do with those used in rowing. You might be starting to guess as to how systemic and axial fatigue could dictate some program design rules for exercise order—more on this to come.

Fatigue's Effects on Hypertrophy

Fatigue can interfere with muscle growth in a variety of ways[8,9]. For one, it prevents maximal stimulus—if you are tired and beat up, you physically cannot train as hard (no matter how motivated you are). Let's say you're supposed to squat 150lb for 5x10 this week because you did 145lb for 4x10 last week, but you're so fatigued that you can only manage 135lb for 5x10 or 150lb for 4x8. Each of these performances is missing the full intended progression, either by weight or by reps. What happens if fatigue continues to creep up next week, the week after, and so on? Eventually, you'll leave your stimulus ranges altogether and cease to make gains. At some point, you have to bring down fatigue in order to continue to present overload and stimulate growth[10–13].

Very fatiguing training also interferes with growth on a molecular level by downregulating anabolic pathways. The more the training pushes to or outside of maximal recovery ability, the more AMPk is activated, which has been shown to reduce mTOR activity—a pathway that plays a central role in muscle growth[14,15]. Cytokines (signaling proteins) are also released from stressed or damaged cells and can affect the growth machinery of nearby cells or signal similar effects in distant cells[16,17]. Thus, being very sore in many of your muscles or in a few large muscles can negatively affect the growth of uninvolved muscles elsewhere in the body. On the hormonal front, cumulative fatigue seems to cause elevations in catabolic hormones like cortisol and reductions in anabolic hormones like testosterone—a recipe for anything but muscle growth[18].

The last effect of fatigue is very serious—injury. Injury will eventually occur if degradation exceeds regeneration for long enough. This can result in an injury that seemingly comes out of nowhere during a single set, a wear-and-tear injury, or long-term over-use injuries like tendonitis that develop over months and years[19]. In any case, if fatigue is not alleviated, you will eventually get hurt. At that point, a morbidly comical "automatic fatigue management" will occur when you are physically unable to train. Since "deload by injury" is a pretty inefficient way to manage fatigue, it's imperative that we be proactive with fatigue.

It is important to recognize, however, that a complete lack of fatigue is not necessary (and might be impossible) for effective training—just feeling sore or tired is not by itself a sufficient reason to take training down to recovery levels in most cases. For example, you might be coaching a bodybuilder who complains that his leg workouts wipe him out. You look at his logbook and he's hitting all-time weight, rep, and set PRs every week. Does he need dedicated time to reduce excessive fatigue in order to keep training productively? Most likely not. If you can still perform well enough to present progressive overload, fatigue is not preventing good training.

The sport science definition of "recovery," is the return of a system to its baseline levels of *performance*, so a small amount of fatigue can be present when recovered, so long as it does not impede performance to a measurable degree. On the other hand, if you're under-performing, especially in sequence (so that it's not likely to be a fluke), excessive fatigue is likely present and will prevent best gains. As you can see, performance is a critical factor in fatigue management assessments and should be weighed heavier than other indicators of fatigue.

In all cases, balancing stimulus and fatigue is the biggest challenge in program design because the most stimulus you can get for the least fatigue will result in the best long-term gains.

The Stimulus to Fatigue Ratio (SFR)

The SFR is a measure of how much stimulus you get for the fatigue cost of any training input and is a central concept to hypertrophy training (and, incidentally, to any kind of training). It's hard to overstate the importance of the SFR, because it essentially unites the three most important training principles: Specificity, Overload, and Fatigue management.

The Stimulus to Fatigue Ratio: The relationship between the stimulus generating abilities and the fatigue consequences of a given exercise, technique variation, session, volume of training, or program. In simple terms, the SFR tells you how much muscle growth a stimulus will give you for its fatigue cost:

SFR = Hypertrophy Stimulated ÷ Fatigue Generated

As you can see, a higher SFR value is better (more stimulus per fatigue cost). You can achieve a higher SFR when the numerator (stimulus) is increased or the denominator (fatigue generated) is decreased. The latter is an interesting case, as lower fatigue allows *increased* training, so lowering the fatigue generated also indirectly increases the potential for more stimulus, further increasing the SFR value. The SFR is not the only means of rating a training stimulus, but more often than not, the training method with the higher SFR will be superior.

Detecting Fatigue

In order to manage fatigue, we must be able to detect and to some extent quantify it. Though there are many indicators of fatigue from tissue disruption to psychological impacts, we can use the following three proxies in combination to give us a very good idea of where fatigue lies on a relative spectrum. When we calculate SFR directly later, we will assign number values to each of these proxies.

Joint and Connective Tissue Disruption

You'll rarely find exercises that don't disrupt the joints and connective tissues at all, but the less disruption the less fatigue and, other SFR indicators being equal, the better for growth. This also extends to techniques within the same exercises. Locking out your elbows on lateral raises might give you a certain level of stimulus, but it might bother your elbows enough to be detrimental to SFR.

The most stimulative exercises will also often impose more joint and connective tissue stress, but for any set of exercises that provide roughly the same amount of stimulus, choosing the ones with the least joint and connective tissue disruption will pay off. For example, you can stimulate the quads about the same with high or low-bar squats, but low bar squats are notorious for putting stress on the wrists, elbows, shoulders, back, and hips (especially for stronger lifters), lowering the SFR of this movement compared to high bar squats. Because of this, many advanced hypertrophy-seekers leave low-bar squats out of their programs altogether.

Perceived Exertion / Perceived Effort Per Set

How much effort you have to expend predicts a lot about how fatiguing a training input will be. Psychologically draining sets make systemic fatigue accumulate faster. There's only so much gut-spilling all-out war you can do in the gym before you burn out. The deadlift is a perfect example—it is a great stimulator of muscle growth, but it often requires so much psychological effort per set that it absolutely drains the hard training potential for that session and in some cases for that week. Perceived efforts also predict calorie costs, and energy demand is a direct factor in systemic fatigue.

Effort perception is often tied closely to axial loading. If you train your hamstrings only with stiff-legged deadlifts and good-mornings, you might find hamstring training very difficult and be unable to do more than two stimulative weekly sessions. If you throw in a seated leg curl, however, the perceived effort, especially via axial loading, is much lower, and a third weekly hamstring session might become a viable option.

This does *not* mean that large perceived effort is always a bad thing, but the trade-off must be worthwhile. A quintessential example of excessive effort that does *not* pay off for SFR is cheating on strict movements—using momentum to heave heavier weight on a movement generates more fatigue without providing more stimulus to the target muscles.

Unused Muscle Performance

Fatigue in unused muscles is strongly indicative of systemic fatigue. When an exercise for a given muscle group is very stimulative, it understandably impacts that same muscle's performance (and perhaps the performance of synergist muscles) on other lifts. If on the other hand the training of one muscle group generates a lot of systemic fatigue, it can inhibit the effective training of other muscles.

To measure the amount of systemic fatigue that an exercise generates, you can track the performance of unused muscles after the exercise in question. For example, if you have leg curls followed by incline dumbbell presses on one day and deadlifts followed by machine chest presses on another, you might find the following: your performance on incline dumbbell presses on the first day is largely unaffected because the amount of systemic fatigue generated by leg curls is minimal, but when doing machine chest presses after deadlifts, you under-perform notably in machine presses. The latter occurs because deadlifts generate a lot of systemic fatigue.

Very systemically fatiguing exercises do have a place in training, they had just better be worth the fatigue by also being hugely stimulative to the target muscle(s). Are deadlifts, standing overhead barbell presses, and even stone lifts pretty good muscle growth stimulators? Absolutely. But they also supply so much systemic fatigue that most bodybuilders, and sometimes even strongmen in a hypertrophy phase, don't find them worth the trade-off for hypertrophy.

Determining SFR

The following method of quantifying SFR is informal and by no means perfect, but can be useful both for program design and for conceptualizing the relationship between stimulus and fatigue. The first step in calculating SFR is to calculate RSM (raw stimulus magnitude) as shown in the Overload chapter and reiterated below. The RSM total goes in the numerator position of our SFR equation to represent stimulus. We then calculate a value for fatigue using three proxies (joint/connective tissue disruption, perceived exertion, and unused muscle performance) and place this total in the denominator position. This effectively calculates a stimulus to fatigue ratio using three proxies for stimulus magnitude divided by three proxies for fatigue generation.

<u>Stimulus Proxies</u>: Mind-Muscle Connection, Pump, Muscle Disruption

As a reminder from the Overload chapter, our proxies for effective stimulus can be used to calculate RSM as follows:

The Mind-Muscle Connection

On a scale of 0-3 how much did the training challenge your target muscles?

0: You felt barely aware of your target muscles during the exercise
1: You felt like your target muscles worked, but mildly
2: You felt a good amount of tension and or burn in the target muscles
3: You felt tension and burn close to the limit in your target muscles

The Pump

On a scale of 0-3 how much pump did you experience in the target muscles?

0: You got no pump at all in the target muscles
1: You got a very mild pump in the target muscles
2: You got a decent pump in the target muscles
3: You got close to maximal pump in the target muscles

Muscle Disruption

On a scale of 0-3 how much did the training disrupt your target muscles?

0: You had no fatigue, perturbation, or soreness in the target muscles
1: You had some weakness and stiffness after the session in the target muscles, but recovered by the next day
2: You had some weakness and stiffness in the target muscles after the session and had some soreness the following day
3: You got much weaker and felt perturbation in the target muscles right after the session and also had soreness for a few days or more

RSM represents the stimulus aspect of the stimulus fatigue ratio. Next we must determine the fatigue aspect.

Fatigue Proxies: Joint and Connective Tissue Disruption, Perceived Exertion, Unused Muscle Performance

Joint and Connective Tissue Disruption

On a scale of 0-3 how much did the training disrupt your joints and connective tissues?

- **0:** You had minimal to no pain or perturbation in your joints or connective tissues
- **1:** You had some pain or perturbation in your joints and connective tissues but recovered by the next day
- **2:** You had some persistent pain or tightness in your connective tissues that lasted through the following day or several days
- **3:** You develop chronic pain in the joints and connective tissues that persists across days to weeks or longer

Perceived Exertion / Perceived Effort Per Set

On a scale of 0-3 how much perceived effort went into the training?

- **0:** Training felt very easy and hardly taxed you psychologically
- **1:** You put effort into the training, but felt recovered by the end of the day
- **2:** You put a large effort into the training and felt drained through the next day
- **3:** You put an all-out effort into the training and felt drained for days

Unused Muscle Performance

On a scale of 0-3 how much performance falloff did you see in unused muscles?

- **0:** Performance on subsequent exercises targeting unused muscles was better than expected
- **1:** Performance on subsequent exercises targeting unused muscles was as expected
- **2:** Performance on subsequent exercises targeting unused muscles was worse than expected
- **3:** Your performance on subsequent exercises targeting unused muscles was hugely deteriorated

Using the above scoring you can calculate SFR using the equation in Figure 3.1.

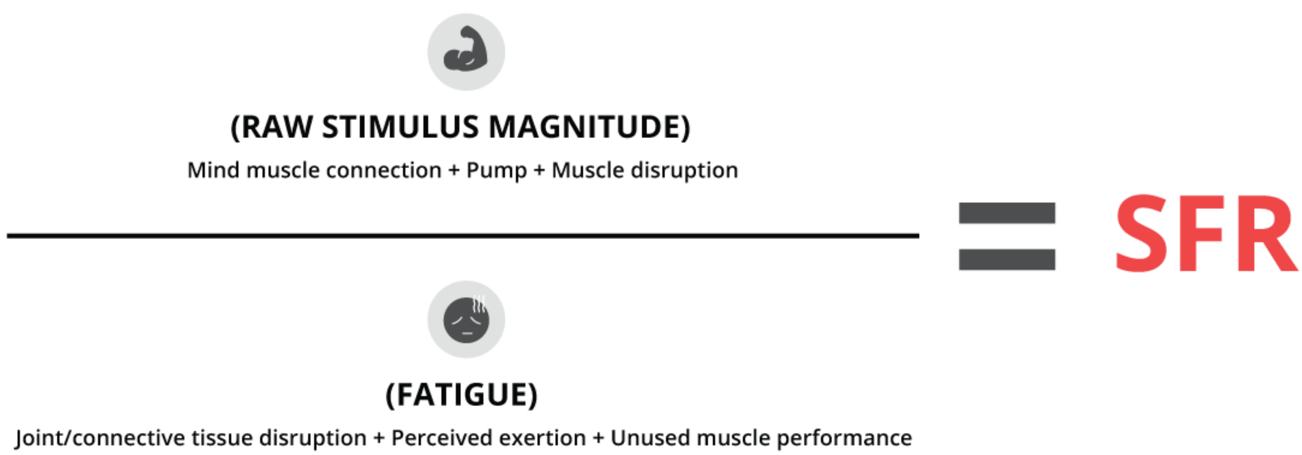

Figure 3.1: SFR Formula

Keep in mind that you don't have to do these formal calculations. Most experienced lifters do these qualitatively in their heads. If an exercise is very stimulative and not very fatiguing, it has a high SFR and vice versa. This equation can be used if you have the time and patience and have trouble with qualitative assessment.

Improving the SFR

To improve the SFR we must either enhance the stimulus, reduce the fatigue it causes, or some combination of both. This is easier said than done because in many cases the more stimulative the training, the more fatigue it induces. For example, for many people, high bar squats are probably more stimulative than leg presses for quad growth, but they are also more fatiguing—meaning the SFRs of the two exercises might actually be very comparable. In other cases, SFR comparisons are clearer. If we compare the quad SFR of deep squats to that of partial low bar squats, deep squats win that comparison by a long shot. The deep squat has the higher SFR because it stimulates the quads more via a larger range of motion and more stretch under tension. Fatigue will be the same or lower than that generated by partial low bar squats, as the extra weight needed to equate total work for the partial low bar squats is so fatiguing.

Another illustrative example is the comparison of hamstring SFR for stiff legged (Romanian style) deadlifts versus conventional deadlifts. While the conventional deadlift does stimulate the hamstrings, it also causes massive axial loading and systemic disruption, all while not taking the hams through a long range of motion. Stiff legged deadlifts, on the other hand, target the hams directly, increasing the stimulus, but use less weight for this purpose so that axial and systemic fatigue components are lower and thus the SFR is higher.

Interestingly, there's no dependable association between the degree of exercise isolation (how compound or isolated an exercise is) and its SFR. This is because while more isolated movements (like the hamstring curl, for example) definitely cause less fatigue, they almost always cause less stimulus as well. You can stimulate great muscle growth from two sets of properly done stiff legged deadlifts, but most people will need perhaps double that volume in leg curls to make the same kind of progress. Since the leg curls cause so much less fatigue, however, there's still no clear winner in terms of SFR.

One way that SFR can be improved is by increasing force application to the target muscle while minimizing energy use and force dispersal to other muscles or structures. Another way of saying this is that SFR improves as a direct result of improvements in technique! For example, if you are doing bent-over rows for your lats, the forearm flexors help execute the movement and push your lats that much further—but if you start involving the glutes and swinging your torso up and down, this doesn't help your lats at all. Instead it costs extra energy and adds systemic fatigue and local fatigue in the non-targeted glutes, reducing the SFR. Good technique also keeps your joints from getting as much wear and tear, which reduces long-term fatigue accumulation and thus keeps the SFR elevated over time. Going through a full range of motion usually enhances the stimulus of the exercise while preventing the need to use heavier weights to equate work in partial ranges of motion. This prevents heavy weight from both increasing joint wear and tear and axial fatigue. To summarize:

Some of the best SFR choices are exercises that allow for:

- The application of high forces through the largest ranges of motion
- Minimal involvement of non-target muscles
- The lowest possible energy expenditure to keep systemic fatigue low
- The lowest axial loading to keep axial fatigue low

Practical applications of these choices for best SFR include:

- Using a full range of motion
- Focusing on mind-muscle connection with the target muscles
- Controlling eccentric and concentric movements to enhance stimulus and reduce joint stress
- Avoiding swinging, momentum, or using unnecessary muscles to move the weight

- Executing the movement such that it biomechanically targets the intended muscle best (rather han just facilitating maximum weight movement—placing your feet low on the leg press to target quads rather than high to push more weight for example)
- Executing the movement such that wear and tear is reduced (not squatting on your toes and giving your knees needless strain for example)
- Doing all of the above in an individually tailored way for your body

The above checklist is both a guide for objectively improving technique and an illustration of why good technique is so worthwhile; it raises the SFR and thus leads to more muscle growth!

SFR and Volume

Recall from the previous chapter that increasing volume causes increased muscle growth up until around MRV when gains per added volume can be non-existent. With enough volume, we see muscle loss (see Figure 2.7 for review). When we look at volume's effect on fatigue, we see that very little volume causes very little fatigue, more volume causes roughly linearly more fatigue, and eventually, high volume causes a disproportionately large amount of fatigue (Figure 3.2).

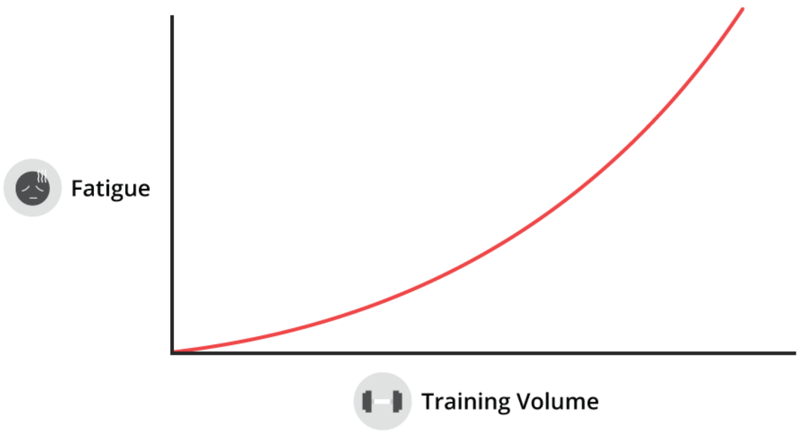

Figure 3.2: The Relationship Between Volume and Fatigue

Fatigue increases exponentially with training volume.

If we intersect these curves to derive SFR, we note that SFR is actually maximized at the lowest volumes (Figure 3.3). Although at the lowest volumes, any added volume causes huge gains and very small increases in fatigue, with every added set, additional gains are exponentially smaller in magnitude, while additional fatigue begins to rise exponentially. This might initially seem to support lower volume training until you take training age into account. As discussed in the Overload chapter, MEV and MRV will both be higher for advanced lifters. Thus, for beginners, the higher the volume of the program, the worse its SFR will be. With very advanced lifters, lower volumes might be so under-stimulative that they are below MEV, leading to very suboptimal SFRs. Additionally, program effect is judged on the absolute amount of muscle grown, not just the theoretical SFR it took to grow that muscle. Thus, while the best SFRs may occur at lower volumes, higher volumes produce the most absolute growth, and must still be performed if maximum growth is desired, even if that means not sticking with the best SFRs all the time.

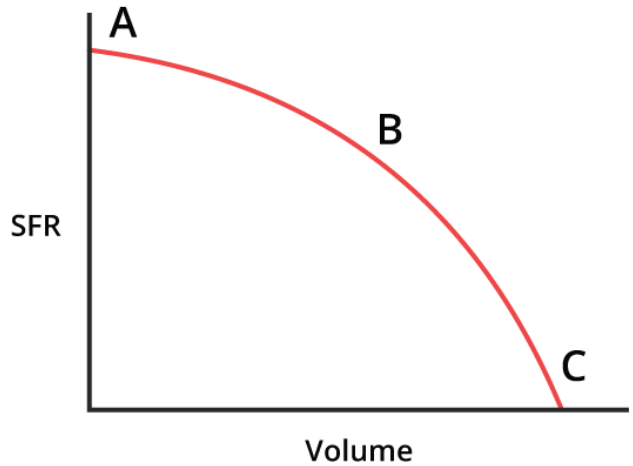

Figure 3.3: The Relationship Between Volume and SFR

In this simplified representation of the relationship between volume and SFR it is clear that SFR is highest at lower volumes (A). At MAV, though absolute growth would be highest, absolute fatigue is starting to climb, thus the SFR is lower (B). Further increases in volume not only decrease absolute growth rates, but exponentially add fatigue, making the SFR plummet (C). Please note that the highest SFRs and the most muscle growth are not the same. Best growth will come from starting at lower volumes (A) and working up to higher volumes (B) to (C).

For the most muscle growth, training across the spectrum from MEV to MRV is beneficial, meaning sometimes you will reach the point where huge efforts mean meager gains and accumulate large amounts of fatigue, but this is the only way to make *any* progress in some cases. On the flip side, if you are writing a muscle growth program for a beginner, the lowest volume program that gets notable results will be by far the best choice.

SFR and RIR

Because stimulus rises roughly linearly, but fatigue rises roughly exponentially, reps very close to failure (~0 RIR) probably don't have the best SFRs. On the other end of the spectrum, training at very high RIRs (over ~5 RIR), though not very fatiguing, also suffers from lowered SFRs in most cases due to minimal stimulus. In order to get sufficient stimulus from such high RIRs, a great deal of volume would need to be added, which itself would generate fatigue and concomitantly lower SFR back down[18,20–23].

As an example of the latter point, let's say your workout is normally eight sets of 28 reps with your 30RM (for simplicity let's ignore set-to-set fatigue). To get the same muscle growth stimulus, you might have to do something like 12-16 sets of 20 reps (10 RIR) with the same load. That is a whole lot of work for one training session, and would likely prove to be at least as fatiguing, if not more, than the eight sets of 28 reps. Put simply, the average stimulus-per-set of very high RIR (far from failure) training is so low that it requires additional volume that probably brings as much fatigue as doing fewer sets of lower RIR (closer to failure) training. Training in the 4-1 RIR range is likely to offer the best trade-off of stimulus and fatigue, and thus have the highest SFRs. This is probably where most training should occur.

Over the course of a mesocycle's volume progression, we might see some changes in the relationship between SFR and RIR that are worth noting. When novel exercises are employed and volume sensitivity is high at the beginning of the mesocycle, it's easy to do very little and still get a very robust stimulus. In other words, you can pay a very low fatigue cost and still get a lot of stimulus. This means that SFRs are probably higher closer to 4 RIR when the accumulation phase of a mesocycle begins compared to later. As training continues, best growth will likely require an increase in the difficulty of training—this is true both across mesocycles and across training ages.

For advanced lifters later in an accumulation phase, training too far from failure might add almost exclusively fatigue and hardly any stimulus. This dynamic probably means that best SFRs for advanced lifters require starting a mesocycle at around 3 or 4 RIR and possibly ending at 0 RIR in some cases in order to continue to stimulate notable growth. Especially for advanced lifters, there may also be certain adaptations, such as the stimulation of *very* high-threshold motor units and perhaps the maximization of satellite cell activation, that become either very difficult or impossible to stimulate without going closer to failure.

The astute reader will notice that because, with more training, you get your best relative SFRs at lower RIRs, the absolute value of SFRs will go down the longer you train. In other words, as you go from week one to week four of your accumulation phase, or from year one to year four of your training career, your relative best SFRs will occur at lower and lower average RIRs (closer and closer to failure). This also predicts that you'll see your absolute best SFRs at the beginning of each timescale and your absolute worst SFRs at the end (Figure 3.4). Such a prediction aligns very well with real world observations. A pro bodybuilder may have to train nine times a week for hours on end to get a measly five pounds of muscle per year, whereas a beginner might train for 45 minutes three times a week and gain 10 pounds in their first year of training!

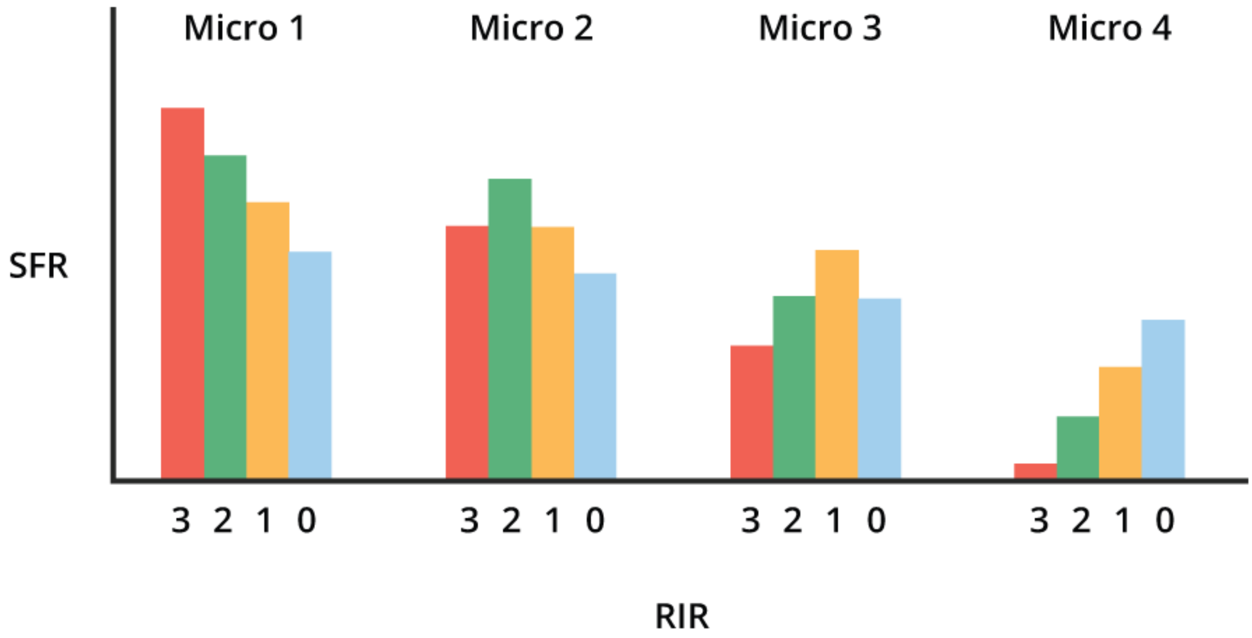

Figure 3.4: SFR and RIR Over the Mesocycle

At the beginning of a mesocycle, higher RIRs have better SFRs because volume sensitivity is high. As the meso progresses, sensitivity decreases and lower RIRs begin to have better SFRs. By the end of a mesocycle the lowest RIRs are the most stimulative, but all RIRs at this point have relatively low SFRs.

If you don't want to mess with altering RIRs over the course of a mesocycle, shooting for around 2 RIR on all sets should get you very close to the best results. Even lifters who choose to stay at 2 RIR the whole time might consider going to 1 or 0 RIR in the last week before deloading, since the extra time to recover may justify the larger raw stimulus magnitudes of the lowest RIR training.

We'll come back to the SFR and further develop related concepts in the upcoming chapters. For the time being, we recommend some thought about the SFR and what it implies for training. It's one of the most important concepts in hypertrophy training (and perhaps in all sport training) and maximizing it will amplify your long-term results.

Planning Future Stimuli

The fact that fatigue is cumulative has some very pertinent implications for program design. When we plan to what extent we will overload any given session (how much volume, tension, and RIR to apply), we must ask at least two questions to make sure we are training as hard as we can, but also taking cumulative fatigue into account:

1. *Is the current session stimulus enough to cause the best (or nearly the best) gains?*
2. *Is the current session stimulus so fatiguing that it will cut our planned progression short?*

Every stimulative session that you do in training should answer the first questions with a "yes" and the second with a "no" in order to be maximally effective for *long-term* muscle growth. The first question confirms that the principle of Overload is attended to and the second brings in Fatigue Management and allows *progressive* overload.

The technical way to phrase the first question could be "is the current session above the stimulus threshold range?" In other words, is it heavier than 30% 1RM, is it 5 RIR or less, and is the volume above session MEV? If at least those three factors are in order, then the session is likely to cause gains. But because we want close to the best gains, the requirement to answer this question in the affirmative becomes more stringent as the mesocycle progresses. If we've already done MEV training at 4 RIR last week, we probably won't see our best gains unless we do something like 3 RIR and *more than* MEV volumes the following week. Of course, we'd get our best *short term gains* if we went right to failure with near-MRV volumes, but the second question reigns in such practices.

Let's say we're in the second week of our mesocycle, and we decide on a session that's at 85% 1RM, 0 RIR, and right at MRV. Will there be a growth effect from such a session? Absolutely! But a session of this magnitude will bring so much fatigue along with it that we won't be able to stimulate growth again the following week and will need to spend a week deloading. If we try to train like this long-term, we essentially train hard for two weeks and then have to take a week off of stimulative training. This ratio of accumulation to deload training would be 2:1. This means we spend only eight months of each year growing muscle, and an entire four months just recovering. What a poor use of time! If we didn't go over the top in that second week, cumulative fatigue would not have risen so fast, and we could have done another 2-4 weeks of progressively overloading training, giving us more like ten months of stimulative training to two months of recovery training per year—a much better ratio for best gains.

If you are new to making assessments of fatigue, a conservative approach is usually best until you know your MEV and MRV better. A few mesocycles into training, you'll have an idea of your MEV and MRV and know roughly how long it takes you to get from one to the other. For most individuals, an accumulation phase (the path from MEV to MRV) will last between 3-8 weeks, with the majority of intermediates and advanced lifters falling in the 4-6 week range. If your mesocycles are within these ranges and you get to the final week thinking "there is no way I could handle one more week of accumulation," you're probably on the right track with your program design!

Every stimulative element has an independent effect on cumulative fatigue and must be considered. If you add tension too fast, fatigue can accumulate too quickly even if your volume and RIR settings are on track. Likewise for volume and so on. The bad news is that everything counts, so you must be very mindful with your training plans to get your absolute best results. On the other hand, this reality gives you more control to mitigate unplanned deviations. For example, if you were supposed to hit 35lbs on a dumbbell lift this week but the gym you're training at has only 30lb and

40lb dumbbells, you can do the 40lb but make sure to do fewer reps than planned, or reduce the set numbers so that you can finish the rest of your mesocycle on track. Thus, by autoregulating your volume and loading progressions via the algorithms introduced in the Overload chapter, nearly all of these dynamics resolve themselves, which is a huge nod to the power of proper autoregulation.

Volume vs. load progressions

Progressing mainly via volume or via load lead to differing fatigue outcomes. Ramping volume up and changing load very little results in "wear and tear" type injuries (like joint pain, for example). Increasing load preferentially with little change to volume on the other hand, increases the likelihood of acute, traumatic injuries (like muscle tears, for example). Many powerlifters report having suffered their most traumatic injuries when they felt their best (and thus were probably making the largest jumps in load). If you're making a big jump in weight in a relatively low fatigue state, you have both the load needed to hurt you and the strength needed to push hard enough to get hurt. Neither type of injury is great, but because wear and tear can be managed and acute injury often comes without warning and can take you out of training completely for some time, the latter is probably the worst of the two if hypertrophy is your long-term goal.

By adding only as much weight as is needed to move through your RIR progression, you can largely mitigate acute injury risk. Rising fatigue from adding sets will also limit how much weight you'll need to add to keep RIR progression in line, further reducing acute injury risk. It must be kept in mind that the best hypertrophy results come from challenging yourself with a progressive volume of hard sets, not by challenging yourself with a progressive loading of "just enough sets." The latter is ideal for strength development, but not muscle growth.

Fatigue Management in Training

Our fatigue management goal is twofold; first, to learn how to keep fatigue from needlessly rising in the first place, and second, to intelligently bring it down when needed. Below are our primary strategies for achieving these goals.

Fatigue Prevention:

1. Training within your Volume Landmarks
2. Using Safe Technique
3. Employing Microcycle Pulsatility

Fatigue Alleviation:

4. Taking Rest Days
5. Taking Recovery Sessions
6. Taking Deloads
7. Taking Active Rest Phases

Let's go through each strategy in detail.

Fatigue Prevention

1. Training within your Volume Landmarks

It doesn't matter how good your recovery practices are if you train more than your body is capable of recovering from (beyond MRV). Most often, MRV is expressed as the number of working sets per muscle group per week, such as "25 sets per week for biceps" (these numbers will differ by individual). If your MRV happens to be 25 sets per week for biceps, that means that you're capable of training your biceps with 25 stimulative sets in one week and then just barely recovering to stimulate them again in the next week. Because of cumulative fatigue, this also means that you will probably *not* be able to repeat this effort more than two weeks in a row without a drop in your performance. That performance drop would usually express itself as a drop in reps at any given RIR (including failure) compared to last week's performance, even adjusted for potentially increased load. If you've under-performed two sessions in a row, you have likely hit your MRV and should probably move into fatigue reduction training and note the volume at which you hit MRV for future reference. The most beneficial way to use MRV is as a rough guidepost by which to organize your meso-cycle progression. If your MRV is roughly 25 sets per week for your biceps, then you should set up a progression that *ends* around 25 sets per week.

There are very nuanced and systematized ways to determine MRV, but it's important to understand, however, that MRVs are very often unequivocal. In other words, when you hit your MRV, you'll know. If you are truly hitting your MRV you will feel like you're pushing that muscle to its limits and often find that your reps are off by 3-5 or even more from your target for a given session.

Sounds pretty simple, but countless lifters hit their MRV walls early on a monthly basis, get frustrated, and try to alter their sleep, diet, or supplement protocols to compensate. While good diet and sleep help with recovery, they cannot compensate for training beyond your MRV. All of the fatigue management strategies in this section assume that you're already training with good technique between your MEV and MRV.

2. Using Safe Technique

The prevention of needless fatigue requires safe technique practices such as those listed below:

Controlled eccentric and amortization

Making sure that the eccentric is controlled is a core aspect of safe technique. This just means that you shouldn't let the weight crash down without guidance. In addition, there should be control as the eccentric turns into the concentric and vice versa. This doesn't require a pause necessarily, but it probably means you should at least slow every rep at its terminal end and gently reverse course rather than violently bouncing back the other way. Uncontrolled, rapid eccentrics and amortizations can cause not only acute injury, but chronic damage as well. The concentric should also be controlled, but can be performed at the lifter's preferred tempo.

Using full ROM

By forcing you to use less weight and targeting more motor units and parts of the muscle per rep, full ROM lifting will often lead to less fatigue and less risk than partial lifting of the same volume. Many a lifter has noticed the reduction in their fatigue and injury rates when switching to full ROM lifting, especially while maintaining eccentric and amortization control.

Stable conditions

Having stable conditions, or a stable 'base' means being balanced in whatever lift you are doing. For example, if you're squatting, your weight should be spread across your whole foot on each side. A big part of creating a stable base for many compound exercises is bracing your torso by slightly arching your lower back, breathing in, and tightening your abs. This has the additional benefit of providing a safer position for the spine.

Having a stable base when lifting can reduce the amount of fluctuation in your technique (especially at lower RIR). More than this, a stable base can allow you to produce more force via the target muscle and requires less force to be produced by stabilizing muscles. This means that you get perhaps a similar level of total fatigue, but higher local and lower systemic fatigue, which bodes very well for the SFR. Any exercise or technique variations that cause lots of instability (bosu ball squats, etc.) have the opposite effect and should be avoided. This is especially true if such unstable techniques are loaded heavily, as injury risk rises substantially.

Avoiding joint pain

Avoiding joint pain seems like a no-brainer, but countless lifters do not. Some will leg press with knee wraps on to divert the pain, train through injuries (rather than around them), and assume that some movements are just supposed to hurt the joints. While some movements do stress the joints considerably, there shouldn't be any joint pain during lifting. If training causes joint pain, adjusting technique to eliminate the pain is ideal. For example, if you leg press with your feet too high on the platform, your lower back might round, causing you back pain. If you lower your feet too much and your heels come way up, you might get knee pain during the movement. Neither is good and what you want to do is experiment with the best intermediate foot position that allows for a large range of motion but neither overstresses your knees nor your back. This way your quads get the most stimulus for the least total fatigue. Another pertinent example is that of upright rows. There is a lot of variation in shoulder mobility biomechanics, and that can be influenced by all the muscles and connective tissues of the several shoulder joints as well as your elbow and wrist mobility. If upright rows hurt your shoulders, try a closer grip, a wider grip, or even an EZ bar grip, and everything in between until you have pain free options. Whatever exercises you do, look for variations that stress your muscle more and your joints less. And if you have tried all the technical variations and your joints still hurt, take a break from those exercises for a while and let your joints recover. There are no must-do exercises in hypertrophy training.

Targeting needed muscles

Good technique demands that you move in such a way that the target muscles of an exercise are actually targeted. A lot of people who squat end up sitting very far back into the movement and using more hamstrings, glutes, and back, instead of the intended quads. In order to meet quad stimulus needs, such lifters sometimes add quad volume through other exercises. This of course means that they will add needless fatigue to their programs by having to do more work to get the same effect for quads. If squatting was performed more upright and with greater knee flexion, less total volume would have to be executed for the same amount of quad growth and fatigue would be lower. Another example is the modification of the cable flye into a sort of flye and press hybrid. The reason for such a modification is almost always because the weight attempted is too heavy with which to actually do a strict flye, so the triceps are brought in to help move the weight. The problem here is that this is supposed to be a chest isolation exercise. Unless you're going to cut back on presses, such a modification just adds junk volume to the triceps and adds fatigue to the program. The flye/press is actually its own exercise, but if you do it, you should be doing it from the start of the meso, and not as a fallback when you've added too much weight to conventional flyes. Targeting the needed muscles often helps mind-muscle connection as well. Focusing on where you feel the stress of the lift will help you ensure that you are targeting the intended muscles.

Avoiding non-targeted muscles and systemic spillover

The corollary to targeting the muscles you want to train is to make sure your technique does *not* target the ones you don't want to train. This does not mean that every exercise must be an isolation movement. Bent rows are supposed to target nearly every muscle in your back, your rear delts, and your forearm flexors, but they are not supposed to target your glutes and hamstrings—which is what ends up happening if you start swinging and heaving in order to lift heavier weight. The same goes for curls, pullups, pulldowns, lateral raises, and every other exercise in which using non-target muscles can allow you to use more weight. By cheating and modifying techniques to lift more, you often end up using those other muscles just enough to create a lot of fatigue, but not enough to stimulate them. This "systemic spillover" of fatigue adds junk volume and prevents you from training as hard as you could have in later days and weeks.

Proper technique can be humbling, and it might mean that you have to reduce the weights you've been using for some exercises, but if you take the time and commit yourself to good technique, you will experience lower fatigue and be able to get that much more stimulus and therefore growth out of your training program. You might also notice that some of the same strategies for minimizing fatigue with good form are those that produce a better stimulus, as discussed in the Overload chapter—more evidence that good technique improves SFR!

3. Employing Microcycle Pulsatility

Any time you train a muscle group first, it automatically relegates the other muscle groups trained that day to lower priority status due to the systemic fatigue generated by the first lift. So, if you do bench press first, that's now a chest priority day even if you do more sets of triceps and more sets of front delt work later on in the session. Because of accumulating systemic fatigue, you simply won't be able to stimulate your front delts optimally if you train them as say the third exercise of the day[24–27].

Instead of trying to optimally stimulate every muscle in every session, programming to prioritize certain muscle groups, but still hit others each session is beneficial. If you have three pushing sessions per week, you might do chest first on one of them, triceps first on the next, and front delts first on the last one so that each gets a day to be prioritized, but all are worked on all three days.

You can also make use of this "pulsatility" in terms of the fiber type you target. For example, the 5-10 rep range targets the highest threshold motor units. Faster twitch motor units likely take longer to recover than slower twitch, so if you do chest first in the 5-10 rep range on Monday and fatigue the faster fibers, they might still be fatigued on Wednesday when it's time to hit the pushing muscles again[28]. Slower twitch fibers on the other hand, might be mostly healed by then, so lighter chest training can be beneficial. Now you're still training chest on both days and healing fast enough to prevent too much fatigue in either fiber type. An added bonus of such training is that because your connective tissues take the most damage with the heaviest training, the lighter training days are unlikely to cause or exacerbate any macro-tearing of those structures. In other words, if your chest tendons are still attached after heavy benches on Monday, they probably won't go anywhere with light incline dumbbell presses as a third exercise on Wednesday.

Rotating heavier and lighter training sessions for the same muscles and prioritizing different muscle groups on different days allows some individual fibers to reduce fatigue while others are trained and lets connective tissues recover between high tension exposures without sacrificing weekly stimulation. The more advanced a lifter gets, the more fatigue they generate in relation to stimulus and the more important programming with higher pulsatility becomes.

We can further manage fatigue by rotating movement type. For example, if you train your back two days per week, you can have a heavy vertical pulling day and a heavy rowing day. The heavy vertical pulling day might involve doing some weighted pullups first, then some unweighted pullups after, in the 5-10 and the 10-20 rep ranges, respectively. The heavy rowing day (horizontal pulling) might involve doing heavy bent rows first and then down sets of lighter bent rows second, with the first sets in the 5-10 and the second in the 10-20 rep range. The last back exercise on the vertical pulling day could be machine rows in the 20-30 rep range, and the last exercise in the rowing day could be pulldowns in the 20-30 rep range. As you can see, on the heavy vertical days, the fibers and connective tissues that are involved in vertical pulling are preferentially loaded and those involved in horizontal pulling are allowed to recover, having only light, high rep work at the end of the session. On the heavy horizontal pulling days, the opposite occurs. All fibers and main angles are worked through the week and full development is stimulated in a way that keeps local fatigue from rising too quickly. This of course can be done with nearly all muscles. Heavy hip hinges and light leg curls for hams, heavy squats and light walking lunges for quads, heavy barbell and light cable curls for biceps, and so on.

Our last tool in the Microcycle Pulsatility toolbox is the use of slightly asymmetrical microcycle design. You could program exclusively equidistant training for a given muscle group. But given that fatigue accumulates, this would mean less recovery over the same rest time as the microcycle progressed. So symmetric programming might not be the best choice. Luckily for us, the human week of seven days is already asymmetric. If you train quads twice a week, training them on Monday and Thursday, for example, actually gives them more rest time after Thursday (when there is more accumulated fatigue) than after Monday—which is a good thing. A good approach might be to split the volume evenly into each session (and then have the longer recovery period after session two when more fatigue has accumulated), or to go with say five sets Monday and nine sets Thursday to bias more training prior to the longer recovery period. This can be taken into account in your Set Progression Algorithm from the Overload chapter. Mind you, this is a very small, but still effective component of fatigue management.

Second, we can structure our training so that our biggest muscles and our most fatigue-generating movements are trained earlier in the week, and our smallest muscles and least fatigue-generating movements later. For example, you can train heavy chest, legs, and back earlier in the week keeping arms, shoulders and calves lighter, and then switch later in the week (Figure 3.5). Mind you, all muscles are trained during both parts of the week, but the heaviest and highest volume sessions for the big muscles occur earlier. Because the most systemically-fatiguing training occurs first, those muscles can begin to recover during less fatiguing small muscle prioritization, resulting in a beneficial asymmetry. To further enhance this asymmetry, days of complete rest can also be strategically placed toward the tail end of the week.

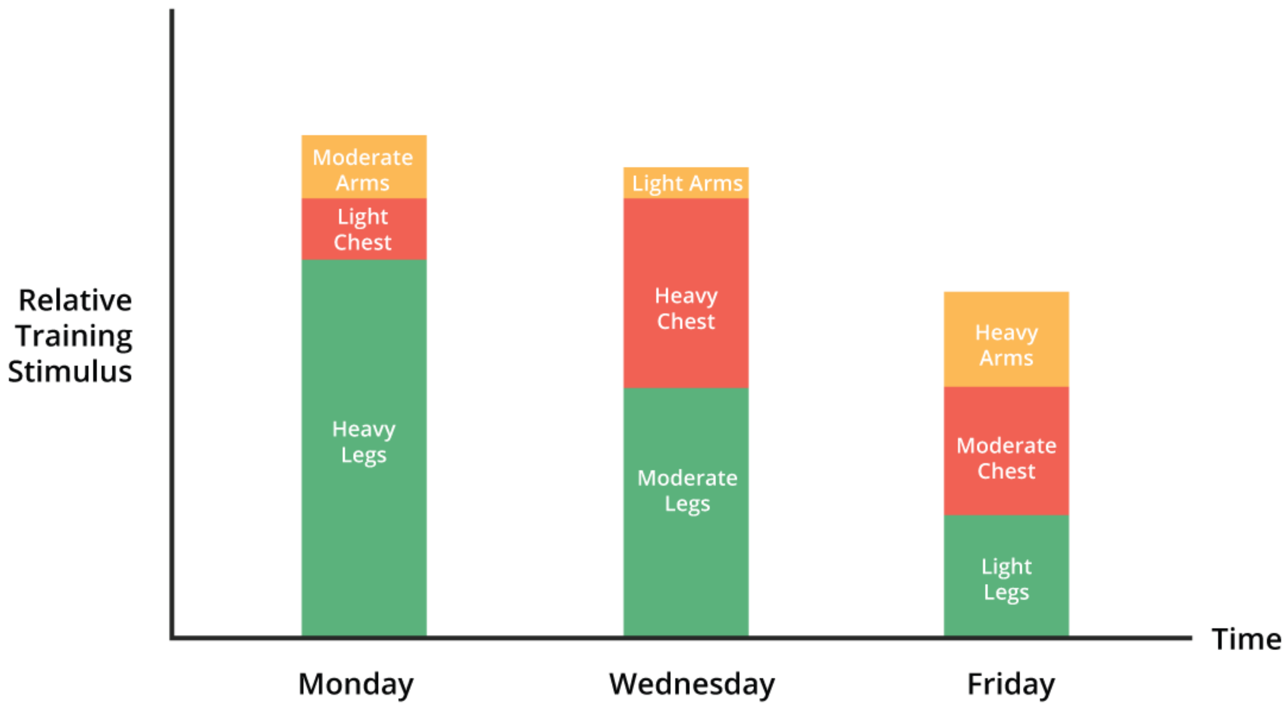

Figure 3.5: Microcycle Pulsatility

In this example each muscle group is trained in each range (heavy, moderate, and light), but the most stimulus is presented at the beginning of the microcycle so that the hardest workouts are done when there is the least systemic fatigue. Two rest days follow Friday's workout in order to allow alleviation of accumulated systemic fatigue from the week's training.

Now that we've discussed fatigue prevention measures, we will move on to strategies for reducing fatigue once it has already accumulated.

Fatigue Alleviation

4. Taking Rest Days

Taking a day off from training is perhaps the least complicated and most effective option for alleviating accumulated fatigue. The main advantage of a rest day is that it does not require you to show up to the gym. Whatever advanced manipulations of volume or load you do in the gym to bring down fatigue, you still have to gather your things, drive to the gym, find parking, wait for the machines, and so on, all of which is fatiguing at some level. Even if you have a home gym, any form of structure and training will be less relaxing than well, just relaxing. A rest day thus effectively reduces psychological fatigue as well as physical.

Even with volume equated, a program with a rest day or rest days will generate less fatigue. For example, 100 total working sets per week will likely build less cumulative fatigue if they are spread across six days with one rest day compared to the identical 100 sets spread across seven days, with shorter workouts, but no days off. Many bodybuilders believe that nothing beats two consecutive days off, so they would recommend putting all 100 sets across five days. Those bodybuilders may be onto something. Our first recommendation is to take one full day off per week. Our second recommendation is to look over your program and see if you can condense any shorter, easier workouts to free up a second rest day.

One caveat here is that advanced lifters might need more than six sessions per week (possibly up to 12), but even then, they should seek to have at least one full day off. If you are not advanced and do not need more than six session per week, doing more is not recommended. Lifters should use only *as many sessions as needed* and not, for example, do biceps and calves alone on a day when those low-impact lifts could have been added at the end of other training days and allowed for a full rest day.

Remember that before any fatigue alleviation strategies, what is most important is that your training volume is under MRV. Once that is controlled, one to two rest day per week can help keep accumulating fatigue at bay and make your training all the more productive.

5. Taking Recovery Sessions

Let’s say that you are a bit more fatigued than you should be at some point in your program. You’re slated to accumulate for another two weeks, but your performance is looking like you only have a week left until you’re over your MRV. You could take a few more rest days this week, but that will extend your training cycle, throw off your schedule, and leave you playing catch-up for the rest of the accumulation. An alternative is to take a recovery session.

A recovery session is a session in which you still train the planned muscle groups, but at very low volumes (and possibly reduced load as well). Recovery sessions allow for just enough stimulus to conserve your muscle mass, but because they are not stimulative enough for growth, they do not add much fatigue and *can in fact stimulate recovery*. If your recovery session training is at a low enough volume, you will actually *drop* fatigue as a result of this session and have lower total cumulative fatigue in that muscle group when it's time to stimulate it next. This buys you more stimulative time and can allow you to finish your planned accumulation phase duration instead of having to scrap the plan to deload early or take whole extra days off. This session should be at your Maintenance Volume (MV) to conserve your gains without bringing the fatigue that comes with stimulating new gains. This means that a recovery session just pauses muscle gain to let your fatigue fall back down to tolerable levels so that you can carry on with productive, stimulative training for the rest of that mesocycle.

If you know your MEV and MRV and have a well-planned mesocycle, recovery sessions should usually be unnecessary. This is different for non-physique sports where such sessions might be pre-planned to bring down fatigue for performance—in strength sports they are used to drop fatigue in advance of very heavy low rep lifting for best output. When training strictly for hypertrophy, however, you need as many stimulative sessions as possible, so recovery sessions should mainly be used in an autoregulatory manner as illustrated in the examples below:

When you hit MRV too early

As described earlier, you can take a recovery session if it looks like you will be over your MRV too soon. If you planned to match reps from the previous week with 2 RIR, but it took 1-0 RIR to match reps and you still have two weeks of accumulation, it might be time to take a recovery session *for that muscle group*. Recovery sessions can and often should be targeted to *just* the affected muscle group. However, if a few muscles, especially large ones that contribute heavily to systemic fatigue, are behind their recovery schedules, you might need to do the whole session at recovery volume, or even a few sessions in order to reduce both local and systemic fatigue and be able to continue your planned progression.

When you suspect a minor injury

Sometimes you do something like sleep on your shoulder wrong and end up having pain that gets worse with every rep when you train it. Instead of trying to push through and exacerbating the problem, you might consider a recovery session. Reducing volume, load, and relative effort of training is a good idea when you suspect a minor injury. The recovery session would keep you from losing muscle in your shoulder and might also slightly enhance healing. If your shoulder is better by the next session, you can train it as planned.

When you have illness without fever

If you are sick and have systemic symptoms like a fever, you probably want to take as many days completely off as it takes to get better. If, on the other hand, you have just a minor cold without a fever, taking recovery sessions can actually speed recovery[7].

For any of the above situations, we recommend making sure that the problem is resolved before resuming stimulative training. The last thing you want to do is waste good training time with an insufficient recovery boost and have to spend even more time actually recovering.

How to perform a recovery session

An effective protocol for a recovery session is to take your planned session and cut the working sets and the reps by half. For example, if you planned on squatting 6x10 at 200lbs, you might squat 3x5 at 200lbs. If for any reason you are not comfortable loading your planned weight for *any* reps, you can cut the load and sets in half and leave the reps as planned, which means in the above example you'd do 3x10 at 100lbs.

How you get back to stimulative training after recovery sessions depends on why you took the recovery sessions. If you took them because you were hitting your MRV too early, your next stimulative session can progress in load as planned, but the volume of training should be dropped to around midway between your MEV and MRV volume. So, if you did week one with 10 sets and your MRV is around 20 sets, then re-starting at 15 or so sets after your recovery session(s) is a good idea. From there, you just apply the Set Progression Algorithm from the Overload chapter and move forward with volume as needed.

On the other hand, if you have taken a recovery session because of illness without fever, or for a suspected minor injury that is resolved after the recovery session, you can follow a slightly different plan to return to stimulative training. Because you've done such low volumes of training during the recovery session(s), just going to the planned volume in the next stimulative session might be a bit much and thus potentially result in the need for another recovery session, and so on. Instead of going straight to the planned stimulative volume, you can progress normally in load, but reduce the volume by 1-2 sets per exercise. For example, if you did five sets of squats and five sets of leg presses on your Monday quad session, and then did a recovery session for Thursday's quad training, your next Monday stimulative session can be something like 3-4 squat sets and 3-4 leg press sets. Low enough to ease you back in, but not so low that you're back at MEV when it's not called for.

While the above are valid means of executing recovery sessions, they are not the *only ways*. For various situations and needs, there are a variety of effective options. Just remember that recovery sessions are characterized by *very large* reductions in volume, or even a combination of volume, load, and relative effort. Whatever method you choose, don't just cut your training short by a few reps or pounds or a half set and call that a recovery session; that's just doing a bad job at stimulating while simultaneously failing to reduce fatigue.

6. Taking Deloads

Once you have hit your MRV on multiple muscle groups or hit your MRV and cycled back down and up again multiple times in the same mesocycle, you are going to be carrying a degree of cumulative fatigue that even a half week of recovery sessions isn't likely to bring down. These situations require a full week of recovery sessions, colloquially known as a "deload".

Deloading not only reduces fatigue from lifting by a much larger fraction than a couple recovery sessions, it is also long enough to allow recovery of more lingering training consequences such as hormonal alterations (testosterone and cortisol, for example) and microtrauma to connective tissues. It is likely that the degree of fatigue reduction that you can get from a full deload week is far beyond that of equivalent but non-sequential recovery sessions week to week. In other words, a full deload week of recovery sessions strung together is occasionally needed for near-maximal fatigue reduction.

Deloads will often be needed when your RIRs approach 1 to 0 and are thus naturally placed at the end of accumulation phases when planned. Deloads should more often be a part of a pre-planned program, but sometimes need to be utilized in an autoregulatory manner. An autoregulated deload is recommended when:

- You have done recovery sessions and resumed training twice for more than half of your muscle groups in the current accumulation phase
- More than half of your muscles have required a recovery session in the last two weeks (even if for the first time)

- You have an illness *with* fever, or a serious injury that won't heal in just a few days

These conditions indicate an elevation in both local and systemic fatigue. Recovery sessions for individual muscles drop local fatigue, but the continued training of other muscles means that systemic fatigue continues to accumulate. Similarly, if more than half of your muscles have crossed their MRVs in the last two weeks, systemic fatigue is probably very high and worth addressing. Illness with fever or more serious injuries also require more than a recovery session before productive training can continue. You can deload before the above conditions occur if you feel they are impending. There is plenty of wiggle room in deciding exactly when to deload. We recommend starting with these guidelines and then using your accumulating training wisdom to make the most informed decisions for yourself. Taking a deload too early now and again is less detrimental to overall progress than delaying deloads. The saying "better safe than sorry" is sound advice when it comes to deloads.

How to deload

<u>Stimulus Reduction:</u>
Deload training structure is fairly straightforward. The first half of the deload should seek to conserve the loads used in the last stimulative week of accumulation training, but cut the sets and the reps in half. The second half of the week can be even less stimulative in order to further promote recovery—cut not only sets and reps in half, but the weights as well. For example, let's say your last accumulation week's quad training was:

- *Monday: 200lb squats for 6x10 (six sets of 10 reps)*
- *Thursday: 300lb leg presses for 8x20*

Your deload week can then look like this:

- *Monday: 200lb squats for 3x5*
- *Thursday: 150lb leg presses for 4x10*

As with recovery sessions, our examples are not the *only* way to construct a deload. Other strategies for reducing volume and load can be effective. The critical element is a *large* reduction in stimulus. Fatigue is best alleviated when your training is substantially reduced. The good news is that there is no risk of muscle loss even with such minimal training across the short timeframe of a week.

Exercise Selection:
There are three primary approaches with respect to exercise selection during deload, each of which have their upsides and downsides.

- Using the recent mesocycle's exercises
- Using the next mesocycle's exercises
- Using intentionally low-fatiguing exercises

The first strategy is the most straightforward. Your deload exercises are exactly the same as those you used in your accumulation. This has the benefit of saving the added stimulus of new movements for later and making the deload weeks load, set, and rep calculation straightforward. The potential (minor) downside is that if you have any over-use injuries or issues, stale exercises might continue to irritate these.

In the second strategy you take the exercises you'll be doing in the next mesocycle and use them in the deload for the current phase. This gives you practice with the new movements so that you can improve your technique and mind-muscle connection (thus amplifying your SFRs once you start the next accumulation) for the next meso while simultaneously dropping fatigue. However, using new exercises poses the risk of introducing too much stimulus (due to the increased stimulus of novel movements). Lunges, for example, can give you DOMS from 1-2 light sets if you haven't done them in a while. Using new exercises can also introduce some uncertainty about the loading, rep, and set ranges to program on a deload, as no data on their recent use is available, as would be if you'd used them in the last accumulation phase.

Lastly, you can choose very low-fatiguing exercises for each muscle group during deload irrespective of whether they were used in the last or will be used in the next meso. For example, if an advanced lifter is doing stiff-legged deadlifts with 400lbs on their last accumulation week for sets of eight, sets of four with 400lbs in deload week will not drop nearly as much fatigue as replacing stiff legged deadlifts with 45 degree back raises, for example. The same muscles are trained, but with notably faster fatigue reduction due to the lack of axial load. Other examples are switching from bench press to push-ups, free weight rows to cable rows, and so on.

While there is no best method, we usually recommend that beginners stick with the first method, intermediates with the first two, and advanced lifters consider a combination of all three. An additional strategy that any lifter might consider is combining some deload training days. This buys more days off, which may have unique fatigue-reducing benefits as discussed earlier.

7. Taking Active Rest Periods

Active rest periods are very powerful fatigue reduction strategies. They are generally used only once per year and typically last 1-4 weeks. More brief active rest phases (two weeks or less), can include no formal training at all. Though pausing hypertrophy training for two weeks will likely lead to some muscle loss, almost all research suggests two encouraging things regarding this. First, the loss is very minimal. Second, when training resumes after two weeks or less, muscle is regained at a very rapid rate. Longer periods of active rest will usually include some training, but at a much lower volume and load—somewhere around MV. Although some less regimented eating can be a good idea for psychological recovery, unrestricted binge eating can cause rapid fat gains and delay future body composition progressions. The physique minded athlete should just be mindful not to gain excessive fat during these rest phases.

The purpose of an active rest phase in hypertrophy training is to allow minor injuries, hormonal perturbations, and psychological fatigue to *completely* come down, so that another year of training can commence without any residual fatigue from the year before. You can see why four week active rest phases are needed if for example, you play American football. The bumps, bruises, fatigue, and injuries from such a sport warrant the longer break. In hypertrophy training, however, injuries almost never accumulate to that extent. For this reason, active rest for hypertrophy goals is usually limited to two weeks, with a primary goal of reducing psychological fatigue.

We recommend at least one full week *completely off* per year for those whose priority is physique development. A very good time for this is right after a deload, preferably during a time of holiday or vacation. This way you really only take a single week off from training, but you get much more than that in total fatigue reduction since the week off follows your deload. Competitive physique athletes can place an active rest period of either type either right before a show prep begins or right after the most important show of the year. Recreational hypertrophy lifters do not usually need active rest periods as much as professionals, but that being said they might take more than one active rest period per year just to enjoy vacation or life since hypertrophy is a hobby rather than a career.

Employing Pre-Planned and Autoregulated Fatigue Management

The above list of fatigue management strategies can be applied in a pre-planned or autoregulated manner or as a combination of both. Pre-planned strategies are programmed into your training in advance. For example, if every Saturday is your day off from the gym, that's a pre-planned use of rest days. Autoregulated strategies are employed as needed when enough fatigue is detected to justify their use. For example, taking a recovery session only when a performance reduction is identified via the Set Progression Algorithm is a form of autoregulation. Both strategies are useful, and each has its own benefits and trade-offs. The most successful training programs likely need to make use of both.

The three fatigue prevention strategies are necessarily pre-planned. Using good technique, training within MRV, and employing microcycle pulsatility should be programmed into training from the start. (Though autoregulation of overload might help adjust a program that accidentally went over MRV or did not reach MRV at the planned time).

Rest days should also most often be pre-planned. If you happen to feel overly rested, take your rest day anyway and simply autoregulate overload—increase stimulus of your subsequent training days or simply take this information into account when writing your next mesocycle.

Recovery sessions should most often be utilized in an autoregulated manner. Pre-planned recovery sessions may, however, be used under certain circumstances. For example, if you have weekend work travel halfway through your accumulation, you can pre-program recovery sessions during that weekend and adjust by making the accumulation a bit longer or a bit more stimulative per-session on average.

Deloads can be taken in both autoregulated and pre-planned manners, but probably make sense to pre-program in most cases. Because more experienced lifters will tend to have a good sense of where their volume landmarks fall, they can use these to dictate when deloads should occur. Although an autoregulated deload would likely lead to deloading at the same time as an accurately pre-planned deload, knowledge of your MRVs and pre-planning allows more structured timing for your training, diet phases, and schedule. For example, if you have a bodybuilding show in 10 weeks and you know you generally need to deload every four to six weeks, you can preplan to deload every five weeks in order to be on schedule to compete. In much the same way, if a vacation is coming up in six weeks, you might just program your mesocycle volume progression to hit MRV and peak fatigue the week before you leave, then deload while you are away.

Lastly, active rest is almost always good to pre-plan so that it overlaps with vacation (if you're a recreational lifter) or with parts of the year that are conducive to rest (if you are a competitor).

As you can see, both pre-planning and autoregulation are important aspects of fatigue management. In fact, by using autoregulated strategies, you can find out a lot about how long your fatigue takes to both accumulate and drop in various circumstances, and you can use that information to make more accurate pre-planned fatigue management strategies in the future.

Over-Application of Fatigue Management

Over-application of fatigue management is really just an under-application of the Overload principle. That being said, there are a few instances worth covering.

Over-emphasis on the recovered state

Being recovered feels great. In much the same way, cooking with a completely clean kitchen is a pleasure. The problem with both constant low-fatigue training or cooking in a constantly clean kitchen is that each requires an excess of effort to pull off. That effort could be better spent building more muscle (or cooking more food in the analogy).

Dropping fatigue (and stimulus) to reveal performance

It is critical to understand that fatigue *masks* performance[29]. Across a well-done hypertrophy mesocycle, fatigue *will accumulate* and thus performance increases *may be masked*. In other words, in most cases, if you are successfully moving from MEV to MRV (unless you are very new to lifting) you should not usually see big jumps in strength performance. Rep strength capacity improves at best rates when training from MEV to MRV, but will *mostly be observed* under less fatiguing and therefore less stimulative conditions, such as *after* the deload, at the beginning of your next accumulation phase.

If you were not aware that fatigue masks adaptations, you might assume that because less volume or relative effort resulted in better performance, you were getting better gains with low volume, light lifting. Unfortunately, low volume, low load training does not lead to as much muscle gain. This could lead to the design of mesocycles as tapers: beginning with higher volumes and intensities and decreasing over the mesocycle to increase performance (Figure 3.6). While this would *reveal* high fitness levels, this structure is very poor at *creating* them and would lead to less muscle gain and less long-term fitness gains[30]. Seeing strength reduction across a hypertrophy program can be a sign of excessive fatigue that will also prevent gains, but large within-accumulation performance increases are not realistic if hypertrophy training is done well.

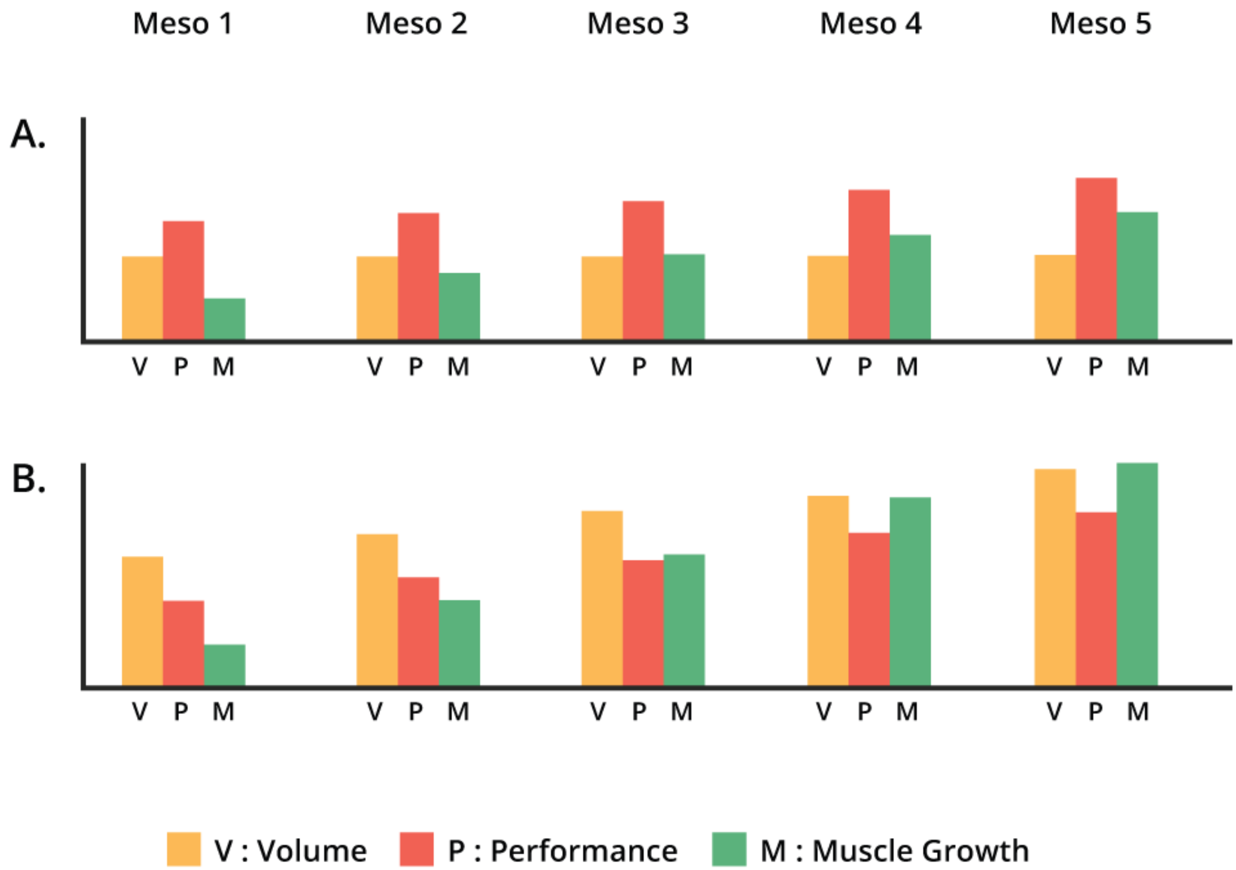

Figure 3.6: Prioritizing Volume Versus Load and Performance Over the Training Block

If we prioritize performance (measured by load increases), we will have to lower the average volume of each mesocycle to reduce fatigue and allow that performance expression (A). This lower volume will result in less muscle growth over time. If we prioritize training volume, we will make less impressive performance gains in the first several mesos, but gain more muscle in the long-term due

Excessive fear of injury

Not every pain sensation means injury. If you feel some tweaking or discomfort, ease in carefully, but see if it can be worked through. If pain fades as you carefully work through your warm-up, you're probably fine. If the pain stays the same, consider
through your warm-up, you're probably fine. If the pain stays the same, consider
switching techniques or exercises. If it increases as you work, a recovery session is likely in order. Be wary of injury, but avoid giving up a full training session every time

you feel any discomfort. With a little practice, most lifters will start differentiating the temporary discomforts of lifting from the pain indication that something is wrong.

Perceptual-only autoregulation

While soreness, how heavy the bar feels, how motivated you are to train, and other such factors are important for assessing fatigue, they all fall short of *demonstrating* it. The only objective demonstration is a sequential reduction in performance. This doesn't mean you should only ever employ recovery training if your performance goes down, but it does mean that you should take perceptual measures of fatigue with a grain of salt. For example, if you're on a fat loss diet, you might feel awful and unmotivated, but once you're warmed up and doing your sets, you may be surprised to find yourself performing well. If you had taken a recovery session based on your motivation levels, you would have missed out on stimulative training.

Relatedly, perceived effort and RIR assessments are biased by perception, even in advanced lifters to some degree. Let's say you squatted 205lb for 10 reps on your first set last week at 3 RIR. This week, you might be planning a set at 2 RIR, but if you're having a very stressful week and end up doing 210lb for 8 reps because that felt like 2 RIR given your stress levels. This is when objective measures and planned progressions are better than autoregulation. In the above example, you can plan to hit 10 reps on each coming week with 210, 215, and 220 before you deload. You can keep an eye on RIR to make sure you're not at RIR 0 to hit 10 reps of 210 and ruin your progression, but having those reasonable rep-matching goals can help with objectivity.

Under-Application of Fatigue Management

Too much volume early on or rapid progressions

For most lifters, the range between MEV and MRV is quite large. This is a great thing, as it allows plenty of time for progressive overload. It can also mean that starting accumulation MEV volumes are so low that they barely feel like training. For example, you might have done 20 hard sets in your last peak week. When your deload is done and you finally feel excited to train hard again, you look at your scientific training plan and it calls for 10, maybe 12 sets in the first week. That gets you a pump and a little sore, but it's just not much of a challenge, so you are tempted to start the new meso at 15-16 sets and feel like you are making real progress. But we don't train just to challenge ourselves, we train to optimize muscle growth. Less challenging workouts in the early weeks of a mesocycle allow for more weeks of challenge (a longer accumulation) and therefore more growth·skipping the bottom end of your MEV-MRV range means passing up easy gains! Perhaps even worse, your average accumulation volumes go up, but your average hypertrophy doesn't. You're literally beating yourself up for no benefit.

Likewise, it can be psychologically tough to apply small, incremental stimuli over time. It's hard to add just one set if you feel like you can add three sets, or 5lb if you feel like you can add 15lb. But rushing the process will prevent your best gains. Another big downside of rapid jumps is injury risk. An impressive body of literature from the study of many sports shows that large jumps in volume and or load predict (and very likely cause) injury[31,32]. Progressing slowly and keeping your accumulation:deload ratio as high as possible across months, weeks, and especially decades will lead to significantly more muscle growth.

Exceeding MRV

It's okay to exceed your MRV slightly, so long as you take appropriate subsequent action (like a recovery session or deload). If you hit your MRV, and then plow along like nothing happened, you will have a problem. Getting to MRV and just above for a week might beneficial on rare occasions, but if you get into the habit of doing it too often, your chances for injury will go up substantially without better results to show for the risk. Training for weeks above your MRV really means "training while unable to provide a progressive overload stimulus"—in other words entire weeks of junk volume training. It is possible that many reported "plateaus" in training are actually just the result of chronically exceeded MRVs[5].

Excessive load

Excessively heavy training does grow muscle, it but contributes so much fatigue that SFRs plummet and risk skyrockets. For muscle growth, there is *no need* to go heavier than 85% 1RM. Even though heavier weights do likely grow faster fibers best, those benefits likely peak in the 80%-85% 1RM range anyway.

Low average RIR

Going to failure causes disproportionately high fatigue accumulation[18,23]. Once you go to failure in a progression, the amount of time you have left in that progression dwindles rapidly. Going to failure too soon can cut progressions short, leaving you with less stimulative training time. Even if you lower your total volume so that you can accumulate for just as long while training closer to failure, you trade away perhaps the most reliable stimulator of hypertrophy—volume. Either way you slice it, if you trend too far away from a mesocycle average of around 2 RIR, you're probably not getting as much as you could out of your training.

Failure to address overlapping chronic joint and connective tissue soreness

Numerous lifters come into the gym week after week, month after month, with chronic and overlapping joint and connective tissue pain that never goes away. This is *not normal* for anyone but perhaps the oldest of advanced lifters. For nearly everyone, repeated joint and connective tissue pain requires adjustment. This might be an alteration in technique, volume, fatigue management, load, and even exercise selection. If you haven't tried all of these yet, we urge you away from accepting joint and connective tissue pain as "just part of the process." That's a good way to ensure that injury makes "the process" of gaining muscle much shorter and less productive than you may have wanted.

CHAPTER 3

Summary

Fatigue is the necessary side effect of stimulative training, but it can inhibit progress if not managed well. Managing fatigue is one of the most important tasks in a hypertrophy training program if best long-term muscle growth is the goal—it allows you to get the best training microcycle to microcycle, the best ratio of training to recovery time across longer time scales, and reduces chances of injury.

Fatigue develops locally, at the used muscle and tissue level and systemically across all body systems. In addition, axial fatigue, although local, can impact many other lifts due to the ubiquitous use of the erector muscles.

Performance is perhaps the most powerful indicator of fatigue. If you can still perform at your usual max levels, and especially if you can present sequentially progressive stimuli, you are not fatigued enough to prevent good training even if other indicators are present. When using performance as an indicator, sequential drops in performance or drops in performance along with other indicators are best used to make the decision to drop training down for recovery.

The Stimulus to Fatigue Ratio (SFR) is a more formal proxy assessment of how much muscle growth a stimulus gets you for the fatigue it generates. The SFR can usually be qualitatively assessed by more experienced lifters, but can be roughly quantified using the stimulus and fatigue proxies and equation below:

SFR = Hypertrophy Stimulus / Fatigue Generated

Hypertrophy Stimulus Proxies:

- *Mind-Muscle Connection:* On a scale of 0-3 how much did training challenge target muscles?
- *The Pump:* On a scale of 0-3 how much pump did you experience in the target muscles?
- *Muscle Disruption:* On a scale of 0-3 how much did the training disrupt your target muscles?

Fatigue Proxies:

- *Joint and Connective Tissue Disruption:* On a scale of 0-3 how much did the training disrupt your joints and connective tissues?
- *Perceived Exertion:* On a scale of 0-3 how much perceived effort went into the training?
- *Unused Muscle Performance:* On a scale of 0-3 how much performance falloff was there in unused muscles?

Fatigue management includes preventing needless fatigue accumulation and reducing accumulated fatigue when needed to continue productive training. This is achieved via the following strategies which include both pre-planned and autoregulated fatigue management:

Fatigue Prevention:

1. Training within your Volume Landmarks
2. Using Safe Technique
3. Employing Microcycle Pulsatility

Fatigue Alleviation:

4. Taking Rest Days
5. Taking Recovery Sessions
6. Taking Deloads
7. Taking Active Rest Phases

CHAPTER 3

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CHAPTER 4

SRA

Linking the principles of Overload and Fatigue Management is the relationship between stimulus, recovery, and adaptation (SRA). SRA dictates when we should stimulate (provide Overload) and when we should recover (manage fatigue) for best adaptation (in the case of hypertrophy goals, muscle growth). SRA sets up what is called the "session-rest-session paradigm." This is the modern training practice of training hard, resting, and repeating at a certain frequency that produces best progress.

SRA in the Context of Hypertrophy

In hypertrophy, we train to stimulate growth processes, then rest to recover from fatigue and allow muscle to grow between training sessions (Figure 4.1).

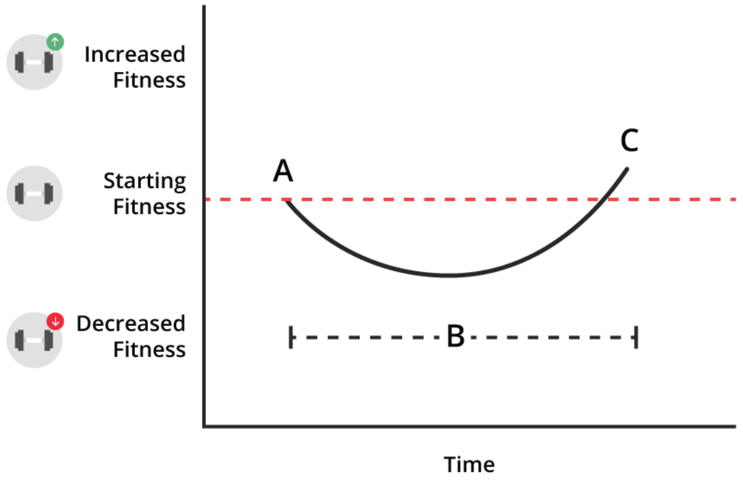

Figure 4.1: The SRA Curve

The SRA curve depicts the stimulus (A) as well as the recovery and adaptation time course (B). After an effective stimulus, fitness is temporarily masked due to fatigue. After recovery, fitness is improved (C) compared to starting fitness level.

So far, the research tells us that a lot of growth *and* recovery occur during the post-training interval and rely on some of the same underlying systems (and thus compete with each other for resources to some extent)[1]. We also know that each relies in part on distinct pathways as well, such that it is possible to get recovery without growth. We don't know *that much more* just yet, but research on the topic continues. Thus, although it is useful to look at SRA as one curve; in reality the time courses of muscle growth and recovery do not overlap perfectly (Figure 4.2).

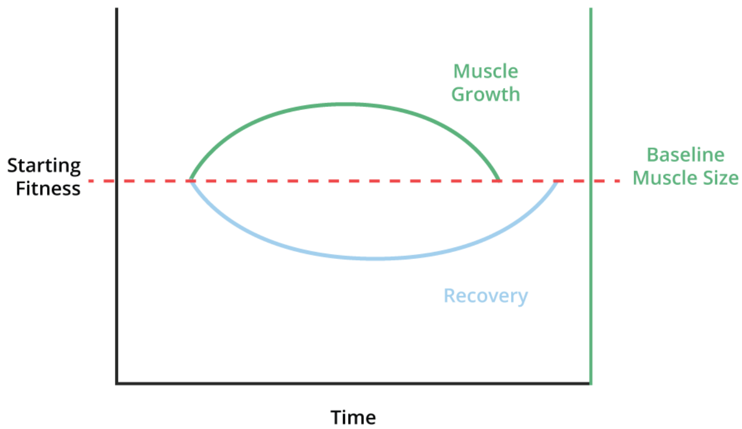

Figure 4.2: The Hypertrophy SRA Curve, Deconstructed

We can separate the hypertrophy SRA curve into its two components; the fractional synthetic rate (FSR) curve (green), and the recovery curve (blue). Muscle growth time course and recovery time course do not perfectly overlap; one can complete before the other.

By separating the SRA curve into its growth and fatigue-recovery components, we can start to get a bit more clarity regarding questions of optimal training frequency. First, ideally, we want the growth curve (technically known as the fractional synthetic rate [FSR] curve—which has been studied in actual muscle tissue) to be as tall and long as possible. Second, we want the amplitude of the fatigue curve to be as low as possible and its length to be as short as possible so that fatigue dissipates sooner to allow more training as soon as possible after growth has completed.

A major concern in the hypertrophy application of SRA is ensuring that the time course of muscle growth and fatigue dissipation overlap. In other words, not training so hard that fatigue-recovery-periods must continue for long after muscle growth has finished and not training so little that we rest when there is neither muscle growth happening nor fatigue preventing further productive training (Figure 4.3). SRA in the context of hypertrophy establishes when we train, how long we rest, and when we train again—giving us guidelines for training frequency, often operationalized as "number of training sessions per muscle group, per week,"; these guidelines are the main focus of this chapter.

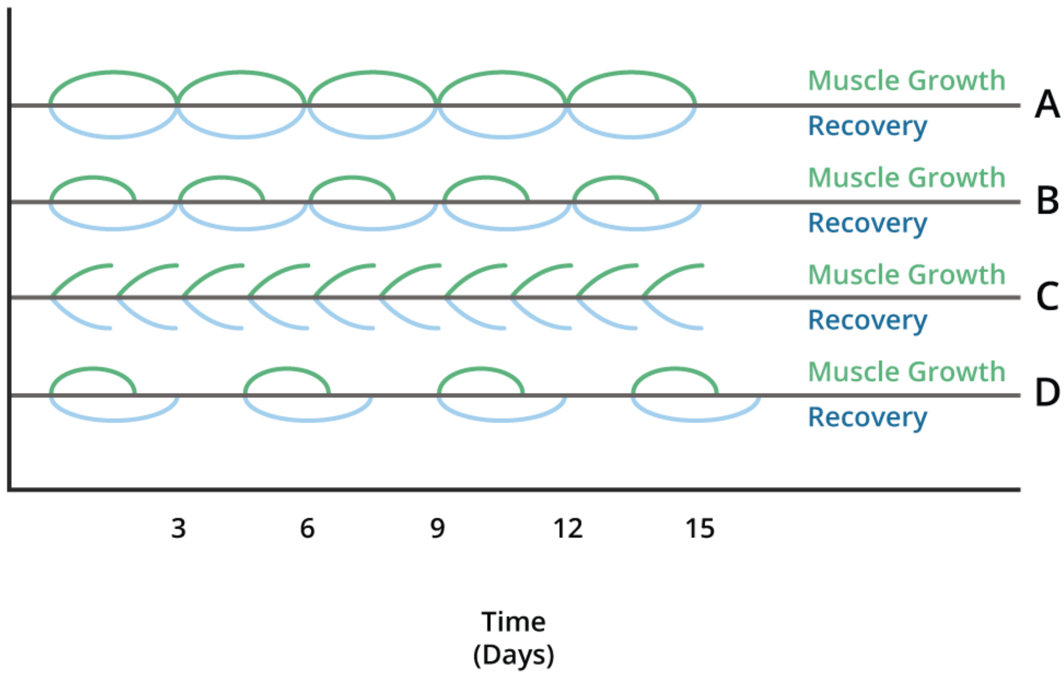

Figure 4.3: Muscle Growth Versus Recovery Time Courses

The first set of curves show idealized recovery-adaptation, where muscle growth completes at the same time as recovery and the next training begins immediately after (A). The next set of curves shows a realistic dynamic for efficient training where recovery takes a bit longer than muscle growth, but the next training session is initiated as soon as recovery is complete (B). The third set of curves shows what happens when training is initiated before recovery or growth processes have completed resulting in more training but not more growth (note that this graph is simplified and that in reality, recovery would start lower and growth would be diminished at each training session) (C). The last set of curves shows what happens when training occurs long after both recovery and growth processes have completed, resulting in less training, but lost chances at growth (D).

In the context of the volume landmarks, we have volumes below MV, which provide so little stimulus that muscle loss results, the MEV, which is the least volume you can do per session and see any tangible growth, then the MAV, which is the exact tipping point at which the balance of training volume (stimulus) and damage (that requires recovery) gives us the most growth. Further still we have MRV which is the most volume we can recover from and then beyond MRV, the point at which recovery takes up all of our resources and there's zero room for growth (adaptation). Beyond this last point training is so damaging that muscle loss has to occur to free up more resources for recovery[2] (Figure 4.4).

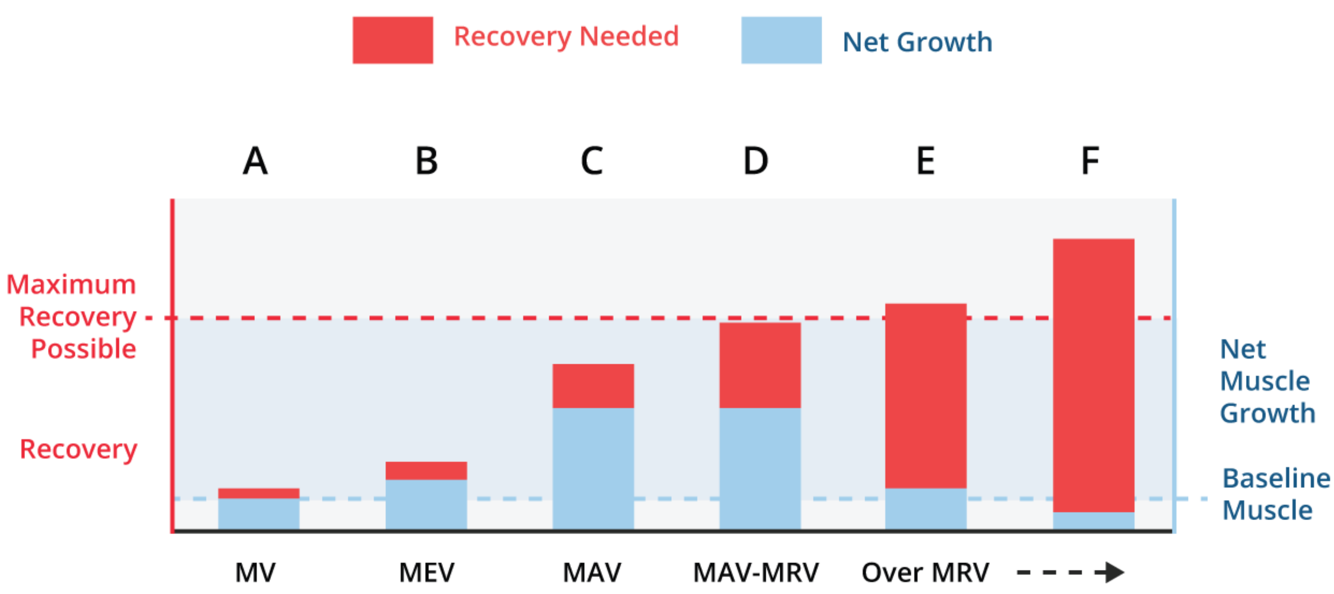

Figure 4.4: SRA and the Volume Landmarks

Training at MV leads to minimal recovery needs and net zero muscle growth (A). Training at MEV will lead to a very small amount of growth and minimal recovery needs (B). Training at MAV will lead to the best absolute growth (C). Training between MAV and MRV causes the most absolute growth, but recovery at this point competes notably for resources and thus less net growth occurs (D). At above MRV growth can still occur, but at a great recovery cost (E) Training farther above MRV can lead to net muscle loss when recovery needs exceed resources even when none are allotted to growth (F)

These concepts all apply to intra-session as well as weekly volume and thus are directly impacted by training frequency—across how many days you divide your weekly volume will determine per-session volume and therefore the stimulus and recovery aspects of the SRA curve.

Unfortunately, at the extremes, the hardest training produces both more growth and more fatigue, and the easiest training produces less of each (Figures 4.5 and 4.6). What this dynamic reinforces is that there is likely a range of training magnitudes (per session) that produce the best relationships of growth to fatigue, and training at the extremes—much easier or much harder—probably produces less favorable ratios. This is the SFR rearing its beautiful head again, as it continues to prove to be a very central concept in hypertrophy training.

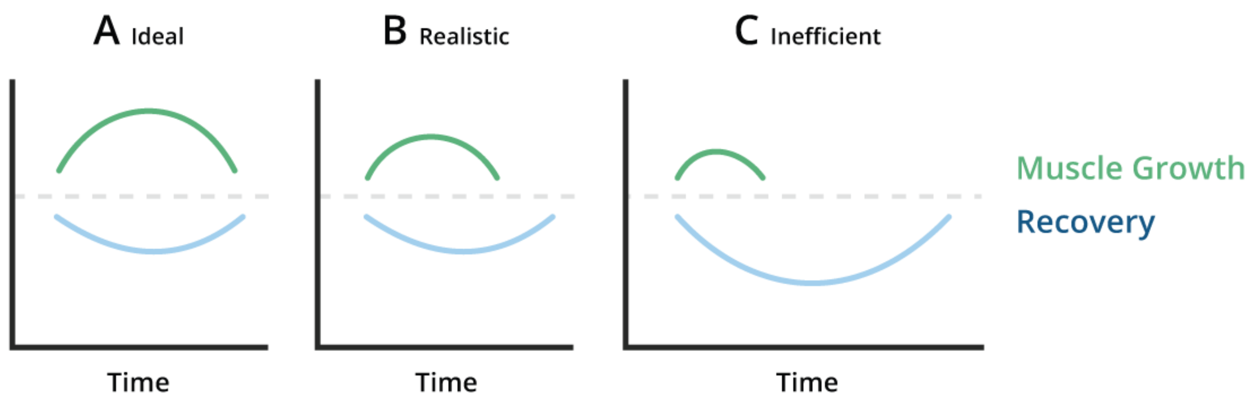

Figure 4.5: SRA Curve Comparisons

In an ideal training world, muscle growth would take as long as recovery so that we were never limited by recovery (A) In reality, SRA curves are more often limited by recovery than muscle growth, meaning we spend some time not growing while we wait to recover to train again (B) Excessive per-session training (often resulting from low frequency training) can cause recovery to take much longer than growth, decreasing total gains (C).

Why does training either too little at a time or too much at a time not produce the best SFRs? Your muscles do not grow unless given a *challenging* stimulus. If your training session fails to meet certain thresholds of volume and load, it might hardly trigger any growth at all, though it will likely trigger some fatigue. On the other end, training that is excessive in volume or load can produce suboptimal SFRs as well, because as mentioned, growth and recovery rely on some of the same resources and pathways which have limits. If so much damage and disruption occur that recovery pathways become exhausted, there is little left over for growth[1].

Either of the above extremes can result from extremes in training frequency (Figure 4.6). For example, if you have 18 working sets for quads to do for the week, six training sessions per week means you do only three sets per session while training once per week means you do all 18 working sets in one session. Even qualitatively you can see why these extremes might not be best for gains.

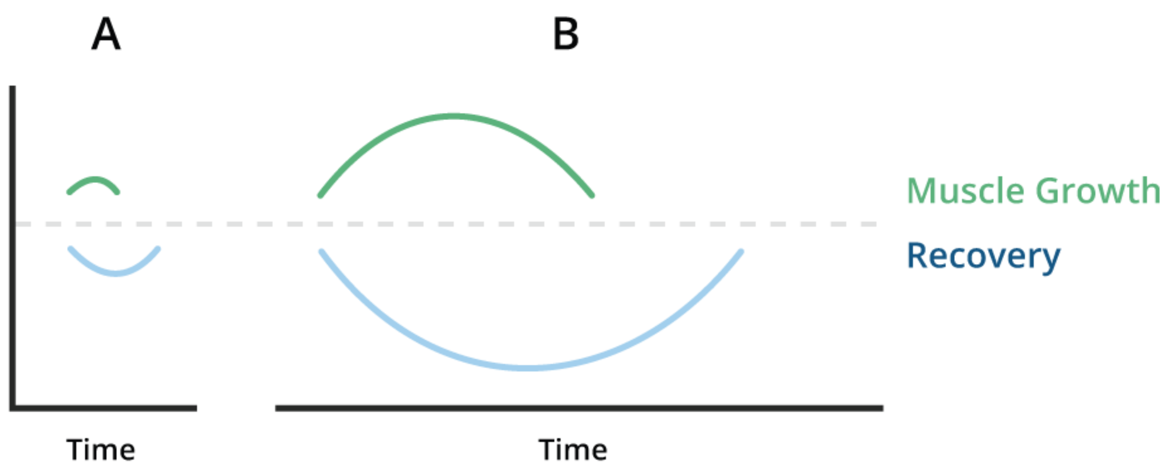

Figure 4.6: The Impact of Muscle Training Frequency on SRA Curve Components

Training with very low per session volumes, which often results from overly high-frequency training results in very small growth curves, although recovery time is also brief (A) Training with very high per session volumes, which often results from excessively low-frequency training, results in a disproportionate amount of time spent recovering after growth has completed. Most training stimuli should be of intermediate magnitude resulting from training frequency between these extremes, around 2-4x per muscle group per week.

Excessively frequent training might not be hard enough (due to low per-session volume) to generate optimal growth, but excessively infrequent training (resulting in very high per-session volumes) might cause so much damage that recovery interferes with growth. Between these extremes, the amount of growth that occurs over time is very similar across a range of frequencies. In order to establish this range, we have to lay out two factors that impact it: per-week volume and the concept of functional overreaching.

Per-week Volumes

Per-week volume is king when it comes to producing training results. Direct studies have shown that frequencies anywhere between 2-4 sessions per muscle group per week have nearly the same results when total volume is held constant[3]. So, the answer to the question "should I train 2x, 3x, or 4x per week?" is: "It doesn't seem to matter much." The take home here is that *within a range of training frequencies*, so long as your total volume is appropriate and constant, any choice is roughly equivalent.

Functional Overreaching

Functional overreaching is the other mitigator. Functional overreaching refers to presenting a stimulus that actually exceeds the optimal SFR considerably, but following it directly with a long enough rest time to allow recovery and adaptation. *So long as more recovery time is taken* after such a stimulus, significant growth occurs and what would have been an unsustainable per-session volume with less rest is now producing very close to best gains[4].

For example, if 10 sets per session is the upper limit of optimal stimulus, three sessions per week with eight sets each would get great results. If we instead did the same 24 sets over just two sessions of 12 sets each, we would get very similar growth.

This is because although 12 sets per session would result in overreaching, the extra few days of rest between them (due to lower frequency) allows for additional recovery and growth time. In essence, functional overreaching might broaden the optimal range of frequencies to include those lower than we might have otherwise excepted.

Both per-week volume and functional overreaching contribute to the fact that optimal frequency is more of a range than a fixed prescription. But that range has limits, and those limits imply that there is training that is too frequent and training that is too infrequent to be maximally effective.

Excessively Low Frequencies

Low frequency training can impact muscle growth negatively either by providing too little volume or, when volume is controlled for, by a lack of recovery resulting from trying to cram too much volume into too few sessions.

Fatigue Versus Hypertrophy Time course

If per session volume is cranked up high enough, it is possible to cause more muscle damage than growth[1]. Because a large amount of damage takes longer to heal than a small amount of growth takes to manifest, it is possible that growth will be completed within a few days, while fatigue lingers for several more. This is a problem because while more growth could occur, the lingering fatigue will inhibit the potential stimulation of that growth. So essentially you are left waiting for fatigue to dissipate and missing out on more gains. To put example numbers to this idea, if instead of doing something like 18 sets in a single workout once per week and growing for three days per week, you did three workouts of six sets each (the same total volume), you could grow 4.5 days of the week (1.5 days after each session—less per-session growth, but more total growth across the week).

This is not just hypothetical. No study has ever found muscle growth elevated past about three days of training, but plenty have reported evidence of lingering fatigue for up to a week or more post-training[1,5–8]. Many bodybuilders swear by lower frequency training, but this is likely because they cram an entire week's volume into minimal sessions and need the other days to recover from such dense training. Science strongly suggests, however, that training muscle groups more frequently than once per week would better serve these bodybuilders.

Rising Systemic Fatigue

In addition to extended recovery needs, the rapidly accumulating systemic fatigue that results from low-frequency training (via excessive per-session volume) has other negative impacts. Too much volume at once results in degradations in technique and mind-muscle connection as well as junk volume training, leading to even less gains.

Junk Volume

Junk food is a term for food that tastes good but doesn't provide many nutrients. In a similar way, junk volume is still training, but it just doesn't cause much of a hypertrophic stimulus. (And unlike junk food, it isn't even enjoyable). If you hit quads only once per week and your MEV-MRV average is 20 sets per week, that means you will have to do all of those sets in one workout. As systemic fatigue goes up and up, your ability to actually recruit your faster twitch motor units falls steadily[9]. Towards the end of such a workout your ability to make the forceful and coordinated movements needed for muscle growth degrades considerably. This is often experienced as feeling "out of gas".

For example, imagine a workout that is 5x10 leg presses, then 5x10 squats, then 5x10 lunges, and then 5x10 leg extensions. By the time you got to leg extensions (or even to lunges) your ability to push close to failure would be very diminished. At first, local quad fatigue can actually help you recruit and thus stimulate more of the faster-twitch motor units, but only to a point. By the third block of five sets, the downside of systemic fatigue would likely surpass the upside of local improvements in recruitment. By the fourth block, your "2 RIR" is more like a 6 RIR as far as the local musculature is concerned and because of how hard you would have to push for such small additions to a stimulus, the SFR of those later sets would be very low. The last sets in such a workout are so under-stimulative that we can classify them as junk volume—they are adding fatigue without scarcely any growth stimulus.

Given the above, the total amount of work in any given session has to be considered—even if each muscle group worked has a reasonable volume individually, too many exercises in a single session can accumulate enough systemic fatigue such that the first set of your last exercise is junk volume. Can you train 10 sets each of quads, hams, chest, and back in the same workout and expect to productively train triceps at the end? Almost certainly not. In addition to a weekly MRV, you have an intra-session MRV; your ability to train at overload in a certain number of sets and still recover to train at overload again *within that same session*. Once you surpass your intra-session MRV, all training after in that session is junk volume.

Technique

Good technique *helps* activate the target muscles and keeps the non-target muscles less active, raising the SFR. Good technique also keeps the lifter much safer. Research across all sports shows that the more fatigue rises with increasing per-session volume, the more likely technique is to degrade; hypertrophy is no exception[10–12]. In addition to losing the benefits of good technique, bad technique itself contributes to further increases in systemic fatigue. This is a very nasty positive feedback loop leading to incrementally worsening per-session SFRs. Notable degradations in technique probably start to occur at the onset of junk volume if not sooner.

Mind-Muscle Connection

The previous section might lead you to try focusing on the mind-muscle connection in the latter half of your session, in attempt to improve degrading technique. Unfortunately, trying to extend workouts by focusing on the mind-muscle connection in their tail ends uncovers a big problem: fatigue *lowers your ability to successfully implement a mind-muscle connection!* You might have experienced this during longer sessions as the feeling that you've "lost touch" with your muscle's movement. Focusing on mind-muscle connection when very fatigued also detracts from the central drive needed for productive training. In other words, when you're very fatigued, you might be able to focus on the muscle or focus on pushing hard, but have a very hard time focusing on both.

Whether it's via junk volume, technical degradation, or the lowered ability to create and sustain a mind-muscle connection, too much systemic fatigue from excessive per-session volume is a big downside to very low frequency training.

Rising Local Fatigue

Rising set numbers benefit the SFR initially—they can mean fewer reps per set for a robust stimulus due to quicker activation and exhaustion of the biggest motor units[13,14]. Rising set numbers also generate local fatigue, however, which can impair performance and reduce SFRs.

Glycogen depletion

When your muscle glycogen stores are taxed, your ability to execute stimulative training will be impaired. Lack of glycogen reduces the capacity for intensity and volume, which limits the ability to generate overloads, often leading to junk volume training.

Excitation-contraction coupling

Local fatigue also interferes with excitation-contraction coupling (ECC). ECC is the process by which neurons signal muscle fibers to contract. Hydration reductions around the target muscle (which can be caused by overheating in the area from many prior sets) interfere with signal propagation in the motor neuron[15]. Many contractions from many sets can also reduce neurotransmitter (signaling molecule) availability leading to less dependable muscle contractions[16]. The space between the neuron and the muscle can also become littered with metabolites from the many previous contractions leading to more signaling problems, and finally a reduction of calcium and other compounds in the muscle cell itself can limit contraction as well[17,18]. In other words, enough local fatigue can accumulate so much that productive muscle contraction is physiologically much less likely. This results in either a diminishing training stimulus due to poorer contraction of larger motor units, or a drop in the SFR due to the need for more central drive (resulting in more systemic fatigue) to get the same local contractile effects.

A noteworthy distinction is that muscles with a larger proportion of faster fibers will experience within-session local fatigue with less volume than muscles with a larger proportion of slower fibers. It is not clear exactly how many sets it takes to create a detrimental amount of local fatigue, but that value *does exist*, and excessive local fatigue is a concern. This is why choosing to do all 10 of your weekly hamstring sets in one workout on an ultra-low frequency program for example may not be a great idea for best growth.

Dose-Response Relationships

The biological processes behind muscle growth have top-end caps regardless of any other interfering effects. A familiar example of such physiological limits is dietary protein intake for muscle growth. Increases in protein intake up to a gram or so per pound of bodyweight per day help grow more muscle, but no reliable added growth benefit comes after this top end[19]. This limit has nothing to do with digestion rate, absorption rate, byproduct clearance rate, or even health—the reason you can't benefit from much more protein is that *your body can only grow muscle so fast* [20]. In much the same way, there is very likely an amount of training volume per session that maxes out muscle growth pathway capacities. Once such pathways are at full blast, no amount of extra training has the ability to make them go any faster. Although there is no direct evidence for an anabolic signaling ceiling, it makes theoretical sense and multiple studies support a physiological limit to muscle growth per-session of stimulus[21–24].

Lower SFR via Excessive Damage

The more you train in a given session, the more damage you cause. Over several days following your workout, your body has to both heal the damage *and* perform the cellular operations of muscle growth with many of the same resources[1,25]. Our bodies have evolved to prioritize damage recovery over growth, because if they didn't, you'd grow and grow with more and more unfixed damage and eventually be traumatically injured. In other words, once you hit a certain number of sets per session, adding any more sets isn't just junk; it actively reduces how much muscle growth you can experience. Note that MRV is the point at which resources are fully at their limits. This means that, short of functionally overreaching, training above MRV is detrimental to muscle gain.

The current data suggest that there is very likely an optimal amount of volume per session that allows enough work to stimulate robust growth but not so much that healing competes with growth pathways[25]. Strikingly, in the studies that demonstrate excessive damage as a negative for hypertrophy, subjects were untrained and volume was fairly low. In fact, many studies on the untrained show that one set to failure per session causes as much growth as three or more sets to failure—the extra sets seem to add about as much damage as they stimulate added growth, leading to a net neutral for additional gains[26–29]. This number is higher for advanced lifters, but it is not clear by how much. While advanced lifters are more resistant to muscle damage at any given load or volume, they are also much stronger and can do more damage per set than beginners[30]. Keep in mind, these studies are mentioned here as evidence for the idea that there *is a point* at which more work does not mean more growth. These studies are done with sets to complete failure, so not representative of a scientifically constructed program and should not be taken to mean that one set per session to failure is the best choice for growth. It's also worth noting that one and three sets causes equivalent hypertrophy only in roughly the first month of training. After that, multiple sets cause more growth every single time. But the point still stands; it's possible to get more (or the same) growth out of less training if any more training just adds damage and not growth.

Another way to view this relationship is through the SFR lens. Because shorter sessions (up to a point) improve SFR of any given volumes, using them might actually let you squeeze more muscle growth out of the same weekly recovery allotment. This means that training more often but with shorter sessions can potentially raise your MRV by increasing per session SFRs. That's an important implication and might help to explain why research has so far uncovered not just that higher frequencies tend to grow more muscle but that they can support weekly MRVs far higher than lower frequencies can[3]. Win-win!

Excessively High Frequencies

With so many downsides to low frequency training, (especially the reduction in weekly MRV), you might be thinking that the highest possible frequency (whole body training every day) is the best option. As with excessively low frequency training, excessively high frequencies also have some serious downsides—some coming directly from the high frequency itself and others from the very low per-session volumes created by high frequencies.

Post-Activation Potentiation

Even with a proper warm-up, the second set of any given exercise often goes better than the first. This is because the nervous system is potentiated by the first working set, muscle and connective tissue temperature is up, and even the alignment of muscle fibers is improved, all of which can result in more faster fiber recruitment and better per-set growth[31]. If we design a program that is so high frequency that only a single set occurs per session, this potentiation is lost. Mind you, this is unlikely in most programs, but it does bear mention given programs like “Squat Everyday” that do prescribe one set per session.

Increasing Fractions of Effective Reps Across Sets

After the first one to two sets, if RIR is kept the same and if rest times are not excessive, reps will likely decline. For example, if you do 10 pullups on each of your first and second sets, you might do only seven or so on your third and fourth sets. This is due to local and systemic fatigue, but has interesting implications for hypertrophy. Only perhaps the last five of 10 reps of the first set are most stimulative to the most growth-prone high-threshold motor units[13,14]. As you become fatigued, however, especially locally, your faster fibers have to activate sooner. Thus, while your fourth set might only be seven reps, you still may activate the faster fibers for five of those. Thus, sets done later in a series have the better stimulus to work ratio. Mind you, this sort of relationship doesn’t go on indefinitely. As we approach 10 sets or more in a workout, fatigue begins to reduce faster fiber activation and the ratio of faster fiber stimulation to total reps drops back down. Put another way, (ignoring other factors for the moment), this mechanism acts to prop up otherwise falling set-to-set SFRs across as many as eight or more sets in a row. This is one of the central concepts behind the myoreps style of training.

Although more total stimulus is obtained from more sets per session (up to a point), each subsequent set stimulates less absolute muscle growth than the one before it. The first sets activate more sensitive pathways, but continued sets decrease this sensitivity. The SFR and muscle growth therefore still decrease with each successive set, but *not nearly as much* as they would without the "increasing fraction of effective reps" mechanism at play[32].

As long as your per-session volumes don't exceed 10 sets per session per muscle group, there is probably no overly compelling reason to split training up into more frequent sessions.

Mind-Muscle Connection Potentiation

You might have noticed over your training career that mind-muscle connection on the first set is often lacking. In fact, the mind-muscle connection seems to have an inverted-u shaped curve—it often improves as you do more sets, up until fatigue forces it to decline. Because this decline does not likely happen before five or more sets, there is probably a mind-muscle connection "sweet spot" somewhere between three and eight sets per muscle group. Because the mind-muscle connection boosts SFR, its peak levels are definitely of interest in programming. If you train with such high frequencies that you can't allot more than 1-2 sets per muscle group per session, you might have to stop your training right before you start hitting your best mind-muscle connections.

Technical Potentiation

Similarly, to mind-muscle connection, technique improves across bouts until enough fatigue sets in to depress it. With the most precise internal and external cues, even the best lifters are unlikely to have their first set in a session be the most technical. After the first set, you can usually spot opportunities to improve technique. Maybe your hips came up just a tad faster than they should have in the squat, or your elbows could have been a little more flush to your body on the close grip bench. You note such deficiencies and you attempt to address them in the next set. By this process, your third, fourth, or even later sets often look and feel the best. You may have experienced this anecdotally as “getting into the groove” after a few sets.

Whether your technique feedback comes from internal feel, video, the mirror, the feedback of watchful training partners, or some combination, better technique props up SFRs and creates less injury risk. This of course boosts how much total productive volume you can do in any given week of training, maximizing muscle growth potential. The peak technique range is likely similar to the peak mind-muscle connection set range: around three to eight sets per muscle group per session. If you train with very high frequency and thus use concomitantly low volumes per session, you might be lowering the average technical proficiency with which you train.

Cell Swelling and Metabolites

We have learned that the pump from cell swelling and metabolite accumulation stimulates muscle growth. So, how many sets does it take to maximize these effects? The answer of course varies based on many factors, but it may very well take more than two sets. Conveniently, given per session volume ranges for peak technique and mind-muscle connection, the biggest pumps probably occur for most people and in most muscles somewhere between three and eight sets per muscle group per session. This is especially true if the sets are submaximal, as most in a logical training program will be.

As we know, the metabolite burn can also improve the mind-muscle connection by allowing you to really feel muscles, especially those you can’t see that well in the mirror, such as triceps, back muscles, glutes, hamstrings, and calves. This improvement can act as a feedback loop to improve your set-to-set technique as well.
For example, if you get a quad pump and burn, you can feel the quads that much more, and you can feel the stretch that much deeper. This can lead you “squat into your quads” (more upright posture with more knee flexion vs. hip flexion) and thus

improve the technique and SFR of your squats. The burning sensation of metabolite accumulation can also confirm technique alterations to target the muscle more.

Improved mind-muscle connection, technique, pump, and burn from multiple sets in a single session cross-potentiate each other and suggest that excessively high frequency, low set-per-session training may not be the best strategy for muscle growth. In reality, while all of these factors prop up the decline of set-to-set SFRs, they may only be able to tie the SFRs of ultra-high frequency training at more moderate frequencies, as high frequencies have the major advantage of having fewer, and thus fresher, high-SFR sets per session. But because these factors might prop up moderate frequency SFRs to tie high frequency SFRs, other downsides of excessively high frequencies might be able to break the tie in favor of more moderate frequencies, as we illustrate below.

Excessive Warm-ups

Even if none of the aforementioned factors amounted to any meaningful downsides for high frequency training, there is the practical concern of warm-up durations. When you are only training two muscle groups in one session, for example, because your per-week frequency for those muscle groups is neither too high nor too low, you essentially have to warm up twice. Once at the beginning of the workout, both as a general warm-up and specifically for the first target muscle group, and once later when switching to train the other muscle group. If you train more frequently and thus train more (let's say three) muscle groups in the same session, you will have to warm up three times; once before each muscle group is trained. If you are training four muscle groups, you'll have to warm up four times, and so on. If we take this logic to the extreme of only one set per muscle group per session, you'll have to warm up for every single set. In other words, even if you only use one warm-up set per muscle group, your warm-up to work set ratio will be 1:1. On the other hand, if you do four sets per exercise and do two exercises per muscle group per session, you only need to warm up twice, for a warm-up to work set ratio of 1:4; this is leagues better than the 1:1 ratio in the ultra-high frequency example!

When you train more frequently your muscles might require less warming up, but in most cases, you'll still end up warming up significantly more with higher frequency programs than you will with lower frequency programs. This means they might take more gym time, or even have a lower SFR when examined in total sets divided by the average growth benefit of each set. In any case, ultra-high frequency is a less efficient way to train, so that should be noted as a downside even if it is worth the trade-off on the net balance for other reasons.

Joint Versus Muscle Recovery Time course

Muscles recover faster than fascia and tendons, which in turn recover faster than ligaments and joint structures[33]. If you train with an extremely high frequency, you tend to train often before connective tissues have fully recovered. In lower frequency programs, while connective tissues do sustain more damage from any given session, they are able to recover more completely between sessions. This might result in not only better long-term connective tissue integrity, but also lower acute injury risk in any given session, as each session in a lower frequency program begins with a lower level of connective tissue degradation.

Higher frequency training also means more reps and therefore more connective tissue stress. Squatting twice per week with two sets per session and reps at 10,8 gives 36 total reps while higher frequency squatting of one set of 10 reps four times a week gives 40 total reps. This might be great for more muscle stimulation, but hard on connective tissues (that you need intact down the line to continue growing). In addition, since the first set is never as warmed up as subsequent sets, having only first sets (or more first sets and less warmed up sets overall) as in the high frequency example might mean even more connective tissue stress.

Remember that one of the biggest upsides to higher frequency training for the muscles that can recover quickly is the boost to weekly MRV. If you can only train your biceps once a week, 15 sets might be their MRV, but if you can train them twice, it might be 25, and three times might be 30, and so on. Again, excellent news for the quickly-recovering muscles. But for connective tissues and especially the slow-to-heal joints, this is at best a mixed bag. Different connective tissues also have different tolerances; the biceps tendon might be good for 12 sessions of biceps per week (which is nothing you would ever do in any sane program, this side of Rich Piana's methods), but other structures run into bigger problems much sooner. For example, heavy pressing even six times per week might wreak havoc on your shoulder joints.

These connective tissue recovery issues don't mean that we can never reap the benefits of very high frequency training. A dedicated mesocycle or a series of mesocycles of higher frequency might allow for great stimulus as long as these are followed up with lower frequency mesos to allow connective tissue recovery. Many lifters have used high frequency training programs with great initial success, but fail to plan or utilize recovery periods and eventually succumb to injury.

Excessive Systemic Fatigue

Although higher frequencies can potentially raise the MRVs of individual muscle groups, they can also allow for so much training that systemic MRV is surpassed. For example, going from four to six sessions of 20 sets each might be fine for individual muscle groups, but adding 40 total sets per week may leave you systemically over-reached. If you do choose to increase session frequency, watch your systemic fatigue and make sure the added volume isn't too much. Practically, we recommend never increasing frequency by more than one weekly session addition per mesocycle.

Intrinsic Variables that Affect Best Frequency Choices

Frequency can be determined to some extent based on how fast muscles can heal from their per-session-MEV volumes (so long as systemic fatigue is also taken into consideration). When they heal, you train them again, and so on, and a natural training frequency emerges. But the underlying reason some muscles heal faster than others is based on at least five factors.

Muscle Size

Larger muscles tend to take longer to heal than smaller muscles. This is due to the fact that larger muscles produce and experience more force and also simply have more muscle volume to damage, and thus that much more to repair. This is at least partly why very high frequency programs work wonders in beginners and intermediates but pose recovery problems in more muscular individuals. While a 250lb advanced, muscular lifter might best benefit from training each large muscle group 2-3x a week, a 115lb not-very-muscular beginner might be able to do full body 5x a week and recover on time, each time. This idea applies to larger and smaller muscles within the same lifter as well—the smaller muscles (side delts, biceps) can usually be trained at higher frequencies than the larger muscles (pecs, glutes). Lastly, as you grow in size and experience, be prepared to alter frequencies.

This knowledge can save you a lot of frustration in your personal and coaching endeavors. For example, perhaps you used to be able to train your back four times per week, but over the last year or so, you keep running into recovery problems. Of course, you should assess your diet, sleep, and so on, but a possibility to consider is that you've gotten bigger and your back simply cannot heal as fast as it used to. You might try three times a week and find it to be ideal. There's no shame in this, and in fact it's an indicator that you're growing!

Muscle Strength

Because strength and size are tightly correlated, as you get stronger, you might need longer SRA intervals and thus potentially lower frequencies to recover. The more force a muscle generates, the more weight it lifts. The more weight it lifts, the more damage it takes on. Stronger muscles also cause more connective tissue disruption precisely because they load those tissues with larger forces.

Muscle Fiber Type Percentage

Faster fibers are stronger per cross-sectional area, and thus generate and take on more damage[34]. They are also less extensively vascularized than slower twitch fibers, which can lead to less efficient nutrient delivery and longer recovery times[35]. Faster fibers have a higher percentage of sarcomeres (contractile apparatuses) than slower fibers (which have more mitochondria and other endurance-supporting machinery that is not directly damaged by force exertion), so they take on even more damage than you'd expect by their size alone[36]. Lastly, faster fibers have less myoglobin and other transport proteins to take surface nutrients deeper into the belly of the fiber for recovery purposes, and because the fibers are typically bigger, their higher volume to surface area ratio makes delivery of recovery nutrients a more time-consuming process[35]. Taking all of that together, it's no big surprise that even when they are of comparable size and strength, muscles with a higher percentage of faster twitch fibers tend to take longer to recover than muscles with a higher percentage of slower twitch fibers—this applies between and within individuals[37]. For example, although quads (slower twitch) are larger than hamstrings (faster twitch), quads often heal from similar set and rep schemes at the same time or even faster than hamstrings.

Something to note is that because faster fibers are bigger and stronger to begin with and get bigger and stronger from training more quickly than slower fibers, the disparity between slower and faster composition muscles grows over time[38]. Thus, if your faster-twitch glutes used to recover at a similar rate to your slower twitch quads, the longer you train both, the more glute recovery will lag, which might force you to change your frequencies over time.

Taking all of these intrinsic factors together implies that muscles that recover from more total work (larger per-week MRVs) will often be the same muscles that can benefit from more sessions per week. Lower training frequencies might not be able to tap into maximum growth potential in such cases. For example, if your hamstrings have an MRV of 15 sets per week at two sessions a week, perhaps their MRV could expand to 18 sets per week if you increased to three weekly sessions, but probably wouldn’t get much higher than that with more session additions. On the other hand, if your side delts have an MRV of 24 sets per week from two sessions, they might have an MRV of 30 sets if you add a third training session for them and 34 sets if you add a fourth, precisely because the very same factors that determine their weekly MRV also make them heal faster and make them able to handle that much more!

An interesting implication of the differential recovery between fiber types is that slower twitch fibers might not be getting their ideal hypertrophy if they are trained at the same frequency as faster twitch fibers. If it takes your faster fibers three days to heal after training, you would train about twice per week for great results. In those very same muscles, the slower fibers might be healed after only 1.5 days and would spend half of each week not growing. A potential way to address this disparity is to have 2-3 sessions per muscle group per week that are done at 2-0 RIR in the 5-10 and 10-20 rep ranges (to train both fiber types) and between those, 2-3 sessions that stop at 5-3 RIR in the 20-30 rep range to target the slower fibers. This both gives the slower fibers enough frequency to optimize their growth and lets the faster fibers recover to have productive sessions. Remember though that connective tissue and systemic recovery might be stressed and should be assessed within this strategy. This strategy also effectively happens to at least some extent with overlapping muscle group training. For example, when you train back, the slower fibers of your rear delts and biceps get very well stimulated, but those muscles will stay too far from failure for their fastest fibers to be fatigued much. The same goes for chest and triceps and glutes and quads.

Sex

Females recover faster on average than males from any given number of sets[39–42]. Not only do they recover faster between sessions, they recover faster between sets in each session[43]. The main reason for this is that on average men have larger and stronger muscles[44]. Psychological differences in effort might also contribute. Women may not be on average as driven to egotistical displays of ability and while this might mean women get less growth than they would out of any given session, it might also keep them growing consistently as they can have more back-to-back stimulative sessions and less injury (and indeed females tend to get hurt—especially traumatically—at lower rates than males). Lastly, females seem to clear metabolites better and faster than males. This is perhaps related to their muscle size to vascularization ratio[45]. Females get both less stimulus and less fatigue from a given set/rep/rest scheme and can thus recover faster, shortening their SRA curves.

Females therefore tend to benefit from higher frequencies than males, on average. Nothing beats an individual derivation and prescription of training frequency of course as there are large, muscular females and small not-so-muscular males, but a good starting point for females might be “add one session per week” compared to what you would program for a male. Because females also have higher MRVs than males, adding one session straight up without even normalizing total volume is probably just fine. In other words, if your male clients train around three times per week for a given muscle group with 3-10 sets per session, trying four times a week with 3-10 sets per session for female clients might be a good place to start.

Muscle Architecture

Muscles are not all built and arranged in the same pattern, and these design differences can impact recovery times. First of all, while some muscles have fibers that mostly align into one force vector, other muscles have fibers that almost never align in the same force vector. For example, when you do a pec fly, almost all pec fibers contribute force to the motion because they all point in relatively the same direction (towards the distal pec tendon). On the other hand, there is no single movement that requires nearly all of your delt fibers to contract. The delts function and therefore recover much like three separate small muscles. The rear delts extend the shoulder, the side delts abduct it, and the front delts flex it. You never really use the deltoid as one muscle and so it recovers from training sessions much more quickly than you would expect for its size.

This is especially pertinent to connective tissue recovery. While your distal deltoid tendon has no problem recovering from the damage incurred by just the pull of the rear, side, or front delt, the pec tendon has to recover from the forces of nearly all of the pec fibers pulling on it in unison. In general, muscles that are designed to unify large simultaneous contractions of most of their fibers into one tendon will need more recovery than muscles that can be activated only in parts and thus have a low connective tissue impact per any given level of force. Muscles like the pecs, lats, and quads are in the first category, while muscles such as the delts, glutes, traps, and forearm muscles are in the second category. The first category of muscles requires more recovery and therefore less frequent training than the second, so that associated connective tissues can endure successive overloads leading to more muscle growth.

Another architectural difference between muscles is how they are positioned with regard to joints, for both their mechanism of action and their propensity to sustain larger forces. Some muscles are attached across joints in such a way that they are more exposed to both eccentric actions and high degrees of tension under stretch.

The hamstrings are a good example. If you slightly bend your knees and keep your lower back in lordosis, flexion at the hips instantly becomes a hamstring-lengthening movement. Because the glutes and most other muscles in the region tend to have a larger ROM in that position than the hamstrings, this makes the hamstrings the limiting factor in flexibility and leaves them very exposed to eccentric stimulus. Because they are the least flexible in this position, the hamstrings not only get a lot of eccentric stimulus on the way down during the hip hinge, but they also get a chance to stretch to maximal safe anatomical positions. Lastly, the rest of the body is stably positioned at this deep stretch (and the eccentric that precedes it) and well suited to support large external loads (like a stiff-legged deadlift or a good-morning, for example). This means that the hams not only get a huge eccentric stimulus, but they also get the most tension under stretch of pretty much any other muscle in the body[46]. This means that rep-for-rep, the hams simply take more damage and will likely need more time to recover from a session of any given set number. In contrast, the side delts are rarely stretched meaningfully under tension and thus simply don't have as much recovering to do between sessions. The delts, the lats, the traps, the biceps, the rhomboids, teres major, spinal erectors, and the forearm flexors are not positioned in ways that allow for very much stretch under tension and can thus potentially be trained more frequently than their sizes would originally imply. Muscles like the hams, glutes, quads, calves, triceps, and pecs can be stretched under tension very easily, and thus often cannot be trained as frequently at MEV-MRV volumes.

The Current Research on Hypertrophy Frequency

Before we delve into the direct research on frequency, it pays to remember that research subjects may differ from you or those who you train along any of the parameters discussed in the above sections. Intrinsic factors have such large effects on frequency needs, that any research-derived numbers should be taken as averages and never applied wholesale to all muscles or all people.

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So far, we have discussed the SRA and what it implies theoretically for training frequency, explored the potential downsides of extremely low or extremely high frequencies, and discussed the relative impact of different parameters on training frequency recommendations. Before we tie all of that information together in an algorithm that you can use to derive training frequencies for individuals, let's ground our theory and predictions in empirical evidence. While doing so, we again urge you to keep these caveats in mind: Research is very often done on untrained subjects and on only fractions of their total musculature (freeing up recovery resources that would have otherwise gone to training and recovering the rest of the body). We can therefore assume that the research will auto-bias in favor of higher frequencies than might be optimal in the real world, especially for experienced lifters training their whole bodies.

Here are some of the basic findings on training frequency from direct laboratory research. For the populations studied (mostly college aged students with 0-3 years of training experience):

1. 1x per week training seems to be insufficient compared to 2x a week or greater training, even when equated for volume[3].

2. When equated for volume, 3x a week training seems to be better than 2x a week training by a small but notable factor. 4x a week training is better than 3x by a much smaller factor, and 5x a week is better than 4x a week by an almost indistinguishable factor[47].

3. Higher frequencies support higher MRVs. Even though non-volume-equated literature is lacking, it's likely that non-volume-equated higher frequencies are even more effective than volume-equated ones. In other words, 3x is considerably better than 2x because of the frequency alone *and also* because 3x training can let you do more, recover from more, and adapt to more volume per week than 2x. Same goes for 3x to 4x, and probably 4x to 5x.

4. Per-session MAVs are not likely to be more than 15 sets per muscle group in most of the groups studied and are probably somewhat more likely to be in the 5-10 set per session range[22,23,48,49].

5. Muscles that take longer to recover (larger, stronger muscles) seem to benefit from higher frequencies as well, but not *as much* as smaller muscles. Individuals who are stronger, training lower body, and or have trained for longer get less out of higher frequencies (though still benefit) than weaker individuals, training upper body, and or who are new to training[47].

(There is no current research on long-term high frequency training, so extrapolating such training into years of practice is at best uncertain and at worst a recipe for chronic injury).

The research on frequency and muscle growth is quickly growing, which is a great thing! But it also means that constant updates will need to be made as our scientific understanding evolves. Luckily, current knowledge is enough to logically derive and update very effective training frequencies for various people.

How Per Session and Weekly Volume Caps Impact Frequency

When looking at training frequency research, it is important to look at total weekly volume. The studies that find better results for higher frequencies use higher total weekly volumes while those that don't, do not. Frequency by itself is much less relevant, aside from the fact that it dictates per-session volume. Once you have your weekly volume set, per-session volume and therefore frequency will be your next program design task.

The likely average sets per session per muscle group for MAV is around 5-10 (meaning that your average sets per session per muscle group across a lifting cycle would be between 5-10, with MEV probably starting lower and MRV probably ending higher). MRV for a given muscle group per session has a likely cap of around 12 sets and the limited existing data show a pretty clear drop-off in effect past about 15 working sets per muscle per session[22,23,48,49]. The degree of systemic fatigue per set of an exercise also probably has a limiting effect on per-session volume. For example, biceps training does not use very heavy loads over long distances, so some people might be able to do 15 sets of curls in a single session without any sets being junk volume. On the other hand, glute training like deficit sumo deadlifts is so systemically fatiguing that more than five working sets might mean junk volume. Similarly, the ability to lift heavier weight comes with additional fatigue, so bigger, stronger lifters might have more limited per-session volumes. It is also likely that the per session, per muscle group MAV can be as low as a few sets per session when new exercises or rep ranges are introduced into training [50].

In terms of total session volume (including all muscle groups worked) 25 total sets per session is a likely average MRV cap. Some people can do north of 30 productive sets per session, but anything much more than 30 sets should raise a skeptical eyebrow. Even if we cap per session volume on the higher end, say 30 sets, this has immediate implications for weekly program design. Specifically, if you want to do justice to a large number of muscle groups, 3-4 sessions per week just may not cut it, especially if you are more advanced. For example, if you want to train biceps, triceps, calves, hams, quads, glutes, back and shoulders thoroughly, that's eight muscle groups. This might mean 10 or more working sets per muscle group per session at various times in your accumulation phase. Even if you train each muscle group a very conservative 2x per week, that's 160 total working sets per week. 160 total sets divided by our 30 sets per session cap is just over 5x per week training to get all that work done. If you tried to do the same volume with only three workouts per week, you'd be at just over 50 sets *per workout*, which will almost definitely lead to junk volume and a great deal of suffering. Very strong and very advanced bodybuilders additionally have *more* muscles to train for specific development—like traps, forearms, and different parts of their backs (vertical vs. horizontal pulling, for example). Further, because they are more advanced, they both need more volume to grow and also likely have a lower per-session junk volume cap—perhaps something like 20 sets per session. If you are looking at 200 total weekly sets and a cap of around 20 sets per session, that's something to the tune of 10 training sessions per week! Either way you slice it, the more advanced you become, the more sessions you probably have to add to your weekly repertoire to keep the gains coming along at their best pace.

It is also likely that the best SFRs are seen with frequencies that result in an average of around 3-8 sets per muscle group per session to be performed. Because of time and resources saved not having to warm up for as large a portion of total training time, the stimulus-to-time-spent-lifting ratio is probably also maximized in this range. The frequency that allows this per-session volume is generally between 2-4 sessions per muscle group per week (of course with exceptions). Again, all of these ranges are average best guesses and although they are a great place to start, volume and therefore frequency should be based on individual response.

Practical Application: Frequency in Program Design

An important point to remember as we work through the following method for frequency needs assessment and program design, is that an effective training frequency is one that lets you train hard (between MEV and MRV), recover, and train hard again, preferably harder with each session within an accumulation phase.

Taking that as our central organizing principle, we can construct a Frequency-Deriving Algorithm with the following procedures:

1. Train a muscle group with session-MEV volume via the "MEV Stimulus Estimator Algorithm" from the Overload Chapter.

2. Wait just until the muscle is no longer sore or tired and train it again.

3. See if your performance on that session is at or above baseline. If it is, note the time interval between the two sessions. If it's not, train the next session as planned, but add one extra day of recovery between the next two sessions.

4. Adjust volumes as-needed from session to session via the "Set Progression Algorithm" from the Overload chapter.

5. After 2-5 consecutive sessions, you are going to get a relatively stable frequency from running this algorithm. This is the frequency you can use for that muscle over the next several mesocycles of training, all the while using the Set Progression Algorithm to make sure you're dosing volume appropriately.

Example 1:

1. You train pecs with 4 sets of bench press in Session A on Monday. You got a good pump and a bit of soreness.
2. You wait for soreness to be completely gone and this takes one whole day, so you then train 4 sets of incline bench in Session B Wednesday.
3. Performance in Session B is at or above baseline, so you train with 4 sets of machine presses on Friday's Session C as planned.
4. Next Monday, you increase your bench press volume to 5 sets in Session A2 so that you get a comparable pump to you first week's Session A.
5. You heal on time to perform well on Wednesday's Session B2, and you have derived that your working frequency for chest is at 3x a week. You continue to add sets as-needed through the accumulation phase, eventually topping out at eight sets per session on average for a total MRV of 24 sets per week for chest.

Example 2:

1. You train hamstrings on Monday's Session A with 4 sets of lying leg curls.
2. Soreness heals in two days, by Wednesday, and you train Good-Mornings for 4 sets.
3. Performance in Wednesday's session (Session B) is at or above baseline, so you train with 4 sets of seated leg curls in Friday's Session C. But you are still sore from Good Mornings and don't perform as planned on seated leg curls. You rest until Monday and do Session A2.
4. You do 5 sets of lying leg curls on Mondays' A2 because you didn't get too pumped or sore from that session last time, calling for a volume raise according to the Set Progression Algorithm.
5. Since you now know that Good Mornings are very taxing even at their MEV, and that they require a longer SRA interval, instead of training them on Wednesday you move them to Thursday and do 2 sets of good mornings plus 2 sets of

seated leg curls. You recover fully from soreness and perform well next Monday (Session A3), and you continue to add sets as needed through the accumulation phase with your newly derived frequency of 2x per week for hamstring training.

It is essential that you hit close to your MEV when you first execute this algorithm. It's easy to train well above MEV, need more days to recover, and mistakenly derive a very low training frequency for all of your muscles—leading you to miss out on potential gains. At MEV, you know that the recovery time is solely determined by the intrinsic factors of that muscle and not by the excess volume. Training with less than MEV would also lead you to conclude that you can benefit from an ultra-high frequency—also leading you to miss out on potential gains by erroneously adopting and excessively frequent program.

Notice that while this method relies on accurate MEV assessment, it does actually derive rather than prescribe training frequency. This is a huge benefit, as it lets your body tell you what your best frequency is. While this method is definitely the superior theoretical method for finding frequency, it is a bit cumbersome for clients or friends of yours that might find the ratings, feedback, and alterations a bit laborious or confusing. The alternative is to modify frequency from a given program based on how your client responds to that program.

In this Simpler Frequency-Deriving Algorithm, you can:

1. Write a program that overloads each muscle group twice a week and at estimated MEV volumes. (Twice per week is a good starting point because it is unlikely to be too high a frequency and shooting low and having to ramp up is less risky than the reverse).

2. Begin working up in volumes via the Set Progression Algorithm or any progression that results in eventually reaching 10 or so sets per muscle group per session.

3. Note soreness and healing timeline during this whole accumulation phase—especially at the higher per-session volumes later on in the phase (7+ sets per muscle group per session). Note whether the soreness heals right before it's time to train again or if it's healed a day or more before (this latter option includes "muscle never gets sore").

4. Note the performance in all sessions during accumulation, especially at higher (7+) session volumes.

5. Finish the mesocycle and deload.

Looking over all sessions, if soreness healed just on time for the next session on average, especially at higher (7+) volumes, leave the training frequency where it is. If it healed a day or more before the next session, increase the frequency by one extra session in the next mesocycle. If at any given point overlapping soreness or performance loss are repeatedly occurring in the higher (7+) volumes, or the Set Progression Algorithm prevented volume increases, consider removing a session in the next mesocycle.

You can repeat this algorithm after every single mesocycle, and that will keep your frequency evolving to your (or your clients') needs.

Simpler Algorithm Example 1:

1. You start by training your side delts 2x a week.
2. You work up to 12 sets per session of side delts before the end of the mesocycle.

3. You at most get sore for a day or so after, never longer.
4. You don't ever experience performance loss in the side delt exercises, and are well-recovered for each successive session.
5. In your next mesocycle, you add a session to side delts, going from 2x per week to 3x.

Simpler Algorithm Example 2:

1. You start by training your quads 2x a week.
2. You work up to 12 sets per quad session before the end of the mesocycle.
3. You get very sore in the quads, but they almost always heal just in time for their next session of the week.
4. Your quad performance hangs in and improves a bit towards the very end of your mesocycle.
5. In your next mesocycle, you don't change your frequency, and you stick with 2x per week for quads for the time being.

Simpler Algorithm Example 3:

1. You start by training your hamstrings 3x a week.
2. You work up to 8 sets of hamstrings per session before the end of the mesocycle.
3. You get debilitating soreness in your hamstrings that overlaps from one session to the next.
4. Your hamstring performance starts to decline, and you have to deload hamstring training earlier than planned.
5. In your next mesocycle, you switch down to 2x hamstring training per week, because 3 sessions were overkill and did not allow for sufficient recovery.

There is no one-size-fits-all method for determining ideal training frequency that takes into account all of the complexities and intricacies of SRA. The takeaway here is that training should allow for effective stimulating, recovering, adapting, and re-stimulating. If your combination of frequencies and other program variables are stimulative, you recover from them, you are improving, and you re-stimulate without much downtime, your program has a fundamentally effective frequency. Any tweaking beyond this is a matter of fine-tuning rather than finding basic effectiveness.

Under-Application of SRA

Excessively Low Frequency Training

There is plenty of nuance and debate to be had when fine tuning frequency of training, but there are frequencies so low that there is no debate that they are less than effective. Dogma is a big problem in nearly every arena, and the "one body part per day" dogma in hypertrophy training is definitely on the list. You might be able to get away with training larger muscles once per week and still make decent gains, but muscles like biceps, side delts, and rear delts that often heal very quickly likely have no business being trained once a week unless you want to miss out on gains, especially over the long-term.

Excessively High Frequency Training

Dedicated phases of higher frequency (flanked by lower volume mesos) can work, but not if you have overlapping soreness and performance loss. If you used to have three hamstring workouts per week, but decide to increase to six, by the middle of the week your hams might be so sore and tight that you are actually weaker than usual—this is a sign that your frequency is too high. Same goes for joint pain. More than a few folks have tried the "squat every day" training approach and have lamented how much their knees or hips hurt a month in. This strategy might get some initial PRs, but you won't be hitting those PRs much longer if your joints are degraded. Long-term productive training is the goal if hypertrophy is your priority.

Supporting Muscle Group Overuse

In *real world* program design, it is important not to overuse certain muscles that are commonly recruited in the training of others. For example, if you want a great row-based back workout, you probably don't want to do a lot of stiff-legged deadlifts, deficit sumo pulls, and good mornings the day before, because your erectors and scapular retractors will be so fried that your rows won't be nearly as stimulative. In fact, your hamstrings might be so fatigued or sore that even getting into the bent rowing position might be difficult. This can be a problem with excessive frequency—the supporting muscles one day are target muscles the next.

You want to make sure that a given muscle has distinct times in the week where it's not sore, tight, or fatigued, and is not being re-stimulated or asked to be a supporting muscle. As another example, if your triceps long head is worked on all pushing days with overhead triceps extensions and on all pulling days with rows and pullups and on some leg days with stiff-legged deadlifts (which require its activation to keep the arms and barbell from swinging out too far forward), a fair question is 'when does it rest and recover?' The answer may be never, which can lead to both excessive muscle damage and excessive connective tissue damage, paving the way to poorer results and potential injury. At face value it can seem like the triceps are quite unrelated to rows and very unrelated to stiff-legged deadlifts, so it's often hard to predict such effect transfers through theory alone. What must be part of the equation in intelligent programming is the constant observation of the responses of all muscles and all joints. You have to keep tabs on what's sore, what's not, what feels like it's being worked and what doesn't, so that you're never over-doing it with muscles and joints that can't handle too-frequent overloads. To keep things simple, just make sure that no muscle or joint is *always* sore and you're probably in the clear and don't need to overthink too much.

Over-Application of SRA

The Quest for the Perfectly Symmetrical Plan

If you take the SRA principle to the extreme, you would make your training as close to perfectly symmetric as possible. That is, training right after you heal and no sooner or later; precluding a typical training structure like triceps on Monday, Wednesday, and Friday if triceps take, say, two days to recover. Instead, triceps would need to be trained after two days no matter the day of the week. The first reason that this is unnecessary is that some degree of regular overreaching and supercompensation are fine *so long as* we regularly get the chance to catch up on recovery. Your triceps would be slightly overreached by the end of Friday's workout in the asymmetric M,W,F structure, but this asymmetry also allows for additional recovery time (Sunday, in this case) to compensate. A seven day microcycle that fits in a week is also convenient and less stressful.

You should seek *good symmetry* in your programming, but perfect symmetry is not required.

Pushing High Frequencies All the Time

As mentioned earlier, muscles recover faster than connective tissues. This means that a frequency optimal for muscle growth and recovery might not be sustainable for connective tissue. Despite this, you can probably get great results in the short term before your connective tissues become a limiting factor. A mesocycle or two of higher frequencies followed by a mesocycle or two of lower frequencies is probably a safe strategy to take advantage of the growth potential from following muscle SRAs on a higher frequency training program without overly taxing your connective tissue. Be especially observant of greater than usual connective tissue irritation in the later weeks of your higher frequency training and consider switching back to lower frequencies for the mesocycle if this happens.

CHAPTER 4

Summary

The stimulus-recovery-adaptation principle lays out the session-rest-session paradigm by which nearly all hypertrophy training is conducted. Training stimulates both growth (adaptation) and fatigue (which requires recovery). Both growth and fatigue require resources and time to complete and resolve, respectively. Progressive overload should be continued once fatigue is sufficiently resolved and adaptations have occurred. At the extremes, the hardest training produces both more growth and more fatigue, and the easiest training produces less of each.

SRA dictates ideal training frequencies as it predicts when growth will have completed and when fatigue will be alleviated enough for more productive training. For most intermediate and advanced lifters, fatigue takes longer to reduce than adaptation (growth) takes to occur. This means that in most cases, recovery is the limiting factor for training frequency. Muscle often grows above baseline for 1-3 days after a given training session, but recovery can take longer. This means that in most cases, 2-4 overloading sessions per week per muscle group are possible to execute sustainably, with exceptions for smaller muscles that recover more quickly.

Issues with Excessively Low Frequency

Excessively low frequencies are not ideal as they result in excessive per-session volume. This can cause more damage than growth, junk volume due to too much systemic fatigue, and breakdowns in mind-muscle connection and technique. Overly high per-session volume can also cause depleted glycogen, problems with excitation-contraction coupling, and exceed muscle growth ceilings, all leading to less growth at a greater work and fatigue cost.

Issues with Excessively High Frequency

Excessively high frequencies can be detrimental as a direct result of the frequency itself as well as due the excessively low per-session volumes that usually result. Too few sets per session means more energy spent warming up that could be better spent training. Further, potentiation of mind-muscle connection and technique from sequential sets is lost if per-session volume is too low. Cell swelling is reduced and metabolites accumulate less with lower volume and faster fiber stimulus will be diminished with respect to total reps. Frequent training might also limit recovery of the slower healing connective tissues and although it increases individual muscle MRV, higher frequency training is more likely to surpass systemic MRV.

Programming Implications

Research suggests that better results are achieved by increasing training frequency from one to five times per week, but that growth increases are smaller with each frequency jump. Per-session MAVs have been shown to be around 15 sets or less per muscle group in most of the groups studied. Due to a lack of volume equated literature and untrained subject populations, per-session MAVs are somewhat more likely to be in the 5-10 set per session per muscle group range in more trained populations and real life training circumstances.

Because different muscles and their respective connective tissues recover at different rates to one another and between individuals, ideal frequency ranges for various muscles and between individuals will differ. Around 3-8 sets per muscle group per session and 2-4 sessions per muscle group per week is likely a good average starting point, but due to large variations between lifters and muscles, frequency selection should occur mainly in an autoregulatory manner.

CHAPTER 3

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CHAPTER 5

Variation

In the general context of sport science, Variation refers to the intentional manipulation of training variables to mitigate the effects of adaptive resistance, as well as to prevent injury. In other words, Variation refers to changing training up on occasion to make it more stimulative and reduce wear and tear from the same repetitive movements.

The Principle of Variation of Training: To improve at a specific sport or physical endeavor, training must occasionally be varied to maintain effective stimulus and prevent wear and tear injury. This variation must occur within the bounds of the principle of Specificity.

There are two important components of the Variation principle: *directed variation and strategic variation.*

Directed Variation describes the idea that in order for Variation to support a desired adaptation, all variants must operate within the constraints of Specificity. On its face the Variation principle may seem somewhat juxtaposed to the Specificity principle. Specificity says, “stay the course” and Variation says, “change the course.” Directed variation says, “change the course, within the confines of Specificity”. None of the variations to your training should ever exit the wide berth of being specific to your goal. If you’re a tennis player and one of your weeks of training is wrestling, this would be too far outside the bounds of the Specificity principle. Variation in tennis is focusing on forehands for a few weeks, backhands for a few, and overhands for a few. Changes, yes, but all under the grand umbrella of tennis-specific training. Secondly, Variation must respect the sub-principle of directed adaptation. In other words, you have to train long enough with one variant for training momentum and long-lasting changes to the body and skillset of the athlete to occur before switching to the next.

Strategic Variation describes the strategic use of certain variants under appropriate circumstances and training periods to promote or support best adaptations or performance. For example, if you are a powerlifter you might use variants of your main competition lifts during a hypertrophy phase and switch to competition lifts during strength and peaking phases. Doing many low bar squats, deadlifts, and regular bench during a hypertrophy phase might give you some aches and pains that prevent best performance once you get to your peaking block. If you instead did high bar or front squats, deficit deadlifts, and incline bench during hypertrophy and gained muscle it would support strength in your competition lifts without the exact same wear and tear. Similarly, you would not do front squats during your peaking phase leading up to competing in the low bar squat. In other words, variations of lifts that serve similar, but slightly different purposes are utilized to best promote the desired outcomes of the phase of training.

The prevention of adaptive resistance and chronic injury are what dictate the need for Variation.

Adaptive Resistance, otherwise referred to as training staleness, is when previously effective training becoming less effective or completely ineffective over time. This happens for a variety of reasons even with progressive overload present in otherwise well-designed programs. It seems that the human muscles and nervous system adapt and become less sensitive to any given stimulus over time. If an alteration of that stimulus doesn't periodically occur, the net gains per session, week, and mesocycle of any given training modality will decrease and eventually plateau.

Injury prevention is a more minor but nonetheless essential feature of Variation. By altering the training modalities used, the same anatomical structures such as joints and connective tissues are not stressed continuously in the same ways for too long, lowering chances of chronic injury. Even if we don't need to vary for training stimulus purposes, Variation may sometimes be needed to prevent wear and tear from getting out of hand and causing injury.

Variation Limits

The Variation principle has a lower impact on long-term muscle growth than the principles discussed thus far. If you lift weights with the muscle groups you want to grow (Specificity), challenge yourself with volumes and loads (Overload), and make sure not to push it too hard for too long (Fatigue Management), you will absolutely grow. This means that you can do any effective exercises for any given muscle group and grow. Looking at a bodybuilder's impressive chest, you can say with certainty that they train their chest hard and takes steps to recover, but you cannot say with any reasonable confidence, "that's a bench press chest" or "that's a cable crossover chest for sure."

That being said, if getting *everything* you can out of your program matters to you, Variation is an important detail. While not the top priority, the specific exercises you choose and how you rotate them *does* impact muscle growth and long-term wear and tear injury rates, which is to say, your ability to keep growing muscle for longer.

Variation in Hypertrophy Training

Variation in hypertrophy must be justifiable from a muscle growth perspective (adhere to the Specificity principle first) and not be done for its own sake. It can be used to improve stimulus potency when movements become stale, to allow overuse related damage to recover, or to support the retention rather than growth of muscle when needed. In the long-term, even retention supports growth by allowing future growth to start where it left off, rather than from a step behind.

Directed Variation in Hypertrophy

As with other sports, directed variation in hypertrophy means that variations to training are implemented with a specificity related purpose. An example of directed variation in the context of hypertrophy would be training legs at MEV while alternating mesos of MEV to MRV back and MEV to MRV chest training *because the current priority is to bring up the upper body*. Variation here is organized within the confines of a specific hypertrophy goal: upper body growth. Directed variation can occur along all parameters and variables of training and when considered in the context of long-term goals, becomes strategic.

Strategic Variation in Hypertrophy

Strategic variation in hypertrophy is the extension of directed variation—training choices are made strategically to both best support current and long-term goals. One example is preemptively switching out an exercise that is starting to feel stale before it has become understimulative. Let's say you have been using the flat bench press as one of your main chest movements for a couple mesos and across those performance has been great, you have a good mind-muscle connection, and get a reliable pump. But come next meso your performance gain rate starts to slow, mind-muscle connections start to feel a little fuzzier, and pumps are there, but less impressive. The next month, instead of waiting for the flat bench to get less stimulative, you might strategically switch it out for the incline bench, wide grip bench, or some other variant. This strategic move stops staleness before it really sets in. A similar strategy can be employed to prevent injury when you feel some recurring twinges or connective tissue disruption is starting to accumulate for a certain movement. In any case, strategic variation is just directed variation that supports more long-term goals.

Variation can be implemented across multiple facets of training:

Exercises

- Compound vs. isolation
- Unilateral vs. bilateral
- Comparable exercises for an agonist muscle
- Barbells vs. dumbbells vs. machines, vs. accommodating resistance (bands, etc.)
- Positioning of hands or feet

Movement Velocity

- Cadence
- Pause inclusion and duration
- Concentric vs. eccentric emphasis
- Mind-muscle connection vs. simple rep completion

Loading

- Relative loading (% of 1RM)
- Absolute loading (actual changes in load lifted irrespective of abilities)

Volume

- Training at MV, MEV, MAV, and MRV

Training Method

- Straight sets vs. myoreps vs. drop sets vs. supersets, etc.

Exercise Order

- Order of types of exercise
- Order of muscle groups trained

Variation also occurs over multiple timescales, from within a single session to across an entire career. All of these options make hypertrophy training quite diverse and complex and require purposeful decision making, but also mean that we have many options for preventing staleness and overuse injuries.

Exercise Variation

In most cases, all the weeks of a mesocycle's accumulation phase should have the same exercises and these exercises should be the most effective at the time for short- and long-term growth goals. This effectiveness can be quantified across three indices.

The first index, which we have already discussed, the **Raw Stimulus Magnitude (RSM)**, takes only stimulus into account. Per set, which exercises stimulate the most muscle growth in the target muscles? What stimulates more quad muscle growth per set to failure; leg presses with a full range of motion or one-legged squats on a balance board? Muscle growth per exercise can be proxied using the **RP MEV Stimulus Estimator Algorithm** from the Overload chapter. The more tension, burn, pump and disruption you get from *a given number of sets of the exercise*, the more effective the exercise likely is. To make this estimation accurate, it is important to judge the muscle(s) being targeted since the goal is to determine effectiveness for the target muscles. Set per set comparison is also important—when you compare two lifts, sets for each should be the same.

Our second index is the previously discussed **Stimulus to Fatigue Ratio (SFR)**, which takes RSM into account but weighs this benefit against the fatigue the exercise generates. SFR can be calculated by dividing RSM by fatigue as assessed in the Fatigue Management chapter. Not only do high SFR exercises tend to grow the most muscle, but they can also be done at larger per-session and weekly volumes because they don't cause as much fatigue. Thus, SFR trumps raw stimulus as an index of exercise ranking in most cases.

The last of the three main indices is the **Stimulus to Time Ratio (STR)** which takes into account the time efficiency of the exercise. The STR divides RSM by the time it takes to warm-up for, perform, recover from, and be ready to perform another set of an exercise. In essence this takes into account *all* of the muscles an exercise taxes in order to measure total training time needed for a certain level of stimulus. For example, if you squat, you need to warm-up sufficiently and take adequate rest time between sets. This might sound inefficient until you consider the fact that just a few sets of squats stimulate the glutes, quads, adductors, lower back, calves, and so on, which makes them (and nearly all compound movements), very efficient and thus highly ranked on the STR index. This index is very useful for those with limited time to train, for whom excessive fatigue is less likely due to those time constraints.

For the ultimate in optimality, those with the nerdiness and bandwidth for it can combine all of the indices to generate the "gold standard" index of exercise selection. Considering stimulus, fatigue, and efficiency, the **Stimulus Fatigue Time Ratio (SFTR)** ranks exercises that stimulate the most muscle growth in the least time and with the least fatigue, so that, given finite gym time, we can cram in even more sets of them and theoretically get the most possible growth.

Which exercises have the highest RSM, SFR, STR, or SFTR? We can't possibly tell you that, because individual differences are so great. Compounds are usually higher in STR and exercises that allow for great mind-muscle connections usually have the best SFRs, but outside of this, you have to try the exercises yourself, and track stimulus magnitude, fatigue magnitude, and the time it takes to perform the movements. Who should focus more or less on RSM, SFR, or STR however, will be discussed in detail in the Individualization chapter!

Exercise Deletion and Replacement

Now that we have learned how to assess exercises for use in a program, we also need to know when to keep them around and when to swap them out. Remember that the purpose of Variation is to prevent adaptive resistance (keep training stimulative) and prevent overuse injuries. There are three main questions to ask towards the end of your current mesocycle to help you decide whether or not to delete and replace a given exercise in the next:

1. **Has performance stalled?** Have I stopped hitting personal bests or being on track to hit personal bests on this exercise?

2. **Is this exercise hurting me?** Is the exercise causing me any aches and pains in connective tissues, especially ones that cannot be remediated with technical fixes and/or ones that keep getting worse? Or for the experienced lifter: Are the stresses on my joints now leading inevitably to future pain?

3. **Is this exercise feeling stale?** In other words, is the mind-muscle connection fading? Are pumps getting harder to achieve? Does your technique feel less and less smooth? Has the exercise ceased to create a lot of target muscle disruption without excessive numbers of sets (especially when compared to joint and connective tissue disruption)?

If most or all of your answers to the above questions are ‘yes’, you should strongly consider replacing the exercise in the next meso. If you answer ‘yes’ to only one of the above, unless it is #2 (the exercise is hurting you), it’s your call whether to delete or wait another meso to reassess.

Let's look at a few real world examples:

1. You have done bent-over barbell rows the past two mesocycles. The last three workouts were all-time PRs and you don't feel any unusual connective tissue pain during the movement. Rows get you a great pump and you feel your whole back being worked by them, seemingly down to the last muscle fiber. In this case, you should definitely keep this exercise into the next meso!

2. You have done seated barbell shoulder presses for two mesos. You are hitting PRs every week, but your left shoulder joint has a sharp pain on some reps, and it seems to be getting worse. You get pretty good pumps from the exercise, but you can't seem to perfect your mind-muscle connection. In this case, you should replace the exercise in the next meso unless you can solve the pain problem with an adjustment to your grip, rep speed, or other elements of your technique.

3. You have done barbell curls for the past three mesos, and in this last one, you have not hit any PRs, though you came close. Your elbows are killing you, and you feel like you'd get a better mind-muscle connection to your biceps by hitting them with a hammer! You should almost certainly switch exercises in the next meso.

Some, especially newer lifters, get a bit overly excited about Variation and will do things like never repeat any exercise in a subsequent mesocycle. This can be a huge downside, ironically especially for beginners, as they will trade off a great deal of momentum that can improve SFRs across mesos. No matter your training age, if your leg press technique feels amazing, the mind-muscle connection is great, the pumps and soreness are real, PRs are rolling in, and your joints don't feel a thing, why would you remove it from your program? There could be some good reasons (the rep range is inappropriate for your upcoming resensitization phase, for example), but "a different phase is starting, so I have to change out my exercises completely" is *not a good reason*. Phases are designed to introduce *needed* variation, not randomly throw it in when it could actually be a net negative.

By following the above guidelines for exercise deletion and replacement, some exercises will be rotated out after one mesocycle, while others may be kept in for a year or even longer. There should be *no dogma* involved in these decisions—you are using actual body responses to determine Variation, which beats pretty much any pre-planned rotating system.

One potential problem with this method is that perception can usurp reality. You might tell yourself that squats are stale when they definitely are not, simply because they are difficult and stressful. Or you might just be bored with an exercise, even though it causes great pumps without pain and so on. Making sure to do an honest and realistic self-assessment is a pre-requisite for good training choices and Variation decisions are no different. If you're getting good pumps, good mind-muscle connections, and good technique with PRs rolling in pain-free, you *can* delete the exercise, but you'd just be following your emotions instead of your body's feedback. And emotions just don't tend to produce the same results as autoregulated periodization.

It is also important to assess whether potential replacement exercises are compatible with the goals of the upcoming mesocycle. For example, if you have a lot of high rep sets coming up you might be setting yourself up for excessive nervous system fatigue and poor local stimulus if you choose too taxing an exercise. On the other hand, if you have very heavy, lower rep training coming up, a machine isolation lift is probably not the best exercise to keep in the rotation for that meso. We'll explore such phasic constraints in more depth in the Phase Potentiation chapter.

Per Session Exercise Number

Cramming too many different exercises per muscle group into a session can mean wasted time warming up, loading the next exercise and so on—energy that could be spent on more hard sets with the first exercise. On the other hand, if your volume progression would lead you to a peak week with say eight sets of squats, this might be too much of one exercise and lead to some junk volume sets at the end. From the excessive frequency discussion in SRA, remember an average of three or more sets per exercise per session across the accumulation phase with a maximum of around 15 total sets per muscle group per session in the final week of accumulation seems to be ideal in most cases.

If we want to stay in an effective volume range (get at least three sets of an exercise on average and end under 15 sets per muscle group per session), we are limited to three exercises per muscle group per session at most—with three being quite high. For example, if we used a five-week progression, with a lower end average of just over three exercises per muscle group per session at most—with three being quite high. For example, if we used a five-week progression, with a lower end average of just over three sets per exercise per session, started at two sets per session and added sets on only three of those weeks, we would end at the very top end of recommended total sets per muscle group per session using three exercises and exceed top end by week four if we used four exercises. Below are two examples to illustrate the effect of total exercise number per muscle group per session on per-session volume (Figure 5.1).

This means that one to two exercises per muscle group per session is probably a good target, and that three might be a top end option. Remember that most session MEVs start at 3-4 sets per session. If you choose three exercises per muscle group, that might mean you do one set of each in week one, which is not an efficient way to start for most. Per week, 2-4 exercises per muscle group is probably a sensible recommendation. This range isn't any lower so that we don't use too little weekly variation but isn't any higher so that we don't exhaust all of our top SFR exercises at the same time.

Exercise	Week 1 SETS	Week 2 SETS	Week 3 SETS	Week 4 SETS	Week 5 SETS
1	2	3	3	4	5
2	2	3	3	4	5
3	2	3	3	4	5
TOTAL SETS	6	9	9	12	15

Exercise	Week 1 SETS	Week 2 SETS	Week 3 SETS	Week 4 SETS	Week 5 SETS
1	2	3	3	4	5
2	2	3	3	4	5
3	2	3	3	4	5
4	2	3	3	4	5
TOTAL SETS	8	12	12	16	20

Figure 5.1: The Effect of Training the Same Muscle Group with Too Many Exercises per Session

Two example five-week progressions that train the same muscle group with three (A) or four (B) different exercises. Each example starts with two sets per exercise week 1 and adds sets on three of the five weeks. In the first example with three exercises per session, we land at the very top end of recommended total sets per muscle group per session (15 sets) in week 5 (A). The second example shows what happens when we use the same strategy with four exercises per session. In this case we exceed top end of recommended total sets per muscle group per session by week 4 (red font) (B).

If we use 1-3 exercises per session and 2-4 exercises per week, with let's say, three weekly sessions, that means we have to re-use some exercises in adjacent sessions within the same week. And there's nothing wrong with that, especially nothing loading variation (discussed below) can't attend to for very beneficial results. One might worry that only 1-3 exercises per session and 2-4 exercises per week means missing out on activating some motor units in a given muscle group that other exercises would hit. There are three ameliorations to this concern.

First of all, well-executed full ROM exercises recruit and stimulate the vast majority of motor units in a target muscle anyway. When you include two exercises of meaningfully different movement patterns, this fraction of recruitment grows even more. Secondly, as long as you hit the main movement patterns within the same week, you don't have to worry about hitting them in the same session. If you do an incline press, a flat press, and a flye movement for pecs in the same week, you are essentially getting all the within-week exercise variation needed for pecs. If you train the quads with torso vertical (squats), torso bent (leg presses), and via extension (leg extensions), you have the quads extremely well covered. Third, even if you are not maximally taxing a muscle in *one* of its movement patterns, it's still almost certain to at least maintain its muscularity in its 'less than optimally stressed" areas for months on end. For example, while flat benches might not optimally grow your clavicular (upper) pecs, training them hard will likely prevent any reduction in upper pec size. As you delete and replace exercises every few mesocycles, portions of muscles that were maintained in the previous meso get their chance to be maximally stimulated in the next. Serendipitously, this novel re-introduction functions to reduce adaptive resistance, likely causing more growth than focusing on all movement patterns of every muscle at all times.

Here's a sample week of quad work that reflects these prescriptions (2-4 exercises per muscle group per week and three or less exercises per muscle group per session) with four quad exercises per week and two variations per session:

Monday:

- Squats
- Hack Squats

Wednesday:

- Hack Squats
- Lunges

Friday:

- Lunges
- Leg Extensions

By using these guidelines, we can get enough Variation for best growth, while still leaving room for later Variation and continued growth.

Movement Velocity Variation

Movement velocity variation has pretty minimal impact (it's the squatting that makes your legs big, irrespective of a two versus three second eccentric), but because movement velocity choices impact load (slower movements demand lighter weight) they can be useful in some cases[1]:

Times of high axial or systemic fatigue

Movement velocity variation can be useful when axial or systemic fatigue is high. For example, if you have a mesocycle with a lot of fatiguing axially loaded lifts, because slow eccentric squats require a lighter load, they might be the perfect fit to free up some axial and systemic fatigue but keep training volume high.

Times with greater injury risk

Pauses and slow eccentrics also make loads lighter and generally make lifting a bit safer, so using more of such variations when injury risk is greater is an intelligent approach. For example, at the tail end of a fat loss phase when fatigue is high and connective tissue is carrying cumulative damage.

Working around injury

Slow eccentrics and pauses are also great variations for working around injuries.

Certain kinds of bangs, bruises, and twinges are not by themselves serious, but can become serious if you just grind through them with heavy loads. Often times, such injuries can hurt only at lockout or only if you take a rebound at the bottom of a lift, or even if you do the eccentric at a normal speed, but do not hurt at all (or much less) if you slow the lift down or introduce pauses.

Improving technique

Lastly, modifications to cadence can be used to recycle a lift for the betterment of technique and mind-muscle connection. Sometimes when you really push for PRs on a lift for a while, especially if it's a compound lift that lets you go very heavy, your technique can get a little sloppy. Each week, in order to keep the PRs coming, you might be losing just a bit more mind-muscle connection and focusing a bit more on just getting the reps. Slowing the cadence or introducing the pause might require lighter loads, but this variation might also enhance your SFR and allow you to grow as much from a lighter weight as you were from the heavier weight at normal speed. Though useful at times, this practice should not be overused. Some lifters will become paranoid that their technique isn't perfect, and they will spend weeks with under-stimulating workouts or will recycle too soon, breaking most of the momentum of gaining rep strength and thus interfering with Overload.

As with exercise selection, momentum also plays a role in movement velocity choices. If you just had a productive mesocycle of squats with a normal eccentric, you might not want to switch to a slow eccentric just for variation because that will require you to re-gauge intensities and MEVs, refine your technique, and so on. If the going is good with a certain cadence of a movement, the best practice is to usually leave it be.

Now let's see how throwing in a bit of movement velocity variation can alter our hypothetical quad plan from earlier:

Monday:

- Squats
- Hack Squats

Wednesday:

- Hack Squats (Slow eccentric, paused)
- Lunges

Friday:

- Lunges
- Leg Extensions

The use of slow eccentric pauses in the second hack squats session reduces injury risk from repetition with heavier weight and introduces a bit of novelty for some potential small added gains!

Load Variation

You can absolutely train with *just* loads that get you sets of 10 for your entire career and grow a lot of muscle. In fact, if you train with exclusively with *any* reps within the 5-30 rep range (or more accurately, in the 30% to 85% 1RM loading range), you will likely put on a considerable amount of muscle mass. Direct evidence from experiments, training theory, and the observation of professionals, however, suggest that using a diversity of loads within the effective range is going to grow even *more muscle*[2].

While it is likely that (especially faster twitch) fibers respond a bit better to the heavier end (that results in sets of 5-10 reps), that range is generally more fatiguing to connective tissues[3]. Some lifts in this range can also be difficult to execute with a good mind-muscle connection and generate less metabolite accumulation and cell swelling. Lastly, intermediate and slower fiber growth stimulation is probably lower with heavier weight[3]. Training exclusively in the 5-10 range thus probably has some downsides, especially from the sustainability and injury risk perspective.

If you had to pick one rep range from 5-10, 10-20, and 20-30, the 10-20 is potentially the most growth-promoting on average across all people and situations. This is because it has the sustainability of lighter training but the shorter duration (and thus lower intra-set fatigue) of heavier training, which is to say it might have the highest average SFR of the three ranges. It's probably not by accident that the "hypertrophy range" has long been speculated to fall in the realm of 8-12 or 10-15 reps per set. The good news is that you don't have to pick one range—you can have your best training by making use of all of the ranges!

If you're going to endeavor to train all three ranges, you have to determine how much of your volume to put in each range. Because the 10-20 range gets the best intersection of safety and SFR, the average intermediate lifter seeking to maximize size gains should probably put the majority of their sets in that range. Perhaps about 50%, for example. We might split the remaining volume evenly between the 5-10 and 20-30 rep ranges. This 25%-50%-25% split is a very good place to start, but it's not for everyone to stay in. In the phase potentiation chapter, we'll discuss how to alter the ranges over each mesocycle, in an interactive way with frequency, to get better results. And in the chapter on Individualization, we'll discuss at length how to evaluate each of your muscles' individual responses to these loading ranges and alter the proportion of your volume to each so that you get your best long-term gains. For the time being, the important lesson here is that nearly everyone should be committing at least *some* of their training to *each* range.

You might ask, how often and where do you vary load? In other words, do we vary load across an individual exercise, across a single session? Or by microcycle, mesocycle, or blocks of training? Do loading variations change across a career? These are all very pertinent questions. The bad news is that we don't have the research or the theoretical underpinnings to give exact, reliable answers to all of them. The good news is that we have enough research and theory to recommend approaches that are likely to work well.

On the exercise front, certain loading ranges and exercises are actually incompatible. If you try to deadlift for 30 reps, your technique will break down long before you maximally activate the spinal erectors, and the main workout will be for your cardiovascular system. On the other hand, machine-based back work is very productively and safely executed for such high reps. In the heaviest range, isolation exercises like lateral raises and pec flyes are probably not sustainably safe to perform. Lastly, slow eccentrics in the 20-30 range might dip below 30% 1RM and would thus likely be too light for optimal growth stimulus. Thus, adding slow cadence to these already very low load exercises is probably not the best choice. You *can* mix loading ranges in the same exercises, but it should be in descending fashion. You can for instance do bench presses with your 5-10RM and then do down sets with your 10-20RM no problem, but you don't want to start with sets of 25 on the stiff-legged deadlift and then work up to heavier sets of five, as your ability to generate maximal forces will by then be degraded, usurping the entire reason for doing sets of 5-10 in the first place.

On the session front, there is no compelling reason to have to train through all or even more than one of the ranges *per muscle* in each session. But, because systemic fatigue makes a large number of sets in the 5-10 range less than productive, longer sessions with multiple muscle groups trained should probably split the first fraction of their sets and exercises into the 5-10 range and then do the rest in either or both of the two lighter ranges. The heavy range should almost always be done first, the moderate range next, and the lightest range last. You can always train lighter even if you are systemically fatigued from the heavy work, but if you're locally and systemically fatigued from lighter work (especially for the same muscle group), heavy work won't be "heavy" in any objective sense.

On the microcycle front, there is good reason to think that at least some benefit may be had from training a muscle group through most, if not all of the rep ranges in a week. As mentioned in the Fatigue Management chapter, it might be a good idea to start the week off with a greater percentage of work in the 5-10 range, leave more 10-20 range work in the middle of the week, and do more 20-30 rep sets towards the end of the week. This allows productive training every day, but keeps loads lighter on average when connective tissues are more fatigued, which can prevent injury. And, because you accumulate fatigue through the week, you essentially do most of your most systemically taxing lifting earlier, when you're the freshest. Grinding through higher reps when tired is much easier and safer than grinding through lower reps. For directed adaptation reasons, there should be no rep range alterations through the meso (in other words if squats on Monday were in the 5-10 range, you should not do next Monday's squats in the 10-20 range).

Some blocks can be strategically varied to bias toward one range or another. For example, a fat loss phase is typically a block long, and during that time, the 10-20 and 20-30 ranges might predominate due to their slight edge in relative safety at a time when you are more fatigued from the calorie deficit.

On the macrocycle scale, you might be able to train a muscle group through all of the rep ranges by dedicating specific mesocycles or blocks to be biased to each range. You might start with a block of evenly split training between all ranges in a muscle gain phase. Then have a block of mostly 5-10 range lifting during a resensitization phase, and finish with a fat loss block preferencing lighter loads.

Lastly, perhaps there should be a career trend in rep range use. This is one of the more speculative discussions in this book, so please take it with a big grain of salt.

There is some argument to be made that beginners should seek to spend more time in the 5-10 ranges so that they can build connective tissue strength and good technique without worrying about high reps (where technique tends to break down for beginners). Intermediates might bias training toward the middle range and slowly begin to figure out, per-muscle, which ranges and what fractions of total volume in each seem to cause the most growth. Lastly, advanced lifters might be very strong, very beat up, and very cautious not to get hurt (as they are in the prime of their competitive careers or just in the prime of walking around, being jacked, and enjoying life). Because of these constraints, they might avoid the 5-10 range altogether on certain exercises.

When we say "the 5-10 range" we mean that your *first set* when you are relatively fresh needs to fall into that range so that we can be sure that the loading range of that weight is roughly 75%-85% 1RM. Rep ranges are just easy shorthand guides for loading ranges, and it's the loading ranges that really matter. If your first set in the 10-20 range was 15 reps but your sixth set with short rest falls below five reps, you might need to lighten the weight to actually be in a maximally hypertrophic (5 or more) rep range. Outside of small adjustments like this, if later sets are slightly shy of target rep ranges, this is fine so long as first sets were in range, nothing falls grossly out of range, and your RIR is within 4-0.

Now let's look at our sample quad week with an example of loading variation applied.

Monday:

- Squats (sets of 5-10 reps)
- Hack Squats (sets of 5-10 reps)

Wednesday:

- Hack Squats (Slow eccentric, paused, sets of 10-20 reps)
- Lunges (sets of 10-20 reps)

Friday:

- Lunges (sets of 20-30 reps)
- Leg Extensions (sets of 10-20 reps, with load adjusted for fatigue from lunges)

Eccentric accentuated loading

There is some speculation in the research community about the effectiveness of eccentric accentuated loading (EAL). EAL involves lifting normal loads concentrically, and then much larger loads eccentrically in the same repetition. The loads are so much heavier during the eccentric phase, that you might not be able to do but a few concentric reps with them and can only slow down their descent. Because of the vastly heavier loading used (generally through specialized machines which can unload and reload weights midway through a movement), EAL has been shown to potentially enhance hypertrophy, specifically faster fiber hypertrophy. However, EAL has two major downsides. First, it's incredibly difficult to pull off in a real training setting, as most people don't have access to the specialized machinery needed for smooth EAL training. Second, because of the much heavier eccentric loads, fatigue can be much greater for EAL than conventional training, and it's not clear if the added stimulus is worth the added fatigue.

Volume Variation

Volume variation can be the choice to train various exercises, muscle groups, or parts of the body with more or less volume, somewhere within the volume landmarks.

While we will cover much of this use of volume variation in the Phase Potentiation chapter, we will discuss one descriptive example here to prime you for that more detailed discussion.

Perhaps you are currently in a fat loss phase, and thus fatigue management is a challenge. To keep fatigue at bay, you can allocate more volume to lower fatigue exercises. For example, you could do squats at the lower end of the volume range, hack squats in the low-moderate range, and lunges and leg extensions in the higher range. This allows the less axially and systemically fatiguing quad moves to make up most of the quad training stimulus, and, while not ideal from the RSM perspective, this can increase SFR in this situation and thus allow for more successful training during a fat loss phase.

We can control the volumes of each exercise in our ongoing example by starting with different set numbers at the beginning of the program, using fewer sets for the more fatiguing exercises and more sets for the less fatiguing exercises.

Monday:

- Squats (2 sets of 5-10 reps)
- Hack Squats (2 sets of 5-10 reps)

Wednesday:

- Hack Squats (Slow eccentric, paused) (2 sets of 10-20 reps)
- Lunges (2 sets of 10-20 reps)

Friday:

- Lunges (2 sets of 20-30 reps)
- Leg Extensions (3 sets of 10-20 reps, with load adjusted for fatigue from lunges)

As the accumulation phase runs, we can willfully bias the Set Progression Algorithm to allot more volume to the less axially loading exercises, and less volume to the larger loading exercises. This biasing is very straightforward. On Wednesday's session, we evaluate the soreness and performance effect of Monday's session. If a volume increase is deemed necessary, we simply add the set(s) we need to the *less axially loading exercise* on Monday, in this case Hack Squats. We repeat this modality for all the days of each microcycle, letting the less axially and systemically fatiguing exercises accrue more sets than the more fatiguing exercises.

Training Modality Variation

Along with exercise, cadence, loading, and volume variation, we can also vary training modalities—we can do straight sets, add down sets, do drop sets, supersets, and so on.

When varying modalities, it is important to remember that we must not violate any other principles of training or degrade training quality. For example, if you are trying to establish a strong mind-muscle connection, using myoreps or drop sets might not be the best practice, since the sheer suffering during these will prevent much focus on the details of the movement. In addition, the modality used must not run contrary to loading. If you're not trying to sum up a lot of metabolites, doing something like supersets would not make a whole lot of sense—for example, supersetting sets of five reps would not be an effective choice. Exercise order needs to be considered as well. You don't want to do something very systemically fatiguing (like drop sets) before something that is best done with heavier loading and a large technical requirement (like straight sets), but the other way around can be an excellent and effective strategy. Lastly, as with all other Variation options, you don't want to vary modalities too much because that can interfere with the momentum effect of productive, long-term training. If you are making excellent gains on straight sets of incline presses, adding dropsets might not be very beneficial.

When choosing Variation in training modality, the following rules can help ensure best practice:

1. Make sure any modality used does not interfere with other more important training principles and practices.

2. Make sure you have a good *reason* for employing any modality you choose, and that this reason fits into the grand scheme of your training plan and goals.

Within these constraints, the below Overload modalities are all options and tracking your performance with them will help ensure that you are making slow and steady progress. Note that the below recommendations are not strict rules, but general guidelines (Table 5.1 in the next page).

	Use	Avoid	Counting
Straight Sets	When doing heavy sets (5-10 reps) and for most of your training in general.	When doing metabolite training (most 20-30 rep training).	Each working set is counted directly (one to one) for the target muscle group
Down sets	When heavy sets drop below 5 reps per set	When you could maintain weight, but drop reps while still staying in the target rep range––in other words, don't do down sets until you have left the target rep range with the heavier starting weight	Each working set is counted directly (one to one) for the target muscle group
Controlled eccentrics and pauses	Especially useful for technique improvement or the management and prevention of injury	When doing sets of 20+ reps, as the loads would likely be too low for best growth	Each working set is counted directly (one to one) for the target muscle group
Giant sets aka marathon sets	When you know your volume landmarks well and want to focus on technique and mind-muscle connection	When you don't know your volume landmarks well, as tracking performance and fatigue over time in such sets is very difficult	The sets (each time you rest) in a giant set are counted as ⅔ a straight set for the primary target muscle group
Myoreps	When you're short on time and with exercises that are not very systematically fatiguing	When mind-muscle connection and technique are the big focus or when systemic fatigue from the exercise is high	Each myorep "mini set" set is counted as ⅔ of a straight set for the target muscle group. This can be modified if your fatigue response to myoreps is very––in this case each "mini set" is counted directly (one to one)
Drop sets	When trying to drive metabolites, usually on isolation or machine moves	When doing systemically fatiguing moves and in the heavy (5-10) rep range Lorem ipsum	Each drop set can count as ⅔ of a straight set for the primary target muscle group
Supersets	**Pre-Exhaust:** When trying to stimulate hard-to-isolate muscles **Non-Overlapping:** When training with limited time	**Pre-Exhaust/Non-Overlapping:** When mind-muscle connection, technique improvement, or performance are the focus	**Pre-Exhaust:** Each Superset can be counted as two sets (or for slightly more accuracy, 1.5 sets) for the target muscle group **Non-Overlapping:** Each superset can be counted as two sets; one for each target muscle group
Occlusion training	When trying to manage or return from injury, or when trying to drive metabolites	On most compound moves and on core moves (chest, back, glutes, etc.). Also, for longer than one mesocycle at a time per muscle group, as metabolite clearance quickly adapts and renders this modality much less effective in mere weeks	Each working set is counted as ⅔ of a straight set for the primary target muscle group

Table 5.1: Overload Modalities Summary

Let's choose a few of these modalities to throw into our sample quad program to see how they might fit in!

Monday:

- Squats (2 set of 5-10 reps): straight sets
- Hack Squats (2 sets of 5-10 reps): straight sets

Wednesday:

- Hack Squats (2 sets of 10-20 reps): slow eccentric, paused: straight sets with down sets as needed
- Lunges (with first set at ~20 reps): giant set of 60 total lunges

Friday:

- Lunges (2 sets of 20-30 reps): myoreps (waiting a few seconds before taking another 5-10 steps)
- Leg Extensions (3 sets of 10-20 reps, with load adjusted for fatigue from lunges): drop sets

Exercise Order Variation

Any variation we apply to exercise order must not supersede the application of the more important and impactful principles of Specificity and Overload. Once these are taken care of, variation in exercise order can be used to target specific muscles strategically. For example, if you want to focus on middle and lower back development and less on lat development in your mesocycle, you might want to place rowing movements earlier in the sessions and vertical pulling movements later. Over the course of the week, you will also want to match exercise order to loading range, such that if you are using squats for heavy quad work, you probably want them both in the beginning of a session and earlier in the week, but if you are using them for metabolite work, you might want to include them in a leg extension-to-squat superset with lighter training later in the week and possibly later in the session.

Another important aspect in exercise order choice is paying attention to individual limiting factors. For example, if your posterior chain and axial loading ability are pretty well potentiated after heavy squats, but your squats are very limited by fatigued posterior chain muscles, it's probably wise to place squats first in a session and good mornings second. Sometimes this might seem to violate Specificity, but in this case that violation preserves overload ability while still stimulating both muscle groups and is your best choice. However you construct your session's exercise order, make sure it maximizes performance for your prioritized muscle groups, and that it doesn't needlessly minimize the performance of other muscle groups.

Let's take a look at how exercise order can be used in the completion of our sample quad routine. In this example, we'll insert other muscle groups that might be trained in the same session, and you can note that when quads are trained heavy, they are trained first. When trained moderately, they can be first or second (since they are a big muscle group), and when trained light, they can even cap off the tail end of a session.

Monday:

- Squats (2 set of 5-10 reps): straight sets
- Hack Squats (2 sets of 5-10 reps): straight sets
- Moderate biceps work
- Light chest work

Wednesday:

- Heavy chest work
- Hack Squats (2 sets of 10-20 reps): slow eccentric, paused: straight sets with down sets as needed

- Lunges (with first set at ~20 reps): giant set of 60 total lunges
- Light biceps work

Friday

- Moderate chest work
- Heavy biceps work
- Lunges (2 sets of 20-30 reps): low rest high rep sets
- Leg Extensions (3 sets of 10-20 reps, with load adjusted for fatigue from lunges): myoreps

Over-Application of Variation

Over-application of Variation is very common for several reasons. First, because novelty does have an element of effectiveness, there is a general perception among many lifters that more Variation is always a good thing. Secondly, progressively overloading the same movements for a whole mesocycle or more at a time can get downright boring. Lastly, excessive Variation can sometimes mask poor fatigue management that will eventually catch up to the lifter and impede best results.

Too Frequent Deletion and Replacement

Technical, mind-muscle, and strength momentum are severely restricted when switching exercises too often. This approach also burns through the highest SFR exercise variants very quickly, leading you to either periods of staleness when there are no new exercises left to turn to or to using low SFR options when they are all that remain.

Too Many Exercises Per Session

By including more than three exercises per session per muscle group, the lifter ends up spending much more time, valuable energy, and mental focus on switching machines, stripping and loading weights, and warming up. There's also a missed opportunity for better mind-muscle connection and thus SFR when doing fewer sets per exercise.

The second downside of too many exercises per muscle group per session is that it prevents future Variation for novelty of stimulus. If you use all of your most effective exercises at once, you never get a chance to re-sensitize to them. You have about one block of training until all of the used exercises begin to get stale and you will be left with less desirable options. For example, if you used squats, hack squats, leg presses, and lunges in each of your last few mesocycles, you probably won't be sensitive to any of those and will be left with less effective quad options for Variation.

Weekly Variation of Exercises

It's somewhat common for bodybuilders to alter exercise selection to some extent week to week. While this may work for a very small number of elite bodybuilders for very specific reasons (essentially, the insatiable need for both novelty and fatigue management at the tail end of career adaptive abilities), it probably isn't the best choice even for most elite lifters.

Weekly exercise rotation has big downsides. For one, you never quite catch the technique momentum you could on any exercise. If you used skull crushers last week and you are using overhead extensions this week, although the novelty is stimulative in the short-term, the switch will lead to lower force production as you re-learn the new exercise to some degree[4–6]. If you had done skull crushers again, you would have benefitted from last week's technical practice and been that much more efficient at them, producing more force and having a better mind-muscle connection, both of which lead to better results. This is especially true when you consider that part of the ability to produce more force as a result of movement learning is the ability to recruit more higher-threshold muscle units[4–6]. Thus, as you use the same exercise over and over and grow stronger on it, you are able to get more and more muscle growth (up to a point). This concept of "momentum" can continue for weeks to months (or even years for beginners) before movements become stale and is the foundation of the directed adaptation portion of the Specificity principle. The use of excessively frequent exercise rotation misses out on these benefits.

Changing exercises every week also poses a problem for both tracking and progression planning. If you did 405lb for 5x8 on leg press last week, how does that compare to leg presses four weeks later after having done squats for the first time in a while. Or from when leg presses were first in your session last time but fourth this time? On the planning side, it is difficult to plan to have harder and harder workouts to satisfy the Overload principle if you change exercises (or for that matter, rep ranges and cadences, etc.) every week. You won't know if your 10 sets of squats and leg presses combined this week are harder than your eight sets of lunges and hack squats last week. A logical progression across an accumulation phase, using the same exercises each week, allows easy adherence to the critical concept of progressive overload and therefore much more likely growth. The most common reason people do many exercises in a session or switch out exercises in a mesocycle is to avoid boredom. In a scientific approach to training, we can do better.

Getting Too Fancy as a Beginner

Beginners have very low MEVs, are developing technique on the core movements, and can get confused by learning too many exercises at a time. In addition, not only do they not need novelty to grow (everything is novel when you are just starting out), they can accrue enough damage from excessive novelty to interfere with muscle growth. All of these factors suggest that beginners would be best served in sticking to the basic core moves (barbell rows, deadlifts, upright rows, presses, squats, curls, etc.) and working on perfecting their individualized technique. They can do this for a year or more and grow maximally without altering grip widths, using specialty bars, or modifying traditional exercises. Save the one-arm cable cobras and Arnold-style rotating dumbbell presses for when someone is very proficient at regular pullups and barbell overhead presses. This not only saves many effective exercise variations for when growth slows in the intermediate years and needs a boost, but also helps beginners establish the strength and technical stability on compound heavy moves that will serve as a base for the rest of their training life. And because their systemic MRVs are very high (though local MRVs are very low), they can tolerate doing a substantial amount of axial loading and compound moves, unlike many more advanced lifters.

Improper Exercise Order

As described earlier, exercise order choice impacts the entire session. Variations here should be strategic. If your lower back is smoked from deadlifts and you want to hit your quads with squats next, your back will give out before your quads are fully stimulated. Same goes for front delt fatigue before chest work, forearm fatigue before back work, and many other examples. When you arrange your sessions and even your weeks, make sure nothing earlier in the program is preventing the effective training of higher priorities later in the program.

Improper Pairing of Exercise to Loading Range

When varying load and exercise choice, make sure that the load is compatible with the lift. If you do stiff-legged deadlifts for 30 reps, your lower back will just get tired and your hamstrings might never get a chance to be pushed to their limits—or worse, your tired lower back will let your spine round and put you at a greater injury risk. On the other end of the spectrum, if you do cable curls for sets of five reps, you will either get hurt or your technique, mind-muscle connection, and SFR will plummet to unproductive levels. Save the systemically fatiguing compound lifts for the 5-10 and 10-20 range, and isolation and machine work for the 10-20 or 20-30 range to stay effective and safe in training.

Exotic Cadences and Executions

Sometimes lifters will eschew full ROM and controlled reps for variation qualities that have no theoretical or practical rationale. “Constant tension” is one such mythical concept, whereby not going through a full range of motion is supposed to make you grow more muscle. While constant tension does allow you to get fatigued with fewer reps and sum metabolites fast, locking out between reps can get you more reps close to failure and sum even more metabolites and is completely safe[7]. Try leg pressing with constant tension, and then try the same load but gently lock out and rest for three seconds every time until you reach 2 RIR. The latter set will be much more stimulative, no constant tension required. In some cases, constant tension can be a fine variation, but we encourage you to look at it as just another very limited tool and not something magical to incorporate at the expense of other options. Same idea goes for doing pulldowns facing away from the stack, doing hack squats sideways in the machine, and many other strange exercise variations that mainly just reduce overload. If an exercise can get you a good mind-muscle connection, it might be valuable even if it looks weird, but you can get very specific and very connected to the muscle on most basic exercises. This way, you can have all of those benefits *and* progressive overload as well.

Under-Application of Variation

Over-Emphasis on Muscle Awareness

There are some lifters who stop tracking strength altogether because “what your muscle feels is what matters, not how much weight you’re lifting.” While feel is certainly important, mind-muscle connections should be cultivated *in addition* to the practice of progressing in strength over time through all major rep ranges.

Restricted Rep Ranges

Hypertrophy doesn't occur only in the 8-12 rep range. Though this is probably the peak *average* SFR for many muscle groups and many people, there are several good reason to branch out to higher and lower rep ranges for most growth. Some lifters don't do anything less than 10 reps because they are too deep into the mind-muscle culture of bodybuilding, and they could benefit if they dipped into lower ranges strategically. Other lifters don't do anything over 15 reps because "that's cardio, bro" or "insert something hardcore here about using *real weights*." They too are missing out on the benefits of training across more rep ranges and therefore loads. If you want to gain the most muscle in the long-term, taking advantage of the benefits of all of the effective rep ranges and associated loads is the best choice.

CHAPTER 5

Summary

Variation introduces novelty in order to prevent adaptive resistance and injury. Directed variation introduces novelty for a specific purpose or end goal and strategic variation directs the use of certain variants in some situations and not others. Although Variation is not critical for muscle growth, it can be a very useful detail if you have all of the previous principles in order.

The most common training variations in hypertrophy occur across exercise, exercise number, exercise order, movement velocity, loading, volume, and training modality. These variations can occur across a single session, a micro, meso, block, or macrocycle, as well as across an entire career.

In hypertrophy, exercise variation seeks to maximize four different indices depending on various circumstances. Raw Stimulus Magnitude (RSM) should be maximized when recovery and time constraints are not pressing but current muscle gain rates leave a lot to be desired. The Stimulus to Fatigue Ratio (SFR) should be maximized when time constraints are not pressing but recovery ability is more limited. The Stimulus to Time Ratio (STR) should be maximized when fatigue constraints are not pressing but time for training is a limiting factor. The combination of all of these indexes, the Stimulus Fatigue Time Ratio (SFTR) calculates how much muscle is grown against fatigue and time costs. Ideally, most exercises in *any* program should rank well on all indices.

Data and experience suggest that 1-3 exercises per session per muscle group and 2-4 exercises per week per muscle group are likely best ranges for within-mesocycle exercise variation in most cases. Varying exercises across macrocycles and careers should depend on individual assessment of staleness, pain, and performance. Within a mesocycle, week to week variation is not recommended. It is likely that making use of the full spectrum of effective loading ranges (and therefore rep ranges) will build the most muscle in the long-term, but these should be organized in a logical manner within and across mesocycles. Movement velocity variation has very minimal impact, but can be used strategically to avoid excessive fatigue or injury or improve technique. Volume variation can also be used strategically, but should be considered within the confines of the volume landmarks. Variations of exercise order and training modality should operate to support Specificity.

Because the Specificity principle establishes that doing a similar type of training in sequence is by default a better idea than changing training very often, any proposed implementation of Variation must occur for a compelling reason—Variation should be employed only when there is a *need* for change.

Variation is never going to create night and day differences in your results, but its intelligent application can keep gains coming more steadily than they otherwise would, and at a much lower fatigue cost. A bodybuilder who employs excessively low Variation might do just as well in the first five years of training as a bodybuilder who employs a proper amount, but as each becomes advanced, the low-Variation bodybuilder might find that lagging muscle groups are not responding as well as they could be and injury is happening more often.

CHAPTER 5

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CHAPTER 6

Phase Potentiation

In sport, Phase Potentiation refers to the practice of arranging training periods that are not only effective, but also prepare the athlete for subsequent effective training or performance. Each phase of training should have improved outcomes because of the previous phase.

The Principle of Phase Potentiation: The strategic arrangement of training phases, such that each phase enhances the outcomes of subsequent phases.

An important component of Phase Potentiation is the prevention of *adaptive decay*.

Adaptive Decay describes the idea that particular training phases might lose some of their effectiveness—not be able to stimulate progress at all, or be unable to preserve the adaptations of the previous phases. When applied appropriately, Phase Potentiation prevents or reduces adaptive decay.

As an analogy, if you'd like to build a skyscraper, which way do you build? While the obvious answer might be "up", the correct answer is to first build *down* by constructing a foundation for the skyscraper to stand on. This analogy is especially apt because it illustrates the idea that Phase Potentiation must sometimes incorporate phases that seem to be moving the athlete away from their best results in the short term as they build that foundation. Powerlifters, weightlifters, and strongmen will take some weeks and months to add muscle size using hypertrophy programs, for example, making their 1RMs and event performances *actually decline* during this time. When they switch back to strength training and then run a peaking phase however, the new muscle built during hypertrophy potentiates the best possible competitive performance. While this process might seem obvious to the reader familiar with these methods, such training is fundamentally counterintuitive.

Phase Potentiation in Hypertrophy Training

Phase Potentiation in hypertrophy seeks to make gains or prevent degradation of previously made gains in the current phase while also setting up the best possible result for the *next* phase of training. Although Phase Potentiation is classically regarded on a mesocycle basis and has its biggest effects on this scale, it also has implications across virtually every training timescale:

Sub-microcycle Phase Potentiation

Rep-to-Rep Potentiation

A given rep potentiates the next rep(s) by honing technique and warming up muscles and supporting structures[1]. If a rep is done poorly, it will fail to potentiate the following reps.

Set-to-Set Potentiation

Appropriate execution of one set potentiates performance and the stimulative effect of the next (across a reasonable number of sets—at some point fatigue interferes with this potentiation)[2]. If you do any single set too close to failure, it can impede the next.

Exercise Choice Potentiation

If you make the wrong choice for your first exercise in a session (like a very tiring lower back lift before stiff-legged deadlifts, for example) or execute the first lift incorrectly, it can impede the safe execution of the next exercise. On the other hand, pre-fatiguing a particular muscle to make it the limiting factor in a subsequent compound movement can be an intelligent use of potentiation. Included in exercise-to-exercise potentiation is the use of post-activation potentiation to improve the quantity or quality of exertion in later sets. For example, starting triceps training with skull crushers can be rough on the elbows and limit efficient training, but if you do heavy shoulder presses beforehand, your elbows may be much better prepared for skull crushers and the weight may not only feel lighter (letting you generate a better mind-muscle connection), your performance may be elevated as well. In general, going from heavier compounds to heavy or moderate isolations is an example of an effective use of exercise-to-exercise Phase Potentiation.

Muscle Group-to-Muscle Group Potentiation

You can potentiate a muscle group's performance by training another muscle group beforehand, especially with certain loading schemes. Deadlifting heavy before doing stiff-legged deadlifts in the moderate rep range can get you primed and ready so that stiff-legged deadlifts feel easier and are performed with better technique and mind-muscle connection. Sometimes the goal is just to prevent interference with subsequent exercises. For example, we might opt for a more moderate volume on back training before chest training later in the session just so systemic fatigue isn't so high that chest training suffers. We can make up for the decreased volume with higher frequency upper body training.

Session-to-Session Potentiation

Session-to-session potentiation is mainly a matter of making sure that the last session's fatigue will not excessively impact the next session. For example, training heavy rows the day before heavy squats might impede your squats due to back fatigue. Using session-to-session Phase Potentiation, you could instead either separate rows and squats by a day or save heavy rowing for a day after squats.

Microcycle-to-Microcycle Potentiation

In order to potentiate the next microcycle, any volume, load, or RIR choices must make the current week effective without limiting next week's training. Deload microcycles must also drop enough fatigue to ensure productive training for the first microcycle of the next meso.

Assessment of RIR and rep progression can help us determine whether our load increases are reasonable and therefore whether our current training is potentiating a full, productive accumulation cycle week to week. Weekly loading increases do benefit tension-mediated growth, but should not come at the cost of other more important overload stimuli. Within potentiation, this means that a given week's loading increase should be stimulative, but not so stimulative that it introduces enough fatigue to shorten the accumulation phase. Using this insight, we can derive a very simple rule for load progression that supports microcycle-to-microcycle potentiation.

Hypertrophy Load Progression: If you are increasing load weekly, add only enough to allow at least the same reps, at the same or slightly lower RIR with at least four weeks of accumulation being the goal.

Notice that there is no top end to accumulation length. In general, when the average lifter trains most of their body between MEV and MRV using the above stipulations, accumulations will likely hit MRV in six weeks or less, though beginners might be able to go as long as eight weeks or even longer. Anything much longer usually means understimulative training at the start, minimal RIR progression, a failure to add volume as performance increases (understimulative training across the meso), or some combination.

Practical Application

Loading progression can look a bit different from one situation to the next, even for conventional training where small enough loading increments accommodate weekly fitness improvements.

Example 1: When weight increments of the machines or available weights are too large for practical increases, some strategy is needed. For example, let's say that your 15RM in the lateral raise is 10lb. How are you supposed to get the same reps at an equal or lower RIR week to week if your dumbbell options are 10lb and then a big jump to 15lb? If you stay at the 10's, either your reps have to increase week to week or your RIRs have to rise. If you go to 15lb after a week, your reps will fall out of your target range due to the large relative weight increase. Under these circumstances, letting your reps rise to make sure RIR is either stable or decreasing slightly week to week is best choice. Once your reps reach the upper end of the target rep range, you can increase weight and likely land at the lower end of that range.

Example 2: Let's say you start your barbell curl with 15 reps and 4 RIR in the first week of a five week accumulation. Week two you add 5lb and get 15 reps again, at 3 RIR. So far, so good. Week three, you go up 5lb again, but end up hitting 1 RIR, which is a bit too fast for your planned accumulation. In the fourth week, you should stick with week three's weight and repeat the same reps, again hitting 1 RIR. In the fifth and final week, you can add 5lb again and probably hit 15 reps at 0 RIR. Notice that we delayed one loading addition, but that since RIR *did not* go up during that time, we did not violate our loading progression rule.

Rep progressions can work *exactly like load progression* so long as we apply the loading rule with a slight modification:

Hypertrophy Rep Progression: If you are increasing reps weekly, add only enough to allow at least the same load, at the same or slightly lower RIR, with at least four weeks of accumulation being the goal.

As we learned in the Overload chapter, relative effort equalizes the stimulative effect of different loading and therefore rep ranges[3]. If your RIR is rising, you need to add more reps to keep it progressing through the effective range. For example, if you get 15 reps at 4 RIR on the first set the first week, then 16 reps at 4 RIR in the second week, but you then get 17 reps at 5 RIR in the third week you are now in violation of the rep progression rule. The following week, you need to raise the reps, perhaps to 20, which might get you to 3 RIR and allow you to continue the progression. This is just an example—any choice that doesn't violate the load and rep progression rules is valid.

Practical Application

Example 3: Sometimes, things can go a bit more smoothly. We might be able to add 5lb every week to our bench press for six weeks without ever losing a rep, moving from 4 RIR in the first week to 0-1 RIR in the last. Other times, load progress might be sped up. Let's say you plan to match your reps while moving up in leg presses by 10lb each week across a five week accumulation phase. You do 205lb for 12 reps at 4 RIR on a first set in the first week, 215lb for 12 reps on the second week with 3 RIR, but when doing 225lb on the third week, you hit 12 reps at only 4 RIR, which is no good because it's a backslide in the overload progression of relative effort. In the next week, you might choose to go up by 15lb to 240lb, and that might get you a 3 RIR effort, before going up another 15lb to 255lb in your last week for a 1 RIR effort at 12 reps.

The most productive mesocycles will be ones in which each week potentiates the following week's training to allow for the longest mesocycles while preventing any understimulative microcycles. In other words, volume, load, and RIR progressions should lead to training that is stimulative enough to cause acute growth each week, but not so fatiguing that it needlessly cuts potential accumulation length (limiting total meso growth).

Mesocycle-to-Mesocycle Potentiation

Exercise Choice and Cadence Potentiation

There are several effective ways to sequence exercises between mesocycles for potentiation. One of these is to use certain exercises or techniques in one phase, while saving others that are better fitted for later training phases. Let's take leg presses and squats. You *can* use either as a primary quad move in the 5-10 rep range for the first two mesocycles in a hypertrophy block, but if you need lots of quad work in the 20-30 rep range in the third meso, squats will not be a realistic choice. So, while you could do leg presses for the first two mesocycles, that might mean that they are stale by the time you get to the third meso *when they are definitely the best tool for the job*. With strategic variation for potentiation, you would use more squats in the first two mesos to potentiate leg pressing in the third.

Another means of using Phase Potentiation mesocycle-to-mesocycle is to work on the non-target muscles that are limiting certain exercises in one meso, in order to make those exercises more effective in subsequent mesos. For example, you might struggle to feel pulldowns in your lats because your forearm flexors are the limiting factor. To potentiate pulldowns, you could focus on other back exercises (those with lower reps and heavier weight so that forearm endurance isn't a limitation) while also training your forearm flexors, especially in the 20-30 rep range. After such a focused effort for several mesocycles, your pulldowns might no longer be limited by your forearms and will better target your lats.

You can also strategically arrange per-session exercise order from mesocycle to mesocycle. Typically, the exercises you do first in a session will be done in the lower rep ranges. Moving an exercise to later in the session and using higher reps and a lighter load allows you to work on technique and mind-muscle connection to improve later mesocycle SFRs (when you move the exercise to earlier in the session and use heavier weight). This is especially effective for technically complex exercises that have not been trained or practiced much in recent months. For example, if you haven't done weighted dips in many mesocycles, you might consider doing them unweighted and placing them toward the end of one of your triceps or chest sessions. They would be awkward at first, but since they are not a primary lift for that session, maximizing SFRs with them isn't as imperative, and since they are unloaded, a bit of technical uncertainty isn't likely to cause injury. The next meso can see you doing dips as a first or second exercise, and by then you'll be technically sound, safe, connected, and with much greater loading capacity and a better SFR. This is by no means a mandatory practice when introducing new exercises, and especially so for movements that are not technically complex, like a dumbbell wrist curl, for example. Use your experience to dictate when this type of potentiation is useful.

Using pauses and slow eccentrics is another way to ease into a newer or less practiced movement and potentiate its more effective use in later mesocycles. In the above example, you might also do the dips with a slow eccentric in that first mesocycle, and take a pause at the top and bottom of each rep. This will improve technique and mind-muscle connection even more, allowing you to transition into a more dynamic execution in the later mesos. As mentioned in the Variation chapter, pauses and slow eccentrics can also be used for technique reset—on an exercise you are used to performing with a more dynamic effort, but that could now use some technique and mind-muscle connection refinement.

Volume Potentiation

Over the course of a hypertrophy focused training plan there are plenty of opportunities to alter volume for Phase Potentiation. Deloads are an important example; not only do they potentiate the next microcycle, they must potentiate the entire next mesocycle. Importantly, deloads also reduce your MEV considerably. At the end of your accumulation phase, your MEV is fairly close to your MRV. If your MEV never went down, you'd soon be starting mesocycles right under your MRV, severely limiting volume progression and making your accumulations very short. Because you spend a week at MV level training during deload, you re-sensitize to higher volumes and your MEV drops, potentiating another productive accumulation. For example, if your MEV to MRV training went from 4-10 sets per session across the last meso, your MEV might be shifted up to eight sets by the end. A deload might drop it to six sets or so, giving you two more weeks of productive training compared to skipping deload. Because deloads only partly reduce MEV, after around 3-6 mesocycles you will need more than a week of lower volume training to separate MEV from MRV. The next level of Fatigue Management and Phase Potentiation is then required—a low volume mesocycle or "maintenance training phase".

A maintenance training phase is typically a 3-6 week accumulation phase characterized by MV training. This is, as you may already understand from our discussion of volume landmarks, a *very* low volume—you should rarely get sore, achieve a pump, or even feel very challenged. These phases should be done during weight maintenance phases as MV is not stimulative enough for muscle growth or retention during muscle gain or fat loss dieting respectively. Muscle conservation during maintenance dieting is best when heavier weights are used (*at low volumes*), so the 5-10 rep range for most exercises is often the best choice. These low volumes drop MEV, resensitize your muscles, re-convert fibers back to faster-twitch variants, and increase strength to some extent. All of this potentiates future muscle growth. For those who have come back to higher volumes after a resensitization phase, the feeling of intense pumps and soreness from just a few sets of higher reps is familiar evidence of lower MEVs.

Active rest phases also potentiate recovery and resensitization, but are best used when psychological fatigue is particularly high, such as after a long fat loss macrocycle. While you could hypothetically *just* do active rest phases in place of all resensitization training, you would miss out on a lot of heavy load technical practice on the exercises you normally use for muscle growth, which might be helpful especially for beginners and intermediates.

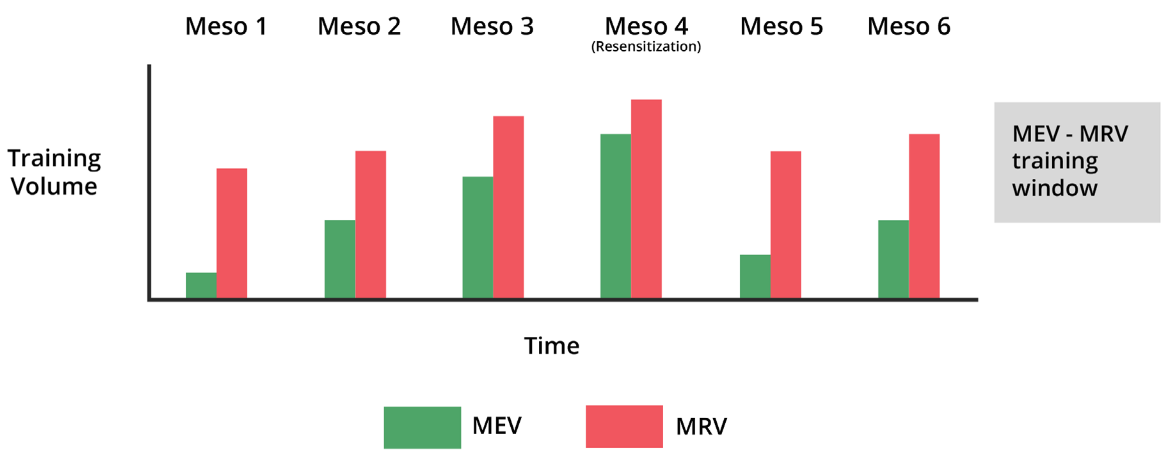

Figure 6.1: Attenuating Volume Resistance with Resensitization Phases

As each mesocycle of hypertrophy progresses (Meso 1-3 and Meso 5-6), the amount of volume required to grow any muscle (MEV) increases, but so does the ability to recover from any given amount of volume (MRV). MEV increases faster than MRV, reducing the size of the MEV-MRV window, creating a lower SFR, and necessitating shorter accumulation phases. A resensitization mesocycle (Meso 4) done at MV, increases sensitivity to volume, reducing both the MEV and MRV in the subsequent mesocycle (Meso 5). This buys us a bigger MEV-MRV window within which to continue productive training (Meso 5-6).

Loading Potentiation

Load-range sequencing across mesocycles can influence growth results as well. Logically altering the percentage of training spent in the heavier, moderate, and lighter loading ranges each mesocycle can potentiate productive training across a training block. As multiple high volume mesocycles are sequenced together, cumulative fatigue, damage to connective tissues, and volume resistance rise together. This means that heavier training becomes both less effective (as greater fatigue levels prevent strength expression at heavier loads considerably more than at lighter loads), and less safe. In addition, high rep and other metabolite techniques tend to build up adaptive resistance much faster than heavy weight, straight set methods, so they cannot usually be used as productively for as many sequential mesocycles. This suggests that one intelligent way to sequence training for potentiation is to increase the fraction of moderate and light work and associated training modalities mesocycle to mesocycle across a training block. An active rest phase or resensitization phase can be taken when necessary, and then the pattern can repeat itself. It is important to note that when a mesocycle is more focused on any one rep range (and therefore loading range), we don't mean that all of your work needs to be done in the given range. For example, a three mesocycle progression as described above could look like this:

Mesocycle 1:

- 50% of the sets in the 5-10 rep range
- 35% of the sets in the 10-20 rep range
- 15% of the sets in the 20-30 rep range

Mesocycle 2:

- 25% of the sets in the 5-10 rep range
- 50% of the sets in the 10-20 rep range
- 25% of the sets in the 20-30 rep range

Mesocycle 3:

- 15% of the sets in the 5-10 rep range
- 35% of the sets in the 10-20 rep range
- 50% of the sets in the 20-30 rep range

Notice that in this structure certain exercises can be loaded in the same range for several mesocycles. This allows for momentum to be built on rep strength and potentiate higher SFRs. For example, you might have high bar squats in the 5-10 rep range in all three mesocycles during this progression. In the first meso, it might be high bar squats *and* hack squats in the 5-10 rep range. In the second, perhaps high bar squats in the 5-10 range and hack squats in the 10-20 range. In the third and last meso, we can again have high bar squats in the 5-10 range, hack squats in the 10-20, and add in leg extensions in the 20-30 range. This method of meso-to-meso potentiation allows for continual exposure to larger and larger volumes that potentiate growth *and* the progression of intensities in any given range. This also prevents the amount of volume increase via the heaviest loading from becoming excessive in order to reduce injury risk as fatigue rises later into the block.

These recommendations can be altered based on each muscle's and each individual's average fiber distribution. For example, a faster-twitch muscle may progress from having 5% to 15% of its volume done in the 20-30 rep range, while a slower-twitch muscle may go from having 25% to 50% in the 20-30 rep range across the mesocycles of the block and so on. What matters is not the absolute numbers, but their relative progressions. This method is not the only way to progress through a block of training,

Frequency Potentiation

Until very recently, there was not enough compelling evidence to support best frequency alterations across mesocycles for phase-potentiation. Though data is still somewhat lacking, we can now give some general recommendations.

As already discussed, heavier training of faster-twitch fibers takes longer to recover from than lighter training of slower twitch fibers and should be done in earlier mesocycles[4]. Thus, there may be some merit to using slightly lower training frequencies in earlier mesocycles. As MEVs and MRVs rise and average training moves into the lighter range, average muscle fibers convert a bit to the slower-twitch range. Thus, across later mesocycles, it becomes harder and harder to cram the additional volume into as few sessions without exceeding per-session MAV. Later mesocycles in a block might therefore benefit from higher frequencies to spread the increasing volume over more sessions. Higher frequencies can also accommodate the shorter SRA curves of the faster healing slower twitch fibers[4]. It does take time to acclimate to higher frequency training though, so it pays to make frequency progressions between mesocycles smooth. A resensitization mesocycle can then be run with lower volume *and* lower frequency to alleviate accumulated fatigue and joint and connective tissue damage and potentiate more training.

As an example of this structure: A resensitization mesocycle could be run with all muscle groups being trained 1-2x a week at MV. The first hypertrophy mesocycle of three after this can hit all slower-recovering muscle groups 2x a week and faster-recovering groups 3x a week, training between MEV-MRV. The second mesocycle might be run with 3x and 4x per week for slower and faster-recovering muscles respectively, and the last one with 4x and 5x per week. By this third mesocycle, fatigue and connective tissue damage would be very high, volume sensitivity very low, and another resensitization phase or active rest phase would be needed. These mesocycle frequencies and volumes would ideally be combined with the load progressions from the last section for a comprehensive, phase-potentiated approach. As with loading progression recommendations, this is not the only way to use frequency for potentiating phases, but it is a very reasonable choice.

Block-to-Block Potentiation

We will illustrate one common way to potentiate hypertrophy training block to block, but please understand that there are many variations on this theme—far too many for an exhaustive list. With an understanding of the underlying principles that produce beneficial potentiated sequences, you can imagine many more such variations.

The most common block-to-block potentiation in hypertrophy is the muscle gain block - maintenance block - fat loss block macrocycle. The first block of training (usually 2-4 mesocycles) is dedicated to gaining muscle through MEV-MRV training and hypercaloric eating. After this block is over, fatigue is high from training, injury risk increases, and muscles are desensitized to the hypertrophic effects of volume. At this point, a 1-2 mesocycle block of maintenance (MV) training and eucaloric eating with less rigid structure can be employed to reduce both physical and psychological fatigue. This maintenance phase prepares the body for another block of hard training and goal-oriented eating. This process can repeat until enough fat has accumulated to make health and muscle gain ratios less optimal. This likely occurs at body fat levels above roughly 20% for males and above roughly 30% for females. A 1-2 mesocycle fat loss block can then be performed with MEV-MRV training and hypocaloric dieting.

Because the end of this series of training blocks happens after at least one high volume training meso, an early resensitization phase is likely needed before repeating the series. Without this, the next muscle gain phase might be less effective as it will start when the lifter is already less sensitive to volume from training during the fat loss phase. Weight gain is potentiated by weight loss, however, so it is often wise to go directly from fat loss to muscle gain. To deal with the sensitivity problem, but make use of the weight gain potentiation, you can run one mesocycle of muscle gain training and eating after your fat loss phase, and *then* run a brief maintenance and resensitization meso or active rest phase before carrying on with muscle gain.

The exact length of any given block (number of mesocycles in a block, number of microcycles in a mesocycle) in this potentiated sequence will vary with each individual's situation and goals. Someone who is very muscular for their bodybuilding weight class might do as little as one muscle gain mesocycle, then follow up their resensitization meso with a three mesocycle fat loss phase. This bodybuilder would train closer to MEV during each meso with minimal progression in loading and reps to stretch each accumulation out and allow plenty of time for an extended fat loss phase, perhaps in preparation to compete. On the other hand, a bodybuilder earlier in their development might be plenty lean but need to prioritize muscle growth. In this case, a three mesocycle gaining block, followed by a single resensitization mesocycle, and then a one mesocycle fat loss block might be the better choice. Again, there are many ways to organize long-term training, but we encourage you to give some thought to this approach and the many training structure options it supports.

Macrocycle-to-Macrocycle Potentiation

Because macrocycles are not as intricately linked to one another, potentiation between them is not as remarkable as potentiation between any of the other shorter timescales of training. That being said, there are a few notable opportunities for Phase Potentiation between macrocycles.

Residual Effects of Previous Macrocycles

One way to potentiate macrocycle to macrocycle is to consider the lingering effects of the last macrocycle's diet and training. For example, if the last macrocycle ended with a bodybuilding show (and the harsh diet and high volume training that preceded it), simply going into the next macro as if you're fresh is unwise. A month-long resensitization mesocycle, an active rest phase (immediately or right after a short post-competition muscle gain phase) followed by low volume can be done first, to potentiate a more successful muscle gain phase.

Macrocycles Dedicated to Strengthening Limiting Factors

When some muscles end up much bigger and stronger than others, the others can become limiting factors to the training of *both*. For example, if you focused on chest in the last macrocycle and made excellent gains, pressing exercises might become limited by triceps. If you'd like to continue to prioritize your chest, you can, but you will have to willfully bias your training to deemphasize triceps in order to keep making progress without that limitation. Instead, you could use macrocycle-to-macrocycle potentiation—taking slightly closer grips on most of your presses for example to target your triceps more. This will allow phenomenal triceps growth with fewer sets of extension exercises and interestingly, fewer sets of pushing movements in total. Your stronger chest can boost your triceps into extremely effective training, increasing both SFR and STR of your triceps focused pressing lifts. Once your triceps are caught up over the course of the macrocycle, you can switch back to a chest focus in the next, and repeat the process, benefiting from reciprocal Phase Potentiation all the while.

This type of potentiation can also be used to bring up muscles that support effective lifting, but that themselves are not needed directly for physique. For example, if your spinal erectors are relatively weak or small, this is not often a huge setback for a championship physique, as judges rarely reward impressive erectors (while they do reward glutes and hamstrings for example). Weaker spinal erectors, however, might impede lifting and therefore the growth of other muscles. If your erectors are the limiting factor in your squats for example, you won't be able to stimulate your quads as well. In this case you can run a macrocycle in which you train the erectors with exercises like deadlifts and high-bar good-mornings but train your quads with exercises that tax the erectors the least, such as leg presses. This allows the erectors to get their best direct stimulation, without adding fatigue from less directly stimulative lifts. In the macro that follows, the erectors may no longer be the limiting factor on squats, and more of these exercises can be done to the great benefit quad development. A similar scenario can occur when forearms limit biceps training or traps limit side and rear delt training.

Potentiation via Exercise Variation on the Macrocycle Scale

By using certain exercises for an entire macrocycle (provided that they aren't stale or hurting you, of course), you can maximize neural efficiency and build momentum on performance, technique, and SFR. Then when you switch to a new exercise in the following macrocycle, the novelty of that new exercise will make it more stimulative and you can start with lower volumes and slowly work up, milking gains along the way. Such potentiation is not exceptionally beneficial when compared to just deleting and replacing exercises via the guidelines from the Variation chapter, but such cross-macrocycle potentiation can be beneficial. This is especially true for beginners who benefit from the technique practice and are less likely to run into staleness or injury when repeating an exercise across several mesocycles.

Different Training Splits

Not everyone's physique responds to the same splits in the same ways. Someone with a very high systemic fatigue cap and more slower twitch fibers might benefit from more frequent training, as they can recover quickly enough from higher volumes in rapid succession[4]. In contrast, someone with a lower systemic fatigue cap and more faster twitch fibers might do best with lower training frequencies[4]. The situation exponentially complicates when you factor in the slightly different fiber type and recovery time courses of each individual muscle. This means that there are hundreds of potential splits for any given macrocycle and individual. In fact, because individuals change over the course of their careers, the dynamics of individual optimality change as well, making the near-optimal split a moving target.

Phase Potentiation can help the search for a better split by using one split to prepare you for the next, as well as allowing you to systematically learn the effects various variables have on a given macrocycle and on the subsequent macrocycle(s). Because it's hard to say whether it was the nutritional conditions of the block, any other variables, or just a fluke that produced certain results, you cannot conclude much from a single training block experiment. If you try a certain split for a whole macrocycle on the other hand, you have multiple blocks from which to learn. Judging split effects from a whole macrocycle is much more likely to lead you to the reality of your physique's responses.

The split you use in any macrocycle can be altered on a number of variables, but it's important to keep the alterations to a few variables at a time and to change things incrementally from macrocycle to macrocycle. To use frequency as an example, if you did 2,3,4 biceps sessions per week across the last macrocycle, it's probably unwise to jump to 4,5,6 or to 0,1,2 sessions across the next macrocycle. The large delta in training itself is another variable to factor out of the noise. And, because your training is a balancing act between frequency, volume, and load that intersects multiple muscle groups (your biceps can interfere with back training, and vice versa, etc.), it's important to move the dial on any one variable (like frequency) slowly so that you have the smallest chances of throwing off the whole split. If you are used to an average 3x per week biceps training frequency, you also probably get the feel for how much volume to use and on what days to place a 4x frequency. But if you're used to a 2x and you go straight to a 5x, you're just shooting in the dark as far as interference with the rest of your split is concerned.

Each macrocycle should be only a slight departure from the last one in terms of some training variables (exercise selection, volume, loading ratios, frequency, etc.) and careful notation of the effects of these changes should be made. As you train for years and years, you will begin to learn more about how your body best responds, enhancing the effectiveness of your training. Because your body never stops changing, this is not a process that comes to an end. You will learn all the way up until you stop training for good, but that's part of the beauty of lifting!

Early Career—to—Later Career Potentiation

Setting up a technical base early in your career will potentiate benefits later. In the beginner stages, growth comes easily from rather minimal efforts. Thus, it's not necessary to push to very low RIRs or very high volumes—and can be dangerous since technique is still under development. During this time, it's a very good idea to practice the core lifts (pushes, pulls, squats, curls, laterals, etc.) with an emphasis on good technique that will become your default for the rest of your career. Once proper technique becomes ingrained across macrocycles of practice, the lifter can shift their focus to training at greater relative efforts. After learning to push to low RIRs with good technique, advanced lifters can focus on mastering the mind-muscle connection to maximize SFRs. Thus, for career-long Phase Potentiation the sequence of focus should be:

Basic Technique → Relative Effort → Mind-Muscle Connection

Without first establishing basic technique, pushing relative effort can lead to further deterioration of technique and impede learning. You can get growth as a beginner and intermediate with not-so-great technique, but once you are an advanced lifter, the fatigue and injury costs of such lifting often become insurmountable. At this point, your only recourse is to go back to the drawing board and re-learn the technique, which requires lighter training that doesn't approach failure, leaving any intermediate to advanced lifter training without robust overload and missing out on growth. Refining technique is also harder once you have bad habits. If you learn technique as a beginner, you grow just as much as if you swing the weight around and you never have to stop stimulative training to relearn. Good technique potentiates the pushing of RIRs both by making it possible without injury and by allowing the movement to occur automatically, so that mental resources can be used to detect, calibrate, and increase relative effort. You can think of your technique as the bolts that hold an engine together. Once they are tight, you can push the engine much harder without it falling apart. A solid technical base and finely calibrated relative effort potentiate a focus on mind-muscle connection. The mind-muscle connection involves the detection of high tension and a metabolite burn in the target muscle, not just an awareness of its contraction, so being capable of safe, hard training that produces those effects is a prerequisite.

Over-Application of Phase Potentiation

Overly Limited Per-Mesocycle Rep Ranges

When lifters first learn about the principle of Phase Potentiation, they often get over-zealous. For example, instead of having three mesocycles with the following loading ranges, they might over-apply loading/rep ranges as in the second example:

A reasonable phase potentiated series of mesocycle rep ranges:

- **Meso 1:** 50% in the 5-10 rep range, 35% in the 10-20 rep range, 15% in the 20-30 rep range
- **Meso 2:** 25% in the 5-10 rep range, 50% in the 10-20 rep range, 25% in the 20-30 rep range
- **Meso 3:** 15% in the 5-10 rep range, 35% in the 10-20 rep range, 50% in the 20-30 rep range

An over-application of Phase Potentiation in mesocycle rep ranges:

- **Meso 1:** 100% in the 5-10 rep range
- **Meso 2:** 100% in the 10-20 rep range
- **Meso 3:** 100% in the 20-30 rep range

This over-application of potentiation results in Fatigue Management problems when *every* workout for the first mesocycle has to be heavy, a loss of loading momentum within any given range, the requirement for frequent exercise rotation to avoid using exercises outside of their concordant rep ranges (like avoiding squats in the 20-30 range), and the excessive re-calibration of SFR.

Excessive Resensitization

It is unclear exactly how long a resensitization phase needs to be, but based on clues in the literature and our experience with thousands of athletes, we cannot postulate any significant resensitization benefits to more than two months. In fact, in about one month, some vast percentage of all that a resensitization phase is meant to achieve is likely complete[5].

Some people might extend their resensitization phases longer than physiologically needed for psychological reasons—perhaps they are burnt out on hypertrophy training or lacking motivation. Of course, it is perfectly fine to train at MV for as long as you need to get back your mojo, but if hypertrophy is the primary goal, getting back to productive training as soon as possible is wise. An active rest phase is a good alternative in this case, as it can often drive training volumes and intensities low enough to make most lifters miss hard training—this might be more efficient when psychological fatigue is high.

Another reason that a lifter might extend a maintenance phase is to indulge in some ego-satisfying strength training. A heavy strength phase or series of phases for fun or for a competition is totally fine if you are doing it out of personal interest, just know that strength training *does not likely potentiate hypertrophy*. Low volume powerlifting or weightlifting training with heavy weight and low reps does resensitize muscle, but it also results in more connective tissue, joint, and psychological stress. And if you peak for a competition or for fun, you will need a full (2-3 week) active rest phase to accomplish enough fatigue reduction to allow for higher volume hypertrophy training again, meaning even more time is lost to this endeavor. Again, this is a perfectly fine choice if you are comfortable trading off some muscle gain, just be aware that there is a trade-off.

If you want to stay at MV training longer as a personal preference, or you want to train for strength for fun or compete in strength sports between muscle gain and fat loss phases, there is nothing wrong with this, but if hypertrophy is your primary goal, a resensitization phase can be as short as one month, allowing you to get back to building muscle that much faster. Or, if you have significant psychological fatigue, an active rest phase can often get you back to a motivated state in a matter of weeks.

Alternating Muscle Gain and Fat Loss Phases Too Frequently

It's unwise to alternate short fat loss and muscle gain phases. From a training perspective, the biggest downside to this approach is the loss of momentum and an inability to accurately autoregulate your training. When you're gaining muscle for multiple mesocycles in a row, you generate momentum in technique, mind-muscle connection, and strength. Your ability to estimate volume landmarks is also made easier thanks to more stable conditions. This increases SFRs and because muscle growth occurs over long timescales, boosts growth. If dieting phases last several mesocycles, error rates in autoregulation are minimized and smoother, more optimal training results. Your leg press MEV for example might be wildly different on a fat loss compared to muscle gain phase, but be fairly predictable across muscle gain mesos. Nutrition based muscle growth problems also result from excessive switching of diet phases (described in detail in the Renaissance Diet 2.0 and Minicut Manual)[6,7]. To summarize, when you gain muscle or lose fat, do it for a few mesocycles at a time (outside of the *occasional* minicut).

Under-Application of Phase Potentiation

No Resensitization Phases

This is probably the most common under-application of Phase Potentiation. Many lifters are just unaware that desensitization to hypertrophy training occurs. These lifters will often end up doing "auto-resensitization" which is not nearly as cool as it sounds. Auto-resensitization is when being hurt by, bored with, or burned out from endless MEV-MRV hypertrophy training results in a switch to lower volume or no training. Most people don't auto-resensitize until *months* of either grossly suboptimal or completely ineffective training—a huge swath of "training plateaus" result from poor Fatigue Management. Taking deloads and resensitization phases purposefully at the right times greatly potentiates long-term gains.

No Rep Range or Frequency Potentiation Over Mesocycles

Although keeping all rep ranges the same across mesocycles is easier and still allows plenty of muscle growth, altering the percent of your weekly volume that comes from each rep range over a series of mesocycles probably works just a little bit better. The same goes for the use of high frequency training. It might be easier to use the same frequency in all mesocycles in a block, but a frequency that's sustainable for all mesocycles may be too low to be optimal, and a frequency that's optimal for one mesocycle may be unsustainable for the whole block. Raising your training frequency through the successive mesocycles in a training block can have small but meaningful advantages. At the end of the day, Phase Potentiation is a training principle because it *works* and while skipping it won't prevent results, utilizing it can enhance them.

No Fat Loss Phases to Potentiate Muscle Growth

If your goal is hypertrophy, especially if you are not a competitor and do not *have* to get lean enough to step on stage, it is tempting to avoid weight-loss dieting (and therefore pauses in muscle gain)—but occasional fat loss phases can actually potentiate muscle growth. The fat gained on a muscle gain phase can eventually be detrimental to further muscle gain—and fat gain *will* happen to everyone (short of perhaps some beginners) on every muscle gain phase[8,9]. Your health can also decline if you gain too much fat over enough unchecked hypercaloric phases[10]. Excess fat can also create loose skin which can impact your aesthetics if you do decide to get lean or compete at some point—and getting lean will be much harder with more to lose, which can lead to prolonged diets that risk muscle loss. If you aren't yet convinced, the research also hints that less muscle is gained overall when starting body fat percentages are higher. This does not mean you must diet down to an extremely low body fat every time you start a muscle gain block, but it does mean that if you find yourself north of around 20% body fat as a male or 30% as a female, muscle growth ratios are unlikely to be maximally efficient. Mind you, these fat loss phases are just to keep you healthy and lean enough to gain muscle efficiently and not to prioritize looking lean or maintaining year round abs.

CHAPTER 6

Summary

Phase Potentiation for hypertrophy ensures that current training is not only acutely effective, but also enhances future training. It does so in part by preventing adaptive decay—making sure that previous gains are not lost during a given training phase so that sequential phases can build upon one another. Potentiation technically happens at all levels of training, but the most complex and impactful potentiation occurs at the mesocycle-to-mesocycle scale.

Two main rules for microcycle-to-microcycle potentiation are: If you are increasing weekly load, add only enough to allow at least the same reps, at the same or slightly lower RIR. If you are increasing weekly reps, add only enough to allow at least the same load, at the same or slightly lower RIR. In either case, shoot for at least four weeks of accumulation.

Mesocycle-to-mesocycle potentiation occurs across exercise selection, volume, loading, and frequency. Potentiation via exercise selection overlaps with strategic variation, whereby you train exercises that are well suited for heavy loading in mesocycles where 5-10 rep training predominates, and so on. Training volume can also be used to potentiate better responses meso to meso. Training with increasing volumes across mesos improves both work capacity and recovery ability, but at the expense of net volume sensitivity. Thus, MEV and MRV both increase across a training block (by a few working sets per week), and this should be reflected in training program design. Loading can also potentiate future training on the mesocycle scale. A training block presumably starts out with low fatigue, faster twitch characteristics on average, and a lower MEV. Thus heavier, lower frequency training is ideal at first. As mesocycles progress, fatigue accumulates, fibers convert slightly to slower twitch, and MEV rises, necessitating higher volumes and frequencies as well as lighter loads. And because higher frequencies are less sustainable, placing them only after lower frequency mesos have been completed leads to longer periods of productive training.

Block-to-block potentiation also exists. When a block of hypertrophy training is complete, a short low volume training block can bring MEVs back down, reconvert fibers back to a faster twitch average, drop fatigue (especially connective tissue fatigue, which can take more time to dissipate), and thus potentiate further productive high volume training. This “maintenance phase” should include very low frequency, MV training (loading can depend on the condition of the lifter’s connective tissues). An active rest phase can be taken for a similar purpose and can often better facilitate efficient recovery from psychological fatigue. An active rest phase is usually shorter than a maintenance phase, however, and may not allow joint and connective tissue fatigue to resolve as completely—bigger, stronger lifters for whom this is usually a more pressing issue might therefore need longer or more frequent active rest phases.

On the career scale, beginner lifters should be most focused on mastering technique, especially for compound barbell basics, which will potentiate the ability to focus on pushing RIR closer to failure during intermediate years. Together these abilities potentiate a capacity for advanced lifters (having already mastered technique and learned how to train very hard) to establish and perfect mind-muscle connection, raising the SFRs of their training.

Phase Potentiation is one of the least impactful of the training principles—a lot of its effects come automatically with good Fatigue Management and Variation and beginners and intermediates can get away without focusing on it directly. That being said, this principle can optimize training in later years. Although gains are still possible for advanced lifters without attention to Phase Potentiation, *optimal* gains are unlikely. And because gains are so slow for advanced lifters anyway, Phase Potentiation is highly recommended to eek out maximal progress!

CHAPTER 6

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CHAPTER 7

Individualization

Individualization is the process by which the training principles are tailored to an individual's needs and their responses to stimuli. An ideal overloading stimulus to some may be either crushingly difficult or barely a warm-up for others. These differences occur between individuals and within the same individual across muscle groups and under different circumstances.

It's possible to understand Individualization as an implementation strategy that modifies training principles rather than a principle itself. Of course, what is also true is that every principle after Specificity can be thought of this way. Overload modifies specific training to make it stimulative enough and Fatigue Management limits Overload to allow for recovery. SRA is merely a guide for applying Overload and Fatigue Management together, Variation just alters the presentation of Overload to keep stimuli from going stale, and Phase Potentiation applies Variation in a strategic manner.

Individualization of the training principles almost always involves differences in the *magnitude* of their application or the specific type of application, not in whether principles need to be applied at all. Everyone needs *some* Overload, *some* Fatigue Management, and so on—there's no athlete who is immune to the principles. Differences in application of training principles are not usually quantum leaps though—if one athlete benefits the most from 10 hours of weekly training, it's possible that some of their peers will benefit the most from something like 15 hours a week, but unlikely that they will need 50 hours, for example.

Intelligent program design involves generating a reasonable training plan to start and then letting feedback from the athlete's responses drive individualized alterations to enhance it. To call back to our earlier analogy, where Overload drives and Specificity guides the missile of hypertrophy, Individualization should be akin to minor in-flight adjustments.

Individualization in Hypertrophy Training

In hypertrophy training, there is bell curve of responses to various training principles, and all athletes over their careers lie somewhere on that curve[1,2]. Effective Individualization means finding specific responses to training variables and fine-tuning training accordingly. Because lifters differ in so many ways, it's not realistic to list all of variables that may impact Individualization, but we can take a look at some of the more important examples.

Work Capacity

Individuals differ in their ability to tolerate a given amount of work at a given load for a given duration. For example, someone might do rows with 135lb for 10,8,7,5,5 reps, but another person with the same rep max might do 135lb for 10,9,9,8,8 reps, demonstrating a greater work capacity despite similar strength. Those with greater work capacity, *all other things being equal*, can produce a more robust hypertrophic stimulus (greater RSM) and can do so in a shorter time (greater STR). Things are almost never equal, however, and often the folks with the greatest work capacities are those with a higher fraction of slower-twitch fibers—cancelling out any significant growth advantage from their work capacity.

From a programming perspective, individuals with greater work capacities can handle individual sessions of higher volumes, both per muscle group and in terms of total session workload. Individuals with a lower work capacity may need to split up their weekly workload into more sessions to make sure they are avoiding junk volume. If you improve your work capacity, you will be able to incrementally create more stimulus. But recovery will also become more and more of a limiting factor. Though improving work capacity can be valuable, doing so for the sake of hypertrophy must *not come at the expense of muscle growth* or you risk violating the principle of Specificity and making less progress on your hypertrophy goals.

Recovery Ability

Different people recover at different rates[3–5]. This is one of the main reasons why autoregulation is so critically important. If you just assume everyone recovers at the same rate, your program might ask most people to train hard again either too early or too late. This is true for the same lifter over time as well, as recovery ability changes.

On a deeper level, recovery can also occur at different rates *between* different body systems and muscles. For example, some lifters will have very quickly recovering neuromuscular systems, but below average joint or connective tissue recovery rates that limit training frequency. The best approach in programming is to make careful observations on recovery status (down to what is recovered, be it joints, performance, etc. and when) and plan and autoregulate Fatigue Management interventions accordingly.

The Volume Landmarks

Any lifter at any given time will have their own individual MV, MEV, MAV, and MRV values. Whenever we give examples of typical ranges of these landmarks in this or any other work, it's *paramount* to keep in mind that these are exclusively *estimates* of where those landmarks *might* be. Absolutely nothing replaces carefully observed responses to training, noted over time, to let you know what your volume landmarks really are. Once you know yours, it also greatly helps to keep in mind that they will change day to day, week to week, month to month, and over the years. Use the rough estimates of your volume landmarks to design your training, but then autoregulate training based on actual, up-to-date body responses.

Genetics: Adaptive Magnitude

One of the most relevant differences for hypertrophy results is the amount of muscle growth per any unit of stimulus an individual is capable of—their adaptive magnitude. Genetics determine this value to a great extent[1,2,6]. Doing your best with your genetics is the name of the game here, rather than assuming those growing faster necessarily have a better training program. As a side note—worrying about whether your growth genetics are good is also a waste of time. Design and execute scientifically sound training and diet programs and you will get the most muscle growth *you* are capable of, whether you stress about your genetics or not! In fact, stress lowers gain magnitudes, so the less you stress, the better!

Genetics: Anthropometry

Though nearly everyone has the same muscles and body structures, body shapes and body part ratios differ. Different limb lengths, slightly different muscle shapes, slightly different pennation angles, and so on can make big differences not only in appearance, but also in the exact technique alterations needed for best training. For example, someone with a long torso might be able to get a big quad SFR by squatting with a close stance, while someone with a shorter torso and longer legs might be better suited to a wider stance to prevent forward lean and the posterior chain from becoming the limiting factor for them.

Differences in anthropometry mean that there are no magic, perfect exercises or ways of performing exercises that *everyone* should be doing. There are only the basic principles of safe and effective execution, and the rest is up to the individual to technically tweak to target desired muscle groups and work to their best SFRs.

Genetics: Fiber Type Distribution

Different people have different percentages of slower and faster twitch fibers[7]. Though these can shift with training and dieting demands, we have good reason to think that such changes are fairly minimal[8]. Because of this, some individuals will benefit more from the heavier end (5-10 reps) of training and others from the lighter end (20-30 reps), with most people in between and everyone benefiting from all the ranges to some extent[9].

Genetics: Responses to Different Growth Pathways

It's very likely that there are genetic differences in sensitivity to different stimuli (tension versus metabolite accumulation versus cell swelling, and so on). Although everyone benefits from all of these growth pathways to some extent and should train to activate all of them, you can bias your training a bit toward stimuli that give you a better response. To determine this, you can monitor your SFRs and your rep-strength increases from mesocycles or blocks of training biased more towards one of the pathways. If you get amazing SFRs from a whole block of mostly 5-10 rep training, then you're probably more responsive to high tension and should invest a greater percentage of your training volume there.

Genetics: Initial Muscle Sizes

We all start out with muscles of different sizes *before* we ever train. If someone starts out with larger muscles than another, even with identical training and gain rates, the person with the bigger starting muscles will likely be more muscular for their entire career. Interestingly, a large fraction of male-female differences in muscle size after years of training can be explained by females just starting out with much smaller muscles, as gain rates between males and females are more similar than you might expect.

Genetics: Gain Rates

In part because of different adaptive magnitudes per unit of volume, different individuals gain at different rates. Due to various higher-order growth processes such as satellite cell proliferation rates, some individuals can have rather unimpressive growth rates at any one time but *keep growing steadily* for years and years, eventually passing up initial high responders[10]. Unless and until you train and eat well for *years*, you really can't tell how good or bad your genetics for muscle growth are. Growth rates also change predictably with time, generally declining with years of consistent training. This point is absolutely *critical* when comparing the effects of different program variables on your own growth over multiple macrocycles. If you used mostly sets of 10 two macrocycles ago and got great results, but got less impressive results with sets of 20 recently, you might be tempted to conclude that sets of 10 work better for you. But, it might be that *nothing* will work quite as well as it used to back when you were more of a beginner. Going *back* to mostly sets of 10 right after the macrocycle of sets of 20 would be more instructive. Avoid attributing beginner gains to specific training programs—beginners will nearly always make great progress, teaching us very little about what works best and worst in the long-term.

Genetics: Maximum Growth Potential

Your satellite cell pool size and other related factors can determine your growth ceiling[10]. One of these other factors is how many muscle cells you have to begin with. For example, someone with a greater number of smaller cells and a lot of satellite cells might not be very big to begin with but with 20+ years of consistent training, might have the potential to be huge. Note that maximum growth potential is quite a bit different than adaptive rate per unit volume or even average gain rate over time, so that fast initial gainers don't always grow the largest, and slow initial gainers might eventually grow bigger than all others.

Genetics: General Muscle Shape

Muscle shape differs person to person, affecting lifting biomechanics as well as aesthetics. Through the inclusion of different exercises, it's possible to grow certain parts of muscles a bit more than others and shape them to some extent, but it's important to understand that this effect is *very small* in the grand scheme[11]. If you think that your "thick all around" quads are going to get pyramid-like sweep, or your high calves will become thick all the way down to your ankles, and so on from changing exercises, you're probably going to be disappointed.

Genetics: Intermuscular Differences

Variables can differ across different muscle groups in the same person. Your quads might have a high MRV and incredible peak growth potential, while your biceps might have low MRV and never be able to grow impressively large. It is thus important to remember that your results for a certain muscle don't necessarily reflect poorly on your training choices. Pairing training via SFRs, volume landmarks, and other features correctly to individual muscles can allow your best growth. This also means that there is no one perfect way to train all of the muscles in your body, approaches should be based on the needs of each muscle group as well as the individual lifter.

Genetics: Sex

Females tend to have higher MRVs and work capacities, as well as be able to recover more rapidly, but in most cases have lower starting points of muscularity and probably somewhat lower growth rates[12–14]. These average differences can be used to make better starting estimates for programming, but because outliers exist and individual differences can be large, individualization and autoregulation are critical to optimize programming.

Training Age

The closer you get to your career peak, the more fine-tuned training needs to be in order to remain effective. For example, advanced lifters often have higher quad MRVs than axial loading MRVs, so they benefit from squatting moderately only after leg pressing or hack squatting heavy so that axial MRVs don't limit total quad work. Beginners might have an axial loading MRV that's completely out of reach of anything they could reasonably do in the gym, so they are best off squatting first to maximize the raw stimulus magnitude of that lift and so on.

Biological Age

Younger individuals might recover faster, but their lack of coordination and experience also mean lower SFRs[4,15]. Older individuals might recover more slowly, but have better mind-muscle connections via the maturity and focus that often comes with age. These differences can mean spending more time on technique with younger lifters and perhaps more time altering training and lifestyle variables to enhance recovery for older lifters, and so on.

Lifestyle

How much someone sleeps, eats, works, and exposes themselves to various forms of stress outside the gym has a massive impact on gain rates, recovery rates, work capacities, and everything on down the line. There are some important insights to derive from this.

First, you have to modify your lifestyle to maximize your muscle growth. Impactful variables like nutrition and sleep should be attended to if you would like to approach your best gains[16–18]. Obsessing over training program details is nearly worthless if you eat poorly and do not sleep enough. How you or any other lifter responds to a given training program at any given time is critically altered by diet, sleep, and stress levels at the time of the program's execution. It's vastly important to remember this before concluding that "XYZ program alteration seemed to work well for myself, my clients, or other lifters." It could just be that they got better sleep this time, or ate better, or managed stress better. Only programming changes repeated many times under similar conditions can begin to tell you about how your body responds to them.

As you can see, differences across multiple variables exist between lifters and across muscle groups in the same lifter and training needs to be individualized accordingly to be most effective for the person and their situation.

Individualization for Specificity

Specificity and Individualization overlap in that each structures training to support specific, individual goals; Specificity does this more broadly, while Individualization refines training further. By the time you have aligned your training with the principle of Specificity, Individualization is just a matter of some very small tweaks and focuses based on your body, genes, situation, and training age. Once a needs analysis has determined which muscles to prioritize (if any), how much time can be allotted to training, and so on, the second order of business is to determine where on the spectrum of RSM (Raw Stimulus Magnitude), SFR (Stimulus to Fatigue Ratio), and STR (Stimulus to Time Ratio) potential exercises lie for the individual. For those who are not time constrained and nowhere close to hitting local or systemic MRV, a focus on exercises with the highest RSMs makes the most sense. For those who also have plenty of time to train but are close to hitting their local or systemic MRV, a focus on SFR is warranted. When time is limited in any case, people are usually not close to hitting MRV because of the time constraint and exercise STR becomes the more important assessment. For those trying to maintain muscle and resensitize without excessive time or fatigue spent on the endeavor, or for those with the time and bandwidth to optimize, exercises with good SFTR (Stimulus Fatigue Time Ratio) are a great choice. Once you have an understanding of where on the spectrum between these four poles someone's programming needs fit, you can assess the degree of stimulus they derive from certain exercises, the degree of fatigue they accumulate, and the severity of their time constraint for training.

Judging a brand new movement is not recommended—as anyone learns a new exercise, STRs will improve with efficiency and as technique and mind-muscle connection improve, RSM and SFR get better as well. Our recommendation is to try an exercise for at least a mesocycle, and probably a full training block, before ranking and comparing it to other exercises. These processes take time and effort, but result in more individualized and effective training!

Individualization for Overload

Different volume landmarks dictate how we ought to individualize Overload strategies. Not only does each person have their own average MEV, they have different MEVs for different muscle groups. On top of this, MEVs change under different circumstances—daily recovery, nutrition, sleep, and activity fluctuations impact MEVs. Your MEV will also rise with the re-use of the same exercises in a training block and will rise for all exercises over months and years of training. MEV will also periodically decline as a result of Variation, deloads, active rest, and resensitization phases. This complexity means that rather than perseverating over "your exact MEV", you should calibrate your MEVs at the beginning of every stimulative training cycle using the MEV Stimulus Estimator Algorithm from the Overload chapter.

Individualization in Overload also means that progressions must be tailored to the individual. A lifter must decide whether load addition or rep additions are best choice to progress through RIR. For example, a single rep addition for a heavier lift such as a squat might move you two reps closer to failure as cumulative fatigue also rises between sessions. Thus, a smaller magnitude addition of load (+5lbs for example) might be more feasible to keep RIR progression from moving too quickly and shortening your accumulation. On the other hand, a load jump of 5lbs on a lighter lift like the dumbbell lateral raise might move you five reps closer to failure, ruling it out in most cases. Rep rather than load additions might move RIR progression more smoothly in this case, since a single lateral raise does not contribute nearly as much fatigue as one rep on the squat.

Also, progression choices can affect SFR across a meso. For example, while stiff legged deadlifts might be an excellent hamstring stimulator for sets of 6-8 reps, any higher rep range can expose the lower back as a limiting factor, degrading the hamstring SFR of the exercise. In this case adding load rather than reps is likely needed to progress across a full accumulation phase with good SFRs. In other cases, rep additions can improve SFR across a meso. For example, pullups might be a great lat stimulator for sets of 5-10, but only because the lifter is not strong enough to do more reps. As they get stronger, they are able to do more reps, and discover that SFRs increase. Load and rep progression are both perfectly valid as long as choices are individualized to produce the best SFRs for the person, muscle, and situation.

Individualization for Fatigue Management

Fatigue Management can be individualized by applying the Set Progression Algorithm from the Overload chapter and using recovery sessions and deloads when indicated. These autoregulation tools *are* the Individualization of Fatigue Management.

In addition to these tools, you also want to keep an eye on potential lag time between muscle recovery and performance as well as connective tissue and joint recovery. If you notice that your muscles are outpacing your connective tissues and joints, then make sure your upcoming deload is on the lighter side so that joint and connective tissue recovery can catch up. Taking more active rest phases and potentially fewer resensitization phases can also be an effective strategy for such an asymmetry in recovery. It's worth noting that as you get bigger and stronger, especially as you approach your career peak, these asymmetries tend to become more pronounced, and a more delicate approach to deloading and a more frequent use of longer active rest phases might become necessary.

Noting responses is a critical aspect for individualizing Fatigue Management. For example, if you locally overreach in a muscle and take a recovery half-week, you might find that this adds weeks of subsequent productive training. Or you might find, especially for larger muscles, that this only buys you another week before local MRV is exceeded again. A few cycles of this should lead you the appropriate Fatigue Management strategy. Autoregulation and therefore Individualization are very limited if not impossible without feedback and adjustment.

Individualization for SRA

The algorithms in the SRA chapter individualize training for distinct SRAs. For individualized training, frequency and volume schemes should not be imposed top-down or without physiological feedback. MEVs for some muscle groups can be confusingly low or high—it might take you one set of stiff-legged deadlifts to hit session MEV for hamstrings, but seven sets of cable curls for biceps. Some generic training plans might hit all muscle groups four times per week, but a lifter using this plan might find that their chest, triceps, or hamstrings don't recover on time while other muscles never seem to get sore at all. Such feedback should be used to change frequencies and individualize the very generic four-times-per-week for every muscle group training plan, making training more effective for the individual.

Individualization for Variation

Strategic variation is in essence, Individualization. Varying program design and exercise choice for Individualization can take many forms, perhaps the most important being to determine relative volume amounts for each of the three main loading ranges. In other words, for each muscle, where does more of the growth stimulus occur; the 5-10, 10-20, or 20-30 rep range? Knowing which ranges produce best SFRs can help you bias your training slightly in that direction. For example, if you find that your biceps really respond best to the 5-10 range, you might do 80% of your bicep work there in your first mesocycle, 65% in your second, and 50% in your third, with the other two rep ranges splitting the remainder.

Figuring out SFR and measuring long-term rep strength progress will help you find your best rep ranges. To determine what ranges are best for individual muscles you can spend a whole training block doing about 75% of your volume in a given range, with the remaining 25% in the other ranges while noting the following:

Pump

How big of a pump you get per set number. If it's a great pump in the 10-20 range from just four sets, but takes six sets to get the same pump in the 20-30 range, the 10-20 range wins.

Disruption

How many sets it takes to get notable disruption to the target muscle (perturbation, local fatigue, soreness). The fewer, the better. Juxtapose this with how your joints feel. A rep range that can toast your muscles the most and your joints (relatively) the least is a good range to prioritize.

Mind-muscle connection

Which rep range gives you best mind-muscle connections. Even 5-10 rep weights can let you feel deep tension through the target muscle if you are a responder to the heavier range.

Performance

How much strength you gain *in that rep range*. If training in the 5-10 range makes your best set of eight skyrocket, you respond well to that range. If it disrupts your joints without making you much stronger over multiple mesocycles, it might not be your most productive range.

Once you make the above assessments for each of the three main ranges, one at a time for each of your muscle groups, you will have insight on the best rep range choices for each. Then you can spend most mesos with an average of something like 50% of your training dedicated to your best rep range and 25% to the other ranges. If you find two or even all ranges equally effective, you can adjust accordingly with less bias to any one range.

You may have already noted that it would take *a very long time* to do the above for all muscles and all rep ranges and therefore get good information about loading range optimality for each of your muscles. Not only does each estimation take a whole training block, you have three ranges to asses—i*t takes years to properly learn your body's responses!* Because beginners and intermediates grow muscle more easily in any rep range, there is no lost growth spending time on these assessments and by the time you become an advanced lifter, you really know a lot about what sort of training works best for you. This allows you to make robust gains for much longer than most because your training gets smarter and more individualized as you go (and start to need more precise training to continue to progress). You'll also find that muscle group rep range optimality can change somewhat over time, so always paying attention to rep range SFRs and carefully recording training results will pay dividends for your entire training career.

The process of calibrating your SFR doesn't just apply to loading ranges, but to exercise order, movement velocity, training modality, and all of the other variables detailed in the Variation chapter. The SFR calibration process is the same for all of them, and allows you to develop a very deep understanding of what works best for you.

Individualization for Phase Potentiation

There are a few individually-specific alterations to the general Phase Potentiation structure of hypertrophy training:

Mesocycle Loading Range Bias

Some individuals respond to lower loads and metabolite techniques better than higher loads and straight sets. Because metabolite techniques tend to self-extinguish rapidly via local vascular adaptations, those individuals who bias their average mesocycles more into metabolite ranges might benefit from shortening each mesocycle, and, interestingly, using more resensitization mesocycles more often, perhaps every two mesocycles of training instead of every three[19,20]. Another approach for such individuals is to increase the amount of sets allocated to metabolite work *as each accumulation phase within each mesocycle progresses*. So, someone could start with an MEV of nine total weekly sets for side delts with three sets in each loading range (the lightest being the metabolite work). This person could then add two sets in the highest rep range for every set added in the middle rep range and not add any sets to the lowest rep range. If MRV is 24 sets, the meso may end with three heavy sets, seven moderate sets, and 14 light sets. This allows more work *over time* in the person's best response (in this example, metabolite) range and, by starting out low and adding sets rapidly to that range, counterbalances the quick desensitization rate.

Mesocycle Length

Mesocycle length is determined by the time it takes to get from MEV to MRV for the individual. Although you can speed up or slow load and volume progressions to fit into a certain meso length, this can only be done to the extent that you can still present progressive overload. For example, if you need to start your mesocycle at 1 RIR to keep it short enough to fit your schedule or you need to start it at 7 RIR to make it long enough, both of these options interfere with best training strategies. Once you know roughly how long your mesocycles are in each dieting phase, most people can then alter them to be longer or shorter by a week or so to make them fit into actual life (or competition) plans. Doing much more than this is not recommended.

Resensitization Phase Length

Some people resensitize to volume faster than others[21–23]. From feedback over time, you'll figure out how long your resensitization phases need to be and avoid spending too much (or too little) time there. When in doubt, spend a little more time resensitizing because an extra week or so of MV training is less detrimental than a full mesocycle of training with less sensitivity.

Mesocycle Number per Block

Some people get so much fatigue reduction and resensitization just from regular deloads that they can knock out four mesocycles in a row before they need more than a week of MV training. Others can only run two mesocycles of high volume training before needing a resensitization phase. Finding your limit will allow you the most productive training and the least wasted time.

Nutritional Phase Length and Frequency

Lifters gain muscle and fat at different rates and in different proportions. Some might need a minicut for every eight weeks of muscle gain, while others might gain for 24 weeks without pause. Some might need to lose fat for 16 weeks to get lean enough to gain mass optimally, and others only four. Choices must be tailored to the individual's needs and no one else's.

Degree of Muscle Group Specialization

Specialization phases will be covered in detail later in this chapter, but we will preview this concept here. At some point in their training careers, the average individual muscle MAVs of nearly all lifters will sum to a higher volume than their systemic MRVs. This means that such lifters will have to employ specialization—training some muscle groups at MEV or MV volumes for a training block in order to free up the recovery resources needed for other muscles to be trained at MAV. In a later training block, these can be swapped so that all muscle groups get a chance for optimal growth over time. This allows long-term progress to continue despite systemic MRV limits preventing simultaneous progress for all muscle groups.

In some cases, this specialization process might be needed irrespective of MRV ceilings. For those who have a very limited number of hours to train per week, training *all* of the desired muscle groups even at MEV might take more time than is available. For example, if you can train only three times per week for two hours each and you are intermediate or advanced, that might not be enough to hit all of your muscle groups at MAV. You might need two hours each per week for just your chest, back and legs. This of course leaves literally no time for arms and shoulders. Specialization will allow you to train some muscles at MAV each training block. This does mean that at any given time in the training year, many muscles will be in MEV or MV mode, and the less time a lifter has per training week, the more this will be the case. The only alternative is to train all muscles in the "dead zone" between MV and MEV all the time, causing no gains but taking just as much time and adding just as much fatigue. Because so many folks have limited time to train, the application of specialization phases is useful for many people, and, when employed, should resolve a lot of previously mysterious plateaus!

Individualization Across Training Age

Beginners

Individualizing Specificity for Beginners

Beginner lifters should be most invested in improving the technical execution of their lifts. The best exercises to learn in this stage are the barbell basics like the squat, deadlift, bench press, overhead press, barbell curl, pullup, row, and so on. These will establish the fundamental movement patterns upon which all eventual exercise variations will be built. Beginners will need to train every main muscle group in their body so that everything begins to grow.

Individualizing Overload for Beginners

To support technical development, lifters in their early years should train mostly in the 5-10 rep range. Higher reps at this stage tends to cause acute fatigue that can degrade technique leading to bad movement habits that last a career. To further prevent technical breakdown and enhance safety, beginners should probably never target below 2 RIR. You might worry that this misses out on some progress, but this loss is nothing another set or two with great technique can't make up for in beginners. Also, beginners *don't have trouble making progress*. Tools that come with greater risks, such as low RIR training, are best saved for more advanced lifters.

Beginners will also be able to increase bar loads more rapidly than others. These rapid strength gains should be spread over longer accumulation phases rather than used up in larger load jumps week to week. In fact, weight should be added using this two-part checklist for beginners:

1. Is the lifter's technique as good or better in this session compared to the last?
2. Is the lifter's RIR still at 2 RIR or higher (higher meaning more reps in reserve)?

If both answers are "yes," then add weight by whatever increment is likely to cause another "yes" answer to both questions next session. In other words, if the answer in this session is "yes" but you add 100lbs to the bar, the next session's answer is very likely to be "no", halting progress. If the answer to one or both of the questions is no, the current weight should be repeated until both answers are yes or it's time for a deload.

Individualizing Fatigue Management and Phase Potentiation for Beginners

Beginners don't accumulate as much fatigue and can generally use the highest RSM lifts without much problem as well as extend accumulation phases for longer before deloading. That being said, fatigue at this stage can have disastrous impacts on acquisition of new technique that last a career, so as mentioned, lower rep ranges and less proximity to failure is best. Beginners also don't need to take as many active rest or resensitization phases. These should be done on an as-needed, autoregulated basis. This means that training blocks will usually be much longer, perhaps as long as a year each!

Individualizing Frequency for Beginner SRAs

Beginners tend to benefit from higher muscle group training frequencies, but lower weekly training frequencies[24]. In other words, from training most muscles at every session, but in fewer sessions per week. Between 2-3 weekly sessions is a great starting point for most beginners. All too many beginners jump in and overdo their early training unnecessarily, burning out psychologically and physically. By keeping the great, easy gains coming at just a few sessions per week, beginners can stay motivated. Very passionate beginners interested in taking their commitment to the next level can likely work up to 3-5 weekly sessions, but should probably not do more than that until they are intermediates.

At three sessions per week, beginners should be training virtually every muscle in every session. (Though this might change for training 4-5 times per week, as muscles like the hamstrings or chest may need some extra recovery time). Regardless of frequency, the beginner should never be running a 'bro split' focusing only on one muscle per session. Technique improves the most with shorter bouts of practice spread over more sessions, so the use of frequent per-muscle training will also help enhance technique for the beginner[25]. This is serendipitous as beginner MEVs are basically one or two sets per muscle group per session anyway, and thus recovering to train every muscle group in every session should not be a problem for them. Because beginners load less weight, the connective tissue and joint loading problems of higher frequency muscle group training are still relative non-issues.

Individualizing Variation for Beginners

Because learning one lift very well requires a lot of focus and a great deal of repetition, learning lots of different lifts can lead to poor technique acquisition. Beginners should constrain their learning to perhaps just two lifts per muscle group per year and include 1-2 exercises per muscle group per meso. For example, they can do only squats and leg presses for quads, stiff-legged deadlifts and lying leg curls for hams, and so on using one or both lifts per meso. Because beginners can get so much out of so little Variation, if they were to run the exercise deletion and replacement algorithm from the Variation chapter, the resulting recommendation would nearly always be to "keep the current exercise in" for perhaps years at a time.

Intermediates

Individualizing Specificity for Intermediates

Intermediates, while still training their whole body, should seek to put more of their efforts (perhaps 65/35) into the larger muscle groups and less into the smaller ones. This means that for those interested in being the biggest they can possibly be, arms and calves and perhaps even shoulders might be lagging behind chest, back, and legs during their intermediate years, but bringing up those smaller muscle groups is easier than bringing up the big ones once you're more advanced, so the name of the long-term game for intermediates is to work most on their biggest muscle groups.

Individualizing Overload for Intermediates

Intermediates should be training in all of the rep ranges, with special attention to the 10-20 range. Additionally, intermediates should begin to work on training across the effective RIR range as they can now safely approach failure with their more solid technique. Training to failure is not often recommended for intermediates, though it may be needed occasionally to calibrate RIRs accurately and prevent lack of relative effort from forestalling gains. Load increases for intermediates begin to follow a fairly standard pattern (described by the Hypertrophy Load Progression Rule in the Phase Potentiation chapter), as their technique is stable and RIRs fall predictably from load increases and accumulated fatigue.

Individualizing Fatigue Management and Phase Potentiation for Intermediates

When a lifter can no longer train with the highest RSM lifts without downsides, this is good evidence that they have progressed from beginner to intermediate. Intermediates should then begin to focus more on SFR, as they will now be pushing sets all the way to failure at the end of most mesocycles, and thus need the enhanced SFR to tolerate this increased source of fatigue. Accumulation phases might also need to be shortened at this point (lowered accumulation to deload ratio) as an intermediate is strong enough to generate more fatigue across a mesocycle.

Intermediates will need to employ resensitization phases more often than beginners, as they will encounter adaptive resistance more often. They will also begin to bump up to their systemic MRVs when trying to train all muscle groups between MEV and MRV and will probably need to limit some (probably the smaller) muscle groups to MEV-only blocks on occasion in order to give their prioritized muscle groups room to grow.

Individualizing Frequency for Intermediate SRAs

Because they are at a much lower risk of burnout, intermediates can usually train up to 4-6 sessions per week—and they'll probably need this many, as their increasing MEVs demand more training time. They can spread their muscle groups over these sessions by following the organic derivation of their optimal frequencies as described in the SRA chapter, eventually leading to most muscle groups being trained 2-6 times per week depending on recovery.

Individualizing Variation for Intermediates

Intermediates should focus on maximizing their SFRs. In addition to finding exercises with a high SFR for them, intermediates should individualize their own techniques within these movements for best outcomes. Not only will this enhance hypertrophy in the intermediate years, it will set up productive, safe, and sustainable training in later, more advanced years. The exercise deletion and replacement algorithm from the Variation chapter will begin to indicate more exercise rotations for intermediates, and they can also begin to include 2-3 exercises per mesocycle per muscle group.

Advanced

Individualizing Specificity for Advanced Lifters

Advanced lifters will have very well developed large muscle groups, but their smaller muscle groups might need work. Some large muscle groups might also be lagging due to genetic limitations. Thus, in order work on balancing their physiques, advanced lifters should spend more of their weekly volume than intermediates on attending to weak points. Additionally, advanced lifters should be focusing on the mind-muscle connection now that their technique and their ability to calibrate relative effort should be second nature.

Individualizing Overload for Advanced Lifters

Advanced lifters will need to push smaller and lagging muscle groups very hard, and because they are well-trained, RIRs of 2-0 can predominate entire phases of advanced training. At some point, not going to all-out failure really is a notable downside when you have a small muscle that has very little effect on systemic fatigue. Because MEVs and MRVs begin to approach each other in advanced lifters, much smaller and less regular set, load, or rep jumps are needed to keep accumulation:deload paradigm lengths sensible (4:1 at least).

Another process to consider experimenting with when advanced is the purposeful biasing of training to portions of the MEV-MRV window. While all muscle gains are nearly certain to occur between MEV and MRV volumes, some portions of the MEV-MRV window might be more or less productive than others for a given individual. It's very possible, for example, that some have a much more pronounced catabolic response to high cumulative fatigue than others, and thus near-MRV training might be suboptimal compared to training closer to MEV. Others might respond best to the very disruptive volumes that are near MRV.

Advanced lifters should have taken every muscle from MEV to MRV numerous times and have very good ideas about what those values tend to be. If they prefer, they can begin to experiment with a few successive mesocycles (for a given muscle group at a time) of either near-MEV training (more than usual progression in load or reps over the accumulation phase rather than sets, ending at around 1/3 of the distance from MEV to MRV), mid-range training (beginning at 1/3 of the way from MEV to MRV, and progressing mostly in load and reps, rather than sets, to about 2/3 of the way to their typical MRV), or top-end training (beginning perhaps 2/3 between typical MEV and MRV, and progressing all the way to MRV by adding mostly sets and only minimal load and reps). A few such mesocycles of just one of the three styles of progression at a time can demonstrate whether the chosen style produced higher or lower SFRs and less, more, or the same repetition strength gain in the target muscle group as going all the way from MEV to MRV, and can thus inform future training decisions.

In general, load, volume, and relative effort recommendations behave in much the same way over the course of a career as they do over the course of the accumulation phase of a mesocycle. At the beginning of the career, higher RIRs have the best SFRs, and lighter loads and lower volumes are best. As the lifter trains for longer and longer, average RIRs need to fall to get the best relative SFRs, the loads need to increase, and the average training volume for best results also goes up. During this progression, any given training session stimulates less and less absolute muscle growth and contributes more and more fatigue. Thus, while beginners probably shouldn’t train too hard because they don’t need to for best gains, the advanced may need to train hard and often for *any* gains to occur.

Fatigue Management and Phase Potentiation for Advanced Lifters

Advanced lifters have to push their bodies to the limits for progress, so they need to be very careful about Fatigue Management. This might even include switching out exercises mid-meso (especially when in contest prep mode) if they are causing too much joint pain or systemic or connective tissue stress. Deloads may need to be lighter than the intermediate average (less average load used) to promote more connective tissue healing.

Advanced lifters, with their accumulating injuries and their ability to lift more weight across more volume, will start to replace some of their resensitization phases with active rest phases so that they can heal up more completely and get ready for another productive training block. In addition, they will be relying heavily on priority phases for specialized muscle groups and will often dip their larger (already well-developed) muscles to MVs to make enough room for the specialized muscles to get their best, uninhibited training.

Individualizing Frequency for Advanced Lifter SRAs

As weights get heavier and requisite volumes higher, advanced lifters will incur greater and greater systemic fatigue per session, increasing the risk for junk volume toward the end. As such, more than six weekly sessions might be required, so advanced lifters with maximal progress goals might need to consider multi-session daily training. A big warning here is that training all muscles with as many sessions as is ideal might surpass systemic MRV, so a specialization approach is also recommended when more than six training sessions per week are attempted.

Training heavy in the lower rep ranges, especially for larger muscle groups, should probably happen less frequently for advanced lifters, as the fatigue and injury risk tradeoffs may make progressively less sense with increasing strength levels and prior injury histories. Bigger, stronger muscles also need more recovery time between sessions and per-session MEVs are higher and splitting up training too much would result in sessions that do not reach the volume stimulus threshold. In contrast, smaller and more resistant muscle groups can occasionally be pushed through more mesocycles of very high frequencies in order catch them up.

Individualizing Variation for Advanced Lifters

Advanced lifters will need to delete and replace exercises more often than intermediates, rating lifts accurately after every mesocycle to decide when. In addition, advanced lifters might find that the heaviest range (5-10) is more injurious and has a lower SFR than the moderate and light ranges, where they now might then spend more of their training time.

Advanced lifters will also make use of various strategies to enhance local muscle SFRs. One such strategy is to modify lifts to target one muscle a bit more specifically than others, such as doing squats on a smith machine instead of with free weights, staying a bit forward of the bar, and getting more upright. This can reduce axial and systemic fatigue while still providing a robust stimulus to the target quads. Another method of this nature is the pre-exhaust method. Performing an isolation movement before a compound movement (like leg extensions before squats, for example) can make that compound limited by the isolated muscle and thus take its motor units closer to full activation and stimulation[26]. This does mean that the total amount of weight lifted is lower in the compound than if it were done fresh, but for advanced lifters, this trade-off of the highest raw stimulus magnitude for the highest local muscle SFR may very well be worth it. Advanced lifters may make use of these and other such methods to limit axial and systemic fatigue, in order to be able to attend to the whole MEV-MRV range.

While beginners and intermediates should try to train with a full range of motion by default, advanced lifters might begin to think about ROM more from a very individualized, SFR-centered view. There are two reasons that advanced lifters might choose partial ranges of motion in their training. The first is when the target muscle is the limiting factor for the movement only in a partial ROM, and not in the full ROM. For example, the triceps might actually be the limiting factors for some lifters in presses that are completely locked out, but the pecs might be the limiting factors if reps are stopped short of lockout. If this is the case for the individual advanced lifter, they may very well prefer to use presses just shy of lockout when targeting their pecs. The second reason is when partial ROM happens to have a better SFR. Now, the SFR difference between a partial and full ROM version of an exercises should be very notably in favor of the partial to consider its preferential use, but this can absolutely happen. If a partial movement promotes considerably more target muscle burn and tension, pumps, and disruption for the advanced lifter, while promoting considerably less joint, connective tissue, and systemic fatigue, its use is absolutely appropriate.

Lastly, by this point in their training careers, advanced lifters should have very accurately derived their highest SFR rep ranges and structured their volumes accordingly.

Individualization of Training for Different Diet Phases

Energy has a tremendous impact on capacities across training variables including the volume landmarks. Different diet phases therefore alter training recommendations and are a critical consideration for individualizing program design. This is covered extensively in our book on the volume landmarks, How Much Should I Train? if you're interested in more detail[27].

Training During a Muscle Gain Phase

Hypercaloric conditions improve both anabolism and recovery making MEV lower and MRV higher[28,29]. Even MV falls, as the extra calories prevent catabolism making less training necessary for muscle retention[30]. This means that when eating more, you can preserve muscle with *less* training, as well as train *more* and still recover—you can do more exercises with higher RSMs to focus on improving chosen muscle groups without having to worry about SFRs and excessive fatigue as much.

When hypercaloric, you can start at lower MEVs and end at higher MRVs. For example, instead of starting at four and working up to 10 sets per session for a given lift across a meso, you might be able to start with three and work up to 11. You might also recover more quickly from session to session, which means a slight increase in frequency to further raise MRVs could be beneficial. The increased adaptive (MEV-MRV) window can allow for a number of training alterations, but the best option for most lifters is to keep weekly volume and load progression the same, but extend accumulation length by one or more weeks. Muscle growth is a slow volume-driven process that is enhanced by small load and rep additions over time. Allowing this process to occur for longer before deload is a safe and effective way to increase gains and the larger adaptive window when eating more allows for this. The big caveat here is that some advanced lifters might not have large enough differences between their maintenance and muscle gain adaptive windows to pull off a whole week of extra training. For such lifters, modulating load is probably the best option and this can be done in an autoregulatory manner. For example, if you are advanced and typically add 5lbs per week to big compound lifts during maintenance, on a muscle gain phase, it might be possible to add 10lbs some weeks. A faster volume progression might also yield results, but can cause overlapping soreness, week to week performance losses and increase injury risk and is probably not the optimal choice.

MAV, the moving volume landmark curve between MEV and MRV, is not only wider during a muscle gain phase but also has a higher peak, which means that the *amount of muscle you grow when training anywhere in the MEV to MRV range is increased*. This is a very big deal, and really underpins how important the hypercaloric condition is for getting your best gains. Individuals will still differ—even if your MAV is identical someone else's, other factors might mean that your best gains are better than theirs, or the other way around.

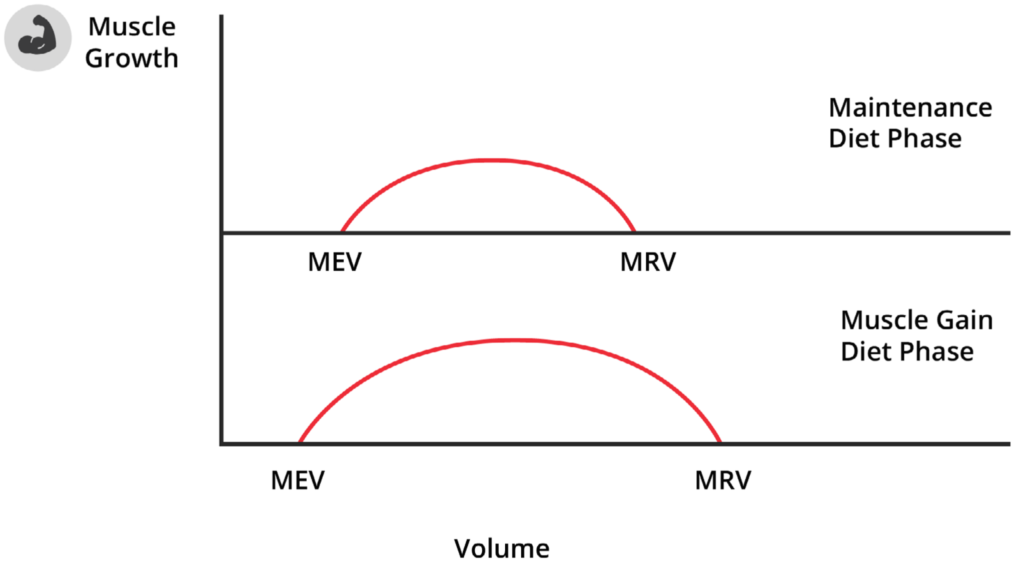

Figure 7.1: MAV During Weight Gain Versus Weight-Maintenance Dieting

Not only does eating a caloric surplus result in a bigger MEV-MRV window, it also raises the height of the MAV curve. This means that muscle growth will be increased for any given volume, load, and relative effort of training.

Because MVs are also lower on a hypercaloric diet, deprioritized muscles can take even less of your resources to maintain. This leaves that much more room for either more muscles to be prioritized or for your prioritized muscles to be trained harder. Because your systemic MRV will also be higher during a muscle gain phase, you essentially get a double-whammy of volume tolerance expansion that paves the way for the most productive training possible.

Training During a Weight Maintenance Phase

The MEV-MRV window during a weight maintenance phase is your baseline adaptive window. A more pertinent discussion to have about this phase is with regard to MV since intentional muscle growth training is a bit of a waste of time and fatigue on a weight maintenance diet, especially for intermediate and advanced lifters. Outside of special circumstances, most advanced lifters should train at MV during maintenance phases; at this point in training age, gaining muscle without a hypercaloric diet is so underproductive that harder training during this phase essentially becomes junk volume. Frequency can be very low on a maintenance phase, as sparing muscle requires minimal stimulation (as little as once per week per muscle group in some cases). Lower volume MV training improves STR (efficiency) and higher RSM exercises can be used as a larger fraction of total training, even compared to the muscle gain phase.

Training During a Fat Loss Phase

In a fat loss phase, the hypocaloric condition limits both anabolism and recovery[31]. MEV is *higher* and MRV is *lower* than it would be in a weight maintenance phase. In other words, not only do you need to train *more* just to prevent muscle loss, you also can't recover from as much training. So, on a fat loss phase, instead of starting at four and working up to 10 sets per session for example, you might need to start with five and work up to nine. You might be tempted to address the smaller adaptive window on a fat loss phase with the opposite of what you do during a muscle gain phase—by keeping volume and load progressions the same, but shortening your mesocycle. Unfortunately, this just leads to a worse training to deload ratio and is probably not the best choice. Since increasing calories for deload on a fat loss phase helps prevent injury and improves recovery, this means that the lower the accumulation to deload ratio, the fewer weeks spent in a calorie deficit and actually losing fat. And if hypertrophy is your long-term goal, this means less total time per year gaining muscle, since fat loss will take longer. A more optimal option is to maintain the more important stimulative variables: mesocycle length and volume progression, and just make smaller weekly jumps in load and reps. Smaller jumps in load mean smaller jumps in strength performance, but the fatigued nature of hypocaloric dieting makes PRs less realistic anyway—and strength is just a monitoring tool, *not the goal* of hypertrophy training. In fact, since the training goal during a fat loss phase is just to prevent net muscle loss, training can actually be altered to extend the mesocycle (improving the accumulation to deload ratio) without much downside. During a fat loss phase, the MAV curve height is close to or at zero for most, especially intermediate and advanced lifters. In other words, most people (aside from beginners) gain close to zero muscle on a fat loss phase irrespective of training.

While beginners might be able do an entire fat loss phase cycling normally between MEV and MRV, intermediates might benefit from staying near MEV, at least in the latter half of their fat loss phases when things get really tough. Staying near MEV is easy to track—just get some pumps, some metabolites, some soreness, and maintain your performance microcycle to microcycle via the Set Progression Algorithm and muscle should be retained. By adding only the smallest needed volumes to say ahead of the MEV landmark, the length of the accumulation phase can be extended. For example, instead of going from five sets to nine sets over four weeks, you might go from five to seven sets over six weeks, creating an excellent ratio of training to deload and therefore fat loss to maintenance with zero muscle loss.

As cumulative fatigue rises dramatically over the mesocycles of the fat loss block, many advanced lifters will see their MEV-MRV window close completely and their MV rise up to or above where their maintenance phase MEV was. This means that if their MV, MEV, and MRV were two, four, and seven sets per session on maintenance, a fat loss phase might see these change to five, seven, and seven—meaning that the minimum amount of training needed to maintain muscle has increased and that gaining muscle has become theoretically impossible. Very high catabolic pressures during fat loss phases mean that MV or MEV training is *not easy* and is *not actually low volume*. Assessments of effort perception might also be very high because of the sheer difficulty of training hard while in an energy deficit, but the resultant pumps, soreness, tension perception, and metabolite accumulation will be similar to maintenance MEV levels.

To sum up, intermediate and especially advanced lifters will need to train hard while on a fat loss phase to maintain muscle, but limited recovery ability will prevent them from training hard enough to gain muscle. Because heavy training is much more fatiguing to connective tissues and more injurious than lighter training, the deeper you go into a fat loss block, the higher the fraction of your training should be in the lighter ranges—which conveniently fits with general mesocycle to mesocycle load and volume potentiation recommendations anyway. Higher frequencies are probably also more anti-catabolic than lower ones, as any delayed super-compensatory mechanisms behind lower frequency gains are likely stymied by a caloric deficit and so recommendations for frequency alteration across a fat loss phase also mirror general frequency potentiation recommendations.

Specialization (the training of some muscles at MEV-MRV while holding others at MV) on fat loss phases does not make much sense due to the proximity of these volume landmarks to one another during such a phase. Training on a fat loss phase should be spread evenly across all of the muscles that you want to maintain. Because of the huge fatigue constraint of the fat loss phase, only the very highest SFR exercises are recommended for use here.

Specialization Phases

As mentioned earlier, at some point all lifters will begin to run into their systemic MRV limit. When muscles become bigger and stronger, the lifter becomes able to train harder and recovery mechanisms become more constrained. Thus, the training of each muscle causes not only more local fatigue, but systemic fatigue "spillover" as well. At some point, if you try to train everything hard in the same meso you run into systemic MRV *before* hitting many (if not all) of your local muscle MRVs, limiting growth. Paying attention to local versus systemic fatigue accumulation can help you decide when and if you need specialization phases to account for this issue.

If your target muscle makes it from MEV to MRV with plenty of soreness, metabolite accumulation and pump along the way, and your motivation to train, your sleep, your mood, and your appetite are normal, you're probably not limited by systemic MRV. On the other hand, if you are having symptoms of exceeding systemic MRV before your individual muscles get to MRV, you are missing out on potential growth that a specialization phase might allow you to recapture. A specialization phase is usually a block in length and as mentioned earlier, involves training some muscles preferentially while just maintaining others.

Thankfully, any local muscle's MV is much lower than its MEV in most cases. This is increasingly true the more muscular, strong, and advanced a lifter gets. An advanced lifter might have a weekly back MEV of 10 sets, but a weekly back MV of four sets, meaning that training their back at MV frees up six sets per week to be allocated to a prioritized muscle! And because growth training ranges from MEV to MRV while MV training *stays at MV*, that difference grows across the adaptive window. What this allows you to do is to train some muscles at MV in order to add volume to other, prioritized muscles, preventing systemic MRV from beating individual muscle MRV to the punch, so to speak. This is especially true when you train the larger muscles at MV. To continue to train the whole body, you can switch prioritized muscle groups back and forth meso to meso or better yet, block to block. To bring up particular muscle groups you can run a series of mesos or macros in a row all prioritizing the same muscles (which you may remember is an application of directed variation).

Keep in mind that that prioritized muscle groups still need MV training for resensitization on occasion. So even if you're working hard on bringing up your upper body, you still need to take a lower volume MV phase every several mesocycles.

Specialization Phases Across Training Age

Beginners can generally train all of their muscles from MEV to MRV without approaching systemic MRV limits and do not need specialization phases. Intermediate and advanced lifters often need to make use of these phases because they are big and strong enough to approach systemic MRV. Not everyone will have to bring de-prioritized muscle training down to MV on specialization phases, however. Intermediates might drop non-specialized muscles just to MEV or so. As lifters accumulate experience and get bigger, their MEVs will rise further above their MVs and start to approach their MRVs, such that "going down to MEV" might free up comparatively little recovery bandwidth. For this reason, as lifters become more advanced, they should likely trend towards a utilization of MVs rather than MEVs for deprioritized muscle groups to free up more recovery bandwidth.

An important factor to keep in mind, especially for advanced lifters, is the large gap between MV and MEV. Training above MV, but below MEV generates fatigue that limits other training, but provides *no additional benefit*. So be careful not to add this junk volume above your MV training for de-prioritized muscles.

Over-Application of Individualization

Special Snowflake Syndrome

You're special, just like *everyone else*. Individualization taken too far can waste mental resources and violate other, more important training principles. For example, Variation precludes finding "the perfect lift" for your chest. Optimal training means distinguishing personal preference from what actually works (sometimes the stuff you don't like actually works better).

Many people abandon an exercise entirely because it "doesn't work for their body." While this might be true in some cases, it is more likely that they have yet to learn proper technique or develop *individualized* execution to make that exercise work for their body. For example, we've all heard the claim that squats simply don't work for someone's leg training. While there are indeed individuals who, because of some mobility, joint design, or injury history cannot productively squat, this scenario probably occurs around 5% of the time in our estimation. In most cases they either need more practice or just haven't individualized their technique yet. Perhaps they are rounding their back or letting their heels rise up—failing to stimulate their quads because of these basic technique mistakes. Or perhaps a wide stance would allow them full ROM and productive squats, but they have yet to try anything but a standard stance. In our collective experience, most athletes and clients can successfully do almost every exercise there is just by learning proper technique and individualizing where needed. Assess basic technique and if honing that does not fix the problem, try altering the technique to better fit body proportion—experimenting with different grip widths, bar placements, foot widths, knee positions, and so on. Only when all of this fails should you delete the technique from your pool of options. And even still, your biomechanics and preferences might change later on in your career, making this previously deleted option viable.

Feel versus Technique

Sometimes lifters will not go through a full ROM because they "feel it more" in their target muscle this way. Growth mostly occurs with tension applied over many sessions and through a full range of motion. Getting the best mind-muscle connection *while sticking within your standardized technique* and ROM can allow you to keep track of your performances, autoregulate your sessions, and check all the muscle growth pathway boxes. Individualizing technique and developing a strong mind-muscle connection are excellent practices, but when taken too far can end up altering things like load and tempo so much that it prevents effective Overload. As discussed earlier, there are some cases in advanced lifters where partial ROM might be warranted, but these are exceptions rather than rules.

Not Giving Technique Enough Time to Develop

When trying different exercises, sometimes technique feels off, mind-muscle connection is weak, and even the joints and connective tissues might feel strained. But that's sometimes how nearly *all new exercises feel*. It takes time and practice to fine-tune a new technique and develop the higher SFR and better mind-muscle connection that eventually make it feel perfectly natural. Unless an exercise causes you severe or increasing pain, it should be used for *at least* a mesocycle (during which time technique can be fine-tuned and individualized) before you consider deleting it and replacing it with another exercise. The same goes for rep ranges and training frequencies. You've got to give any new strategy enough time to be sure you're not throwing away a potentially useful tool.

Under-Application of Individualization

The Pro Program Copy

If you copy the program of a pro bodybuilder and try to implement it, there is a better chance you will get disappointing results than good ones. Why? Because the best programming is tailored to you (your training age, experience, volume landmarks, loading ranges, exercises, etc.) and because the pro is likely advanced and you might be an intermediate or beginner, there's no good reason to think that program would be your best choice. You can look at programs for inspiration and perhaps to pick up a few useful strategies, but copying them wholesale will almost never bring best results.

Training Partner Cloning

Unless you are training with your genetic twin and you both have followed the same training and lifestyle choices for years, you are probably not of the same weight, height, age, anatomy, genetics, or lifestyle as your training partner. So why would you do the same exercises, sets, reps, and often weights? Solidarity between training partners is an awesome thing, but it begins and ends at going to the gym together, spotting, and encouraging each other. The details of what you're training, how you're training it, and how often you're training should be *individually derived* and prescribed as much as possible.

The Grind

Bodybuilding has a culture of glorifying suffering—which is fine to some extent, hard training gets results when structured well, but grinding through all pain can actually limit results. Some lifters will plan on a six week accumulation phase, *lose* rep strength on the net balance because they hit systemic MRV at week four, but out of misplaced dedication, just keep going. Another common example of this folly is to assume that there are must-do exercises. "You have to deadlift for a big back." While deadlifts are highly effective, a combination of stiff-legged deadlifts and barbell rows can almost certainly lead to just as much back growth—if not more given the reduction in joint stress and systemic fatigue. The grind is great, but applying a scientifically principled program and grinding where it counts is even better. Hopefully by using the concepts described in this book, you can create and select programs that are scientifically-derived and logical and push through the productive grind on those, leading to better gains.

CHAPTER 7

Summary

Individualization modifies the application of all of the other principles. Once you have designed a training program that adheres to all of the other principles, you can use Individualization to fine-tune it. Genetic factors, training age and diet phase are some of the main variables that dictate Individualization needs, though factors like available time for training, sleep habits, and stress are also important factors to consider.

Individualization determines what muscles you prioritize at a given time and where along the RSM to SFTR spectrum most of your training should be focused. It also helps you calibrate exactly how much volume you need for best gains, and means you train as much as you can and take fatigue alleviation measures at just the right time. Differences in recovery rates between all of your individual muscle groups can help you derive a range of effective frequencies for each muscle group's training. An attention to which exercises, cadences, loading ranges, and other training variables seem to maximize stimulus and minimize fatigue for you can help you slowly tailor training to better reflect specific needs over time. Differences in strength, recovery, sensitivity to muscle growth, and connective tissue versus muscle fatigue dynamics can let you know what Phase Potentiation structure is best for your long-term gains. As lifters progress from beginner to advanced, their individual needs change. Beginners benefit from more basic technique work, lower volume, and a small number of total exercises that can cover large swaths of muscle each. The more advanced you get, the more you'll have to focus on relative effort and mind-muscle connection, higher and higher volumes of training (which might also mean more frequent training to fit it all in without exceeding per-session systemic MRVs), and a greater number of more specific exercises that target more specific muscle groups, maximize SFRs, and keep staleness at bay. Advanced lifters will also need to pay closer attention to cumulative fatigue and take more drastic steps to minimize it, as it will rise to unsustainable levels more easily and more often.

Specialization phases are periods of training in which some muscles are prioritized over others. These phases can help alleviate plateaus due to systemic fatigue limiting the training capacities of individual muscles. Beginners do not usually have this problem, but intermediate and advanced lifters begin to need these phases. Non-prioritized muscle groups can be trained at MEV or MV for intermediates, but most advanced lifters will need to take these muscle groups down to MV to free up more recovery room for the training of prioritized muscles.

Individualization offers insight on how, when, and how much the six core training principles need to be applied. Individualization is listed last because it is used to modify the previous training principles, but it is a very important principle in itself—one that becomes more important the more advanced the lifter gets.

CHAPTER 7

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CHAPTER 8

Summary and Special Cases

Summary of Training Principle Application for Hypertrophy

Specificity

For Specificity in hypertrophy training, all training should lead to muscle growth, muscle retention, or support future muscle growth. Any training that does not meet these criteria will take away from hypertrophy results and should be avoided if physique development is your only goal. When designing training for hypertrophy goals, the Specificity principle dictates that you make a needs analysis to assess what muscular development is necessary for physique competition or individual preference.

If you have other non-hypertrophy goals and training types, trade-offs in physique development will have to be made. These will be larger when the other training taxes the same structures as your hypertrophy training and when it includes dissimilar stimuli (like running marathons while trying to build bigger legs for example). The more calories needed and the more disruptive and fatiguing the non-hypertrophy training is, the more it will interfere with hypertrophy training and results (like training for an MMA fight while trying to grow muscle).

In all cases, repeated, sequential training (directed adaptation) is best for progress across weeks and months at a time. This suggests that exercises should definitely not be changed weekly and keeping the same exercises for months at a time can sometimes be beneficial.

Overload

In order for training to produce adaptation it must be sufficiently challenging and it must progress—becoming more challenging over time. Progressive overload in hypertrophy occurs via volume, tension (load), and relative effort.

Volume

The effective rep range for hypertrophy is around 5-30 reps per set. Sets per muscle group per week should start at around MEV and end around MRV across an accumulation phase. These values differ across individuals, across time, across muscle groups, and across different exercises. You can use the RP MEV Stimulus Estimator Algorithm and the RP Set Progression Algorithm to determine reasonable starting and ending set volumes for each of these.

Tension/Load

Lifting with loads of anywhere between 30% 1RM to about 85% 1RM produces an effective hypertrophy stimulus. The stimulus is nearly equivalent in magnitude at any value between 35-85% so long as volume is adjusted for load (more volume for lighter loads) such that you are in the effective relative effort stimulus range.

Relative Effort

The most effective relative effort stimulus range for hypertrophy is between 5-0 RIR. With smaller gains in stimulus per unit as failure is approached. Ideally, training should traverse most of this range over an accumulation for all but beginner lifters. Beginners should train no closer than two reps from failure at any time to support safety and better technique development.

Fatigue Management

Because fatigue is accumulated along with adaptation, in order to make continued hypertrophy progress, planned and autoregulated strategies to alleviate fatigue are required. Strategies for improving SFRs are also useful Fatigue Management tools. SFRs can be estimated by experienced lifters or roughly calculated using mind-muscle connection, pump, and muscle disruption as proxies for stimulus magnitude and using joint and connective tissue disruption, perceived exertion, and unused muscle performance as proxies for fatigue.

Fatigue can be managed via prevention, by training within the volume landmarks, using safe technique and employing microcycle pulsatility. Once fatigue has accumulated, alleviation strategies can keep it from being detrimental. These include taking rest days, recovery sessions, deloads, and active rest phases when needed. The experienced lifter can pre-program most of these alleviation strategies, but autoregulation is also useful for anyone when fatigue unexpectedly accumulates too quickly.

Variation

The purpose of Variation is to prevent adaptive resistance (keep you sensitive to training stimuli) and to minimize wear and tear injury risk from repetitive movements. Too much variation, however, can lead to lost momentum and less effective training in intermediate and advanced lifters and poor technique acquisition in beginners.

For per session variation the top end for number of different exercises per muscle group is probably around 1-3. This range is capped by total set ranges as discussed in the SRA chapter. Because an average of three or more sets per muscle group per session across a meso is likely needed for effective stimulus and a total of 15 sets per muscle group in any one session is a reasonable ceiling, this caps exercises per session for a muscle group at three—with three often being too high as this might mean you do one set of each exercise week one. One to two exercises per muscle group per session might be a better starting place in most cases. On a per week basis the best range of exercises per muscle group is likely around 2-4 exercises. Beginners should likely shoot for the lower end of per session and per week recommendations for better technique consolidation.

Exercises and cadences that require lighter loads can be used to minimize fatigue, work around injuries, or improve technique, but should only be used for the latter when technique is poor enough to make the lift understimulative or dangerous. Load and volume variation can be used within a session to make sure that the heaviest lifts for the most prioritized muscles are done when fresh at the start of the session. A similar organization can be used across the microcycle to manage fatigue—placing heavier, more fatiguing work at the beginning of the week when you are fresher and placing higher volume, lighter work towards the end of the week. Similarly, across a block of training, earlier mesocycles can be biased towards the 5-10 rep loading range and move into larger percentages of lighter loading ranges across mesocycles to manage fatigue and volume sensitivity. Training modalities can be structured along the same lines with heavier, more tension based lifts (like straight sets) used more often in earlier mesocycles and lighter, more metabolite dependent lifting like myoreps and supersets used towards the end.

Phase Potentiation

Across training age, a lifter's focus should go from basic technique development to pushing relative effort with good technique, to a focus on mind-muscle connection (once technique is solid and relative effort is second nature).

Within a mesocycle, potentiation when progressing with load should involve adding only enough load to allow at least the same reps, at the same or slightly lower RIR. Progressing with reps should involve adding only enough to allow the same or slightly lower RIR. At least four weeks of accumulation should be the goal in either case.

Training with increasing focus on lighter loading ranges across mesocycles and across careers potentiates longer periods of growth (because of the more rapid loss of sensitivity in the lighter loading ranges) and the prevention of injury as fatigue accumulates but weights get lighter across the block and sensitivity decreases as injury risk increases across a career.

Individualization

Individualization needs, as the name of the principle suggests, require individual response feedback from the lifter. There are no specific recommendations or ranges here. To individualize a program, take the effective ranges and recommendations from the first six principles and then adjust each aspect of training according to individual responses.

Autoregulation

Because optimal hypertrophy stimuli vary person to person and within the same person across muscle groups, over time, and under different circumstances, autoregulation is critical; it solves any questions about how to modify mesocycles for best hypertrophy under any given set of circumstances. All of the algorithms in this book are means of autoregulating your programming. When using the MEV Stimulus Estimator Algorithm on a hypercaloric phase for example, your volume recommendation will automatically be lowered because when eating more, you will tend to get pumps and soreness with lower volumes than usual. Then, the Set Progression Algorithm will guide your set additions, and the Hypertrophy Load and Rep Progression Rules will guide your load and rep additions. Make use of these algorithms to simplify the individualization and autoregulation of your training.

Junk Volume and Advanced Lifters

This powerful insight from the volume landmarks with respect to phasic hypertrophy training is worth reiterating; advanced lifters need very little stimulus to keep their gains, but a whole lot to make new ones. In other words, the gap between their MV and MEV is large. This means that there is a lot of opportunity for very poor training if volumes fall into that large gap. If your MV is four sets per week and your MEV is 10, for example, doing seven sets per week gives you more fatigue than four sets by a long shot, but no additional benefit. If the goal is just to maintain muscle, especially for advanced lifters on a maintenance diet, training can and should be very minimal. In this situation, knowing your volume landmarks can save you tons of wasted training and unnecessary fatigue. Our book How Much Should I Train? describes this concept in much greater depth.

Mesocycle Length Choices

What limits mesocycle length:

- **You should start each meso at MEV** so that you can have the most time spent doing stimulative training as you progress from MEV to MRV

- **You should start each meso at around 4 RIR** so that you can have the most time spent doing stimulative training as you progress from ~4 RIR to ~1-0 RIR (or from ~4 RIR to 2 RIR for beginners)

- **RIR should fall over the weeks irrespective of volume or load increases**, because of fatigue accumulation limits

- **The more fitness you gain, the longer your MRV is delayed** and the longer your accumulation can last (allowing beginners to have much longer accumulations)

- **Your ratio of fatigue accumulation to fitness gains (the ability to do more reps or add weight) is a big factor in determining when you hit MRV**

- **Adding volume, reps, or load too quickly can shorten your accumulation and limit growth**

- **Adding volume, reps, or load so slowly that RIR is not changing or is increasing can lengthen your accumulation, but be under-stimulative and limit growth**

All of these factors intersect to give everyone in every situation the rough duration of their accumulation phases, assuming that the Set Progression Algorithm and Load/Rep Progression Rule are followed. Typical accumulation duration is 4-8 weeks, with longer durations more common for beginners and shorter for more advanced lifters.

Mesocycle to Mesocycle Progress

Progression with matched rep range for the same exercise across mesocycles

If you keep a lift and rep range target from one mesocycle to the next, how much you progress in load depends on how fast you add fitness. In an ideal situation you would be able use your ending weight from one mesocycle as the start weight for the next, but this ideal circumstance is not often the case. Usually, (especially advanced lifters) will need to start at a lower weight than they ended with last accumulation. The good, news is that load increases will then be more possible and likely result in a heavier weight by the end of the second accumulation. It is always better to start a bit more conservative—it is less detrimental to add more weight across a meso when load is too light than to deal with the accumulated fatigue of overshooting load early on. Nothing replaces honesty with yourself and your abilities in this calculation. You get no bonus points for burning out midway through your meso and hitting MRV early, but you get great results from rational progressions while staying in the effective RIR range.

Progression with different rep ranges for the same exercise across mesocycles

Progress *between* loading ranges is not expected, just within them. If you did incline presses in the 5-10 range in your last meso and you plan on repeating incline presses in the 10-20 range next meso, the recommendation, not surprisingly, is to pick your approximate 10-20RM and start the next meso at that weight. To be very technical, you should choose a weight between your 14 and 24 rep maxes to get reps in the 10-20 rep range, as they will be offset by 4 RIR to begin with. This does mean you'd be using a lighter weight in your second meso compared to your first, but there is nothing about that progression that violates Overload since the rep targets differ. So long as you're within your relative effort effective range and so long as you're progressing in volume and reducing RIR over the accumulation phase, you are stimulating near-maximal hypertrophy.

Progression with different exercises across mesocycles

When switching to a new exercise, loading should be assessed independently and not based on weight used for other lifts. The answer to the question "if I did smith machine squats with a narrow stance for sets of 8 at 315lb in the last meso, what weight should I use for regular squats this meso?" is "whatever weight gets you in the rep range you want to target at the appropriate RIR for squats this meso". Different people will have different exercise to exercise load ratios, so accurately predicting target weight across exercises is not realistic. This does mean that you need a bit of trial and error, but because loading ranges are so wide, you can estimate a weight to get you in the target range fairly easily. A logbook can help, but so long as you are within the rep range you want and you are truly working at 4 RIR or so in the first week and progressing from there, everything else handles itself.

Measuring Progress

Changes in muscularity are often subtle and come about slowly. This makes judging progress challenging and although aesthetic changes are great confirmation, they can take some time to be able to see. There are, however, a number of ways aside from flexing in the mirror and making qualitative visual assessments, to confirm that you are growing muscle.

Raw Stimulus and SFR

High RSM and SFR ratings cannot confirm that you're making good gains, but good gains are impossible without them. In other words, if your workouts cause awesome pumps, great mind-muscle connections, tons of perceived effort, and predictable fatigue and disruption, you can at least be sure you're doing enough on the stimulus side. What is left is to make sure that you are eating enough and recovering enough to let that stimulus cause growth. If your stimulus is good, you are eating enough to grow, and you are recovering, you can feel confident that you are making progress.

Rep Strength

If you've been gaining strength in an exercise for several mesos, this can be a good sign of growth, but can also just be a sign of technically, architecturally, nor neural-drive-propelled strength improvement. Hitting all-time PRs upon reintroducing an exercise you haven't done in a while, however, is robust evidence of growth. Because you're not very technically adapted to this exercise yet, we cannot attribute the PRs to nervous system adaptation, so muscle gains are the likely explanation.

Your goal in training should not be to explicitly get stronger, as focusing on strength as the goal can lead to poorer technique, lower mind-muscle connections, and lower SFRs that do not support hypertrophy. Your rep strength *should* increase regularly anyway through carefully programmed hypertrophy training, but more so after muscle gain phases and across blocks and macrocycles of training. Within the accumulation phase of a mesocycle, where fatigue summation can mask fitness gains in the short term entirely, this progress is less expected.

Body Composition Measurement

Short of an MRI scan or bomb calorimeter, no assessment tool as of this writing provides enough precision to detect muscle gain across weeks or mesocycles—and MRI scans are very expensive not widely available while bomb calorimeters are very unethical and pretty counterproductive (the subject would need to be combusted to get a reading). The most precise method widely available for use, the DEXA scan, is still lacking. Due to noise, a DEXA cannot tell you how much muscle was gained, just whether or not it was gained. Beginners may gain 10-20lb of muscle per year and thus get strong confirmation, intermediates might gain 5-10lb per year and see a trend toward increase on their DEXA reading. The advanced, who might gain 2-5lb per year, won't have hardly any use for body composition devices at all, as gains are too slow and small to fall outside of the noise. At that point, rep strength and looks (often on a bodybuilding stage) are all you have to go by.

Troubleshooting Lack of Progress

There are several checklist items that can help us troubleshoot a lack of progress:

1. **Mind your volume landmarks.** Make sure, for whatever muscle group you are training, that you are between MEV and MRV. Anything outside of that range is not going to grow any muscle. Using the tools in this book, keeping notes, and being honest with yourself can go a long way here.

2. **Manage fatigue.** Make sure your Fatigue Management is fundamentally in line. This means eight or more hours of sleep per night, diligent eating, manageable emotional and physical stress, and so on as well as appropriate deloads, auto-regulation, and active rest phases.

   Our book Recovering from Training goes in-depth on this topic if you'd like more details and strategies.

3. **Attend to SFR and rep variation.** Make sure that your SFRs are solid and that you're including all of the three main rep ranges. If you've only ever done sets of 5-10 for biceps you cannot say your biceps are stalling without moving some training into the 10-20 or 20-30 range.

4. **Attend to technique, RIR, and mind-muscle connection:** Make sure the target muscle is being stimulated first via good technique, second via near-failure training, and third via a good mind-muscle connection.

5. **Manage nutrition.** Make sure that you're hypercaloric in your gain phases and gaining *net* weight over the *macro*cycle. If you gain 10lb on your muscle gain phase and lose 15lb on your fat loss phase, you might be getting leaner over time, but not much bigger.

6. **Run resensitization and or active rest phases.** Make sure you are including occasional active rest phases and or occasional 1-2 month resensitization phases to keep your training stimulative.

7. **Be patient.** Make sure you spend enough time in each training phase. Muscle grows appreciably over a training block, not over the week or even the month. Being diligent for a training block with all of the above attended to should result in gains.

8. **Be realistic.** Make sure that your goals are is realistic, keeping your genetics and training age in mind.

9. **Be consistent.** Make sure that your training, diet, and sleep are *consistent*. If you cannot consistently apply a variable, you cannot expect results, nor can you assess and adjust for to improve outcome.

Special Case Training Techniques

Very Low Injury Risk Training

In some special cases, more conservative training practices are warranted. For example, maybe you have pulled the same muscle three times in the last three months, and you have a physique contest coming up. You don't want to risk not being able to train that muscle at all. Another example might be that you are traveling, using different equipment, and are maybe jet-lagged and stressed. Injury risk goes up under such circumstances[1–4]. In cases like these, one option is to alter your normal training enough to decrease injury risk, but not so much that it ceases to provide muscle growth stimulus. The other, even more conservative option, it to just train at MV—though this will mean paused muscle growth progress, sometimes that might be worth the trade-off for injury prevention. Most of the following training modifications will cost you some gains, but are useful in situations like those described above:

1. **Don't use any weights heavier than 70% 1RM.** This will also mean that you never drop below your ~15RM on any exercise.

2. **Use full pauses in every directional transition on every lift.** For example, when doing pulldowns, you would pause both at the top stretch of the movement and at the bottom, with the bar on your upper chest. This reduces peak force exposure, which is often highest in transitions from eccentric to concentric and back again.

3. **Slow eccentrics to around three seconds and concentrics to around two seconds** both to preserve technique during higher fatigue reps and to prevent higher forces from being generated.

4. **Focus on the mind-muscle connection.** This alone can lead to you use less weight and can boost SFRs without increasing injury risk[5–7].

5. **Stop accumulation phases when you are roughly ⅔ to ¾ of the way to your MRV.** You will know where this number is if you know your MRV already. If you don't know your MRV, this volume often coincides with your workouts starting to generate very big pumps and lots of muscle soreness. As soon as you detect that, deload.

6. **Add reps instead of weight every week/microcycle.** If you add reps, stimulus progression still occurs, but without force increases that bring slightly more injury risk.

7. **Choose machines more often than free weights.** Machines allow you to stay more stable during movements and thus lower the chances of technical devia-

tions and the spikes in force production needed to correct them.

8. **Avoid lower RIRs.** You are more likely to get hurt when you push your body to its limits. Very low RIRs create instability and risk. Stopping with at least two reps in reserve is a good idea when decreased injury risk is needed. This will be partially covered by shortening your accumulation in most cases.

9. **Be *very* conservative when adding sets.** Rapid increases in volume have been reliably demonstrated to cause increases in injury risk[8,9]. If you would ideally add two sets in a given condition, add one set instead, and so on.

If you employ all of these modifications in the same program, you get a program that creates a very low injury risk, but still has some, albeit submaximal, muscle growth effect. As mentioned, these modifications are best used under conditions where other variables increase injury risk and trading off some gains for a reduction in that risk is worthwhile.

Post-Injury Return to Training Guidelines

If you have been injured, physical therapy may only have the goal of getting you back to "normal function." Normal function being sitting down and getting up out of a chair, walking upstairs, shopping for your groceries and so on. These capacities are important to be sure, but not exactly what lifters need for their "normal function". As far as those who train are concerned, injury recovery is achieved when you are back in the gym and can safely continue progressive stimulus advances. In many cases, physical therapy stops short of this. The advice to "gradually resume normal training" is great, but we can certainly get a bit more specific. Of course, getting doctor approval for this process is always advisable.

There are roughly six phases of training on your way back to normal training post-injury:

1. Finish PT

Finishing physical therapy as prescribed before attempting to return to the gym is critical. In order to be ready to follow the steps below, you should be cleared for most daily tasks.

2. Occluded Isolation Movements

Occlusion of target muscles can allow for great hypertrophy stimulus with much lower forces than usual[10–16]. Occlusion training is a good first step after completing PT. (If you are easing back in from an injury of a muscle that cannot be occluded (like your pecs) then skip to the next step).

Start with only *one* occluded set in the first session and only in isolation. Use roughly 20% of your 1RM weight. For example, if you are rehabbing a quad, you can start with very light occluded leg extensions for just one set. Only go through as much ROM as you can without feeling pain at the injury site. Feel free to ramp up your set numbers per session slowly, but make sure soreness resolves between sessions, especially in the injured area. Train the recovering muscle three times per week *at most*. You can increase weight very slowly, working up to roughly 30% of your 1RM. We recommend staying at 3 RIR or higher in this phase.

3. Short Rest Isolations and ROM Increases

Once you are up to 30% 1RM, you can switch from occlusion to normal isolation training, resting just long enough between sets for all pain induced by metabolites to clear. During this phase you can increase weights slowly up to 50% 1RM. Keep reps at roughly 25 or more for the first working set. Increase volume as tolerated with full recovery between 2-3 weekly sessions, and feel free to push up to 1 RIR toward the end of this phase. Seek to slowly but surely expand your ROM so that by the end of this phase, you can take the joint through its normal ROM or very close with minimal discomfort. Once you can do that, you can begin the next phase.

4. Add Compound Movements

You can now begin to integrate compound moves into your training. For quads, this can mean leg presses or even squats. Take full pauses between each concentric and eccentric phase, focus on stability and let the full ROM of the movement develop over time or as your injury site allows without discomfort. Once you have settled back into good technique on the compound move, you can reduce or even eliminate isolation work if you'd like and get most of your volume from the compound movement. If you keep isolation work in, do it *before* the compound work in the session so that you can use less weight for the compound. Very slowly progress the weight until it's at around 60% of your 1RM, which means first sets of roughly 15-20 reps. Once you are there with minimal to no discomfort and great technique, the next phase can begin.

5. Load Increases

By this phase, you should be very close to resuming normal training. Now you can slowly and steadily increase weight on the compound movements to around your 10RM. This should take at least a month from the end of your last phase, if not longer, and there is no rush. Once you can handle your 10RM for multiple sets with no symptoms of the old injury, you can resume careful, properly programmed, normal training!

6. Normal Training

How long it takes to get back to normal training will depend on the nature and severity of your injury and the speed at which your body recovers. For the average injury that requires surgery or serious rehab, this process often takes six months to a year. Luckily, within about three months of starting this process, you should have regained nearly all of your lost muscle, and then it's all new gains after that, so by the time you're back to normal training, it is possible to be more muscular in that area than ever.

This sort of approach to recovery is tedious, but it pays huge dividends. The alternative is of course to rush the process and risk re-injury and starting over again. Getting it right the first time can test your dedication to lifting more than any normal training might, but will also yield the best results for your long-term gains. You don't have to follow this process verbatim, but employing its general progression of isolation to compound, high to low RIR, low to high load, and restricted to full ROM, will support your injury comeback journey. As in hypertrophy, nothing replaces individualized recommendations—do not follow this or any instruction online or in a book if your medical professional advises against it or if it is causing pain to the injury.

Hypertrophy Tips for Those with Less Time

The vast majority of this book focuses on the optimal way to approach hypertrophy training. Recommendations assume that the lifter will have the motivation, energy, and time to execute the training program in that most optimal of ways, but we understand that this not the case for everyone. While understanding what is optimal is a good idea for anyone interested in hypertrophy, the average person has less-than-optimal time for training.

The bad news is that some trade-off of results will occur when training time is limited. There's just no trick or hack that allows the same growth results from training four hours a week as for training eight. Maximizing the STR will cost the SFR and especially the RSM, but there are a few strategies that can help time-limited lifters get the most out of the time they do have.

Use mostly compounds

Compound exercises like the squat, row, and various pressing movements allow you to train multiple muscles at the same time, increasing the STR. Since less total training is happening, the higher fatigue from such lifts is less problematic.

Use more general compounds

Instead of using a targeted compound like the wide grip bench, use more general compounds like the close grip bench. Targeted compounds like the wide grip bench do train multiple muscles at the same time, but they train the target muscle (in this case pecs) very well and the other muscles very poorly. More general compounds like the close grip bench train multiple muscles with about the same stimulus (chest and triceps in this case), and thus save big on time. Other examples include using wide grip pullups versus underhand, close grip pullups. The former targets the lats well, but gives less stimulus to other muscle groups while the latter allows the exercise to stimulate all involved muscles a bit more at the expense of targeting the lats, which can be helpful for those short on time.

Use exercises that minimize warm-up times

The bench press requires you to get a station, warm-up with the bar, add some weight, get collars, and find a spotter before you begin your working sets. Pushups require perhaps one set from the knees, one set of a few reps from the feet, and then you're golden. Same goes for leg press versus lunges, plate loaded machines versus selectorized ones, and barbells versus dumbbells. If you pick exercises that don't take long to set up and warm-up for, you have more time to do more working sets in the gym, and thus maximize results. Compound lifts should make up most of your work if you have limited training time, but compound lifts that require less warm-up should be prioritized among these, and other lifts with limited warm-up needs should comprise the rest of your training.

Use more of the lighter loading ranges

There's nothing special about using 20-30 rep ranges except for the fact that they take less time to warm-up for. If you squat with 300lb for sets of 5-10, you might have to do 3-5 warm-up sets of increasing weight to be safe. If you're doing lunges with 50lb for sets of 20-30, you might do two warm-up sets before using that load for a working set is safe. If you find yourself using tons of time warming up for heavy weights, consider using lighter ones.

Use antagonist supersets

Doing a set of pushups, resting 15-30 seconds, doing a set of pulldowns, resting 15-30 seconds, and repeating is an example of antagonist superset use. For those in good systemic (especially cardiovascular) shape, supersets like these allow one muscle group to recover locally while another one does a working set, and vice versa. This saves huge on time, and though it's not going to let advanced bodybuilders grow much muscle, it's excellent for beginners and intermediates short on time. For them, it also doubles as great cardio and calorie burning work as well.

Use other time-saving training methods

Even if antagonist supersets are not realistic for your goals and limitations or if you're already using them, other high STR training methods can be used with great benefit, such as myoreps and drop sets—especially with muscles that recover very rapidly and have no systemic or synergist limiting factors.

Cycle volume less or don't cycle at all

Ideally, you'd start at MEV and work up slowly to MRV, perhaps going from 3-4 sets per session up to 10 or more per muscle group in each meso. This strategy, though likely optimal for gains, means that your sessions in week one might last 45 minutes each while your sessions in week five last nearly two hours. For people with limited time to train, starting at MEV, but not moving up as much in volume might allow them to get in all their work in their limited training time. Thus, in the above scenario, perhaps they would still start at 3-4 sets per session, but end their accumulations at 7-8 sets. In fact, if time is very constrained, the same set numbers can be conserved for all training weeks.

Use lower RIRs

Because so little volume is being done per week with limited time, recovery ability is not as much of a limiting factor and going much closer to failure from the first week of accumulation can be a wise move. This increases the level of stimulus without increasing the time needed to train. While not optimal in a perfect world, this is a great option for those with less time for training. Instead of starting at 3 RIR, a time-constrained program can start at 2 or even 1 RIR and begin to hit 0 RIR halfway through. This maximizes the per-set stimulus (RSM), and the STR at the cost of the SFR. But who cares about SFR if you're training at 1/3 of your potential MRV, anyway?

Use distinct specialization phases more often

As discussed, advanced lifters in particular need considerable volume to *progress*, but very little to *maintain* muscle. Advanced lifters with limited time to train might be best served using very distinct specialization phases. For example, a lifter might train only two muscle groups very hard from MEV to MRV, but train the rest of their muscles at MV. This would advance the target muscles while maintaining the others, and switch out which muscles are prioritized every couple mesos. This is of course a slower way to make progress, but trying to train all or most muscles for growth with limited time as an advanced lifter can mean no progress.

Cardio and Hypertrophy Training

From a perspective of pathway activation and energy shuttling, cardio seems like a net negative for muscle growth. Indeed, past some point, the more cardio you do, the more you impede muscle growth and in some cases risk muscle loss. For hypertrophy focused training, cardio should be limited to what is needed for basic health and work capacity. For hypertrophy goals, the negatives of doing additional cardio occur through a multitude of mechanisms, including:

- Energy spent doing cardio could have been spent doing more hypertrophy work
- Cardio activates catabolic pathways like AMPk, that reduce or reverse muscle growth
- Cardio burns local muscle glycogen reducing training energy and anabolism potential
- Cardio uses nutrients that could otherwise feed muscle growth
- Cardio uses time that could be spent on recovery activities such as relaxing or sleeping
- Cardio can add systemic fatigue which can lower your training stimulus
- Cardio can cause wear and tear to the same joints you use for hypertrophy training
- Cardio can be psychologically fatiguing
- Cardio can cause damage that interferes with training and uses up recovery resources

That's quite a few downsides, but remember this list is with regard to doing *more cardio than needed* for best hypertrophy outcomes. If you train with relatively low volumes and do no cardio, you'll likely experience a very impressive *increase* in your MRV if you begin to do some cardio. This is because your cardiovascular system will be able to support better performance in training. A lot of powerlifters report near-magical results from adding a bit of low intensity cardio a few times per week on top of their low volume powerlifting programs for precisely this reason. Now, if you're training very seriously with high volumes five or more times per week, hypertrophy training *is your cardio*. You might benefit from some small amount of low intensity cardio (perhaps a few times a week for 20 minutes or so) but much more than that might sap your training energy. You can experiment with cardio by adding a few short cardio sessions to your program per week and see if you perform better in the gym and *gain more rep strength over multiple mesocycles*. If that occurs, you can add a bit more cardio and see if the trend continues, and so on. Lifters who are very sedentary will benefit the most from some dedicated weekly cardio time.

The amount of systemic fatigue added per calorie burned is directly proportional to the intensity of the activity that is burning those calories. NEAT (Non Exercise Activity Thermogenesis—calorie burning activities of daily living like walking around, playing with kids, cleaning the house, etc.) can burn a huge number of daily calories and is minimally fatiguing. For this reason, keeping NEAT high is often a better choice than adding cardio for those focused on hypertrophy (especially if their cardiovascular fitness is already fairly good). This is especially true during fat loss phases when energy resources are low and needed for actual hypertrophy training—in this case burning the most extra calories with the least fatigue is even more critical. Adding NEAT and keeping calories high and more fatiguing cardio at a minimum is a good place to start on a fat loss phase, but experimenting with cutting calories versus adding NEAT or low intensity cardio and the impact on your training performance and weight loss will help you individualize your program. The best choices will differ person to person and for the same person at different stages of a fat loss phase. Cutting calories might be an easy way to keep weight loss coming with little impact on performance early in the diet, but as calories get low, adding NEAT might be preferable to losing more food and so on.

A warning sign that you're doing too much cardio (or eating way too little) is when your NEAT takes a huge plummet. When you can barely get out of a chair and going down to check the mail seems like a Lord of the Rings journey, you might be doing a bit too much cardio or not eating enough. Sometimes at the tail end of a very long diet, and at very low body fat levels, this can just be a part of the process, but if you're in that situation a few weeks into dieting, you're probably doing too much cardio, not eating enough, or both.

Lastly, if you choose to do cardio, certain modalities and timing structures are better than others:

- **Distribute cardio over as many muscles as possible** so as not to fatigue certain muscles too much (incline walking is better than cycling, elliptical is better than both)
- **Limit impact to joints** (elliptical wins this one again, cycling is good, walking is fine, but running is not the best choice)
- **Limit intensity** so that systemic fatigue and local fatigue are not excessive—capping at 140BPM might be wise in many cases. High intensity interval training (HIIT) is not best choice for hypertrophy goals
- **Limit cardio sessions to 60 minutes or less** to prevent excessive joint, psychological, and other body system fatigue
- **Separate cardio and lifting by two or more hours** and when they must be done in the same session, do cardio before lifting to prevent interference with anabolic signaling
- **Make sure cardio is not limiting your ability to perform when lifting**, and if it is, you're probably doing too much cardio or the cardio you are doing is too intense

Strength and Hypertrophy Training

While strength increases are expected in the long-term as a result of muscle gain, smaller time scale strength assessments during hypertrophy training are not so clear cut. A relatively safe bet is to seek volume and load levels that either keep performance within an accumulation phase constant or allow it to rise only slightly. A constant performance over the accumulation phase *must* mean an increase in underlying fitness, since fatigue accumulation is also rising and masking performance. Another option is to allow small gains in performance to be made, but address them immediately with higher volumes. For example, as seen in the Set Progression Algorithm, if performance is much better than expected, more sets are added to the program for its next session. Performance being much better indicates low fatigue, and thus the ability to recover from and likely benefit from more volume. If you're asking yourself "should I increase the number of sets on triceps extensions this week" and you are tempted not to increase because "the added fatigue won't let me hit as big of a PR as I had wanted," then you're trading off productive volume for a lower fatigue state and faux-gains. While a single mesocycle can be rigged to expose more fitness by dropping more fatigue, such a meso will only peak your performance for a few weeks. Trying that same peak next month will be unlikely to lead to the same results in strength gains, if any at all since the peaking of performance prevented effective stimulus and growth. An improvement of rep strength in all of the rep ranges you train for hypertrophy is evidence of progress, but the key is making the biggest rep strength jumps *mesocycle to mesocycle*, and especially *macrocycle to macrocycle, not microcycle to microcycle*.

If we take a macrocycle view, the distinction between strength-focused and hypertrophy-focused training becomes very clear. If you bias your training toward strength enhancement (by training with willfully lower volumes) for several mesos, your strength will improve via alterations in neural and architectural features, but very little of this improvement will be owed to increases in muscle size. If, on the other hand, you train that entire time to enhance hypertrophy, you might actually get to the same strength levels at the end of that macrocycle, but most of the gains will be from added muscle size that could then support even further strength gains with a strength focused macrocycle. Which approach is better depends entirely on your goals. If you're a competitive lifter at the top end of his or her weight class, the first, strength-oriented approach is best because it makes you stronger but not much bigger! But if you're interested in physique development, then the latter approach is the clear choice, as it adds vastly more muscle.

The difference between strength training and hypertrophy is clear if you look at the performances and appearances of powerlifters and bodybuilders. Powerlifters are much stronger for the muscle they have, but bodybuilders tend to have more muscle. Powerlifters train with lower volumes and prioritize within-accumulation strength progression, while bodybuilders do much higher volumes; these high volumes do an excellent job stimulating growth, but interfere with optimal strength expression per unit of muscle mass. There's no right way to train; there's just the way to train for what you want: hypertrophy or strength. To optimize for one means sacrificing progress on the other, so choose what you want and don't be fooled into thinking that you can have a single mesocycle optimized for both strength and hypertrophy gains.

Hypertrophy Training for Other Sports and Activities

So far in this book we have outlined the most important principles and practices within the context of training for the sole purpose of physique enhancement. A common and important question is how much of this information can be transferred when considering hypertrophy training for other goals—sports and activities that are not physique oriented. Many athletes can benefit significantly from gaining muscle mass, or maintaining their existing muscle while reducing bodyfat. Unfortunately, the principles and practices of hypertrophy training outlined in this book cannot be directly applied to those training for other sports or activities, for whom physique is not the primary goal.

Although hypertrophy training is an important part of many other sport training programs, those programs are of course constrained by the principle of Specificity. This means that for example, for Rugby athletes, training for Rugby would come first and hypertrophy would be added *only* if a needs analysis revealed that the athlete would be better at Rugby with more muscle. Even then, hypertrophy training would happen only in the off-season, when it would not detract from important Rugby performance. Hypertrophy training for such a Rugby athlete would be also be constrained to the muscular development needed to perform better in Rugby and nothing more. As another example, for an endurance athlete, a needs analysis might *never* suggest a need for more muscle (and in some extreme cases less muscle might be needed for best performance) and hypertrophy training may never be implemented for endurance athletes. This section will highlight differences in hypertrophy training for physique versus sport and outline basic recommendations.

Hypertrophy Training Conflicts with other Sports

Body Composition Needs

Body composition management is a key difference between physique development pursuits and other sports. Physique training is generally a long-term approach to achieving the greatest levels of muscularity with a focus on getting to lean body fat percentages from time to time to compete or prepare for more muscle gain. In sport there are normative values for competitive bodyweight and body composition differ greatly depending on the sport. Some athletes may benefit from being as large, muscular, and strong as humanly possible in the cases of American Football, Sumo Wrestling, and Strongman. In weight class sports such as barbell sports and combat sports its generally advantageous to be as muscled at your weight class as possible without having to perform disruptive weight cutting practices. Other sports such as gymnastics, sprinting, and jumping events, the athlete's power to weight ratio is a critical factor to their success. Ultra-endurance athletes need some leg muscularity to perform, but upper body muscle mass or too much leg muscle actually become a hinderance for such athletes.

As with everything else there is room for individual variation, but more often than not world class sprinters will look a certain way, and world class shot putters a different way. Although this may seem somewhat obvious, the reason it is important is because hypertrophy training in sport is used to fill in body composition gaps outlined in the needs analysis. More specifically, hypertrophy training is used to bring an athlete's muscle mass up to competitive levels, change weight classes, or maintain their lean body mass while reducing body fat to more appropriate levels (whatever those are for the given sport). In most sports, the goal is not to become indefinitely more muscular or leaner, but rather to reach an ideal competition body weight and composition for performance of the sport.

Unlike physique development standards, the ideal body weight and composition for a given sport usually relates to the strength or power to bodyweight ratio needed to perform. As previously mentioned, this can be more important in some sports than others (gymnastics vs American football for example), but is always beneficial to consider. In strength and power sports (which are most sports aside from endurance), the goal is generally to hypertrophy the faster twitch muscle fibers preferentially. Now there is plenty of room for discussion on the merits of intermittent sports and the need for proper conditioning, all of which is valid, but the needs of those muscle fibers are largely trained by practicing the activity itself and the conditioning activities that fall within the realm of Specificity.

Faster twitch fiber development will lead to larger increases in strength and power per cross sectional area than the development of slower twitch fibers, and the former should in theory represent a substantial portion of the athlete's weight in lean body mass (genetics aside). In physique training, all faster, intermediate, and slower twitch fibers are grown since the concern is visual not functional—they need as much muscle as possible and are not concerned with what function the different fiber types support. Those who train for physique gain weight through training all of the fibers, which is a great way to build the most mass possible, but unfortunately not a great way of developing an ideal strength or power to weight ratio for sport.

Endurance sport training is generally oriented towards conditioning the slower twitch fibers to be as enduring as possible. Carrying loads of lean body mass can actually be a significant disadvantage in endurance sport, as it just makes the athlete needlessly heavy and the energy requirements for performance needlessly large. Although endurance athletes typically do not need huge volumes of resistance training, especially for the sake of hypertrophy, it is still often advantageous to maintain or even enhance strength to some degree. This is particularly true for events with significant changes in elevation, where having strength provides a significant benefit in maintaining output and preventing injury. Training in the 5-10 rep range is an excellent way for endurance athletes to maintain their muscle size and strength without growing extra muscle or disrupting their sport-specific training.

Conflicting Levels of Preparedness in Fitness, Skills, and Tactics

Another differentiating feature between training for sport and physique is that sport involves a large variety of fitness, skill, and tactical demands. Although it is fun and a little bit silly to think of a good hypertrophy training session in terms of skills and tactics, its ultimately a lot of picking things up and putting them back down. In sport training we have to be mindful that we can overload a variety of fitness characteristics at a given time, as well as present overload stimuli in the areas of skill and tactical development. Unfortunately, hypertrophy training will almost always lower the athlete's preparedness for any downstream fitness characteristics (maximal strength, power, speed) due simply to exceeding the MRV's of those characteristics. In fact, hypertrophy training can also have an upstream negative effect on endurance training, when the local fatigue in the legs prevents an athlete from achieving an appropriate intensity or duration of activity. More simply put, the fatigue generated from hypertrophy training often prevents other fitness characteristics from being expressed, and therefore overloaded in training. Since Specificity dictates that you train for what you wish to perform on, hypertrophy training is therefore contraindicated in many sport cases (aside from discrete phases to bring the athlete up to competitive body size or composition standards).

This overlap in the taxing of MRVs can also manifest in the areas of motor learning and tactical development. Fatigue is a nasty inhibitor of technique expression, decision making, as well as motor and cognitive learning. The high fatigue conditions of hypertrophy training can often make it very difficult to learn, refine, or integrate skill or tactical elements in training. These all need their own version of an overload stimulus to improve, as well as ideal conditions and rest for the brain to consolidate and the athlete to improve.

Although hypertrophy training has very distinct benefits for most athletes, it is very much like that one friend who is seemingly allergic to everything, making it very difficult for them to go out to eat with other people. Hypertrophy training tends to overwhelm all other training elements. A very savvy coach can identify this and strategically adjust volumes across all training activities, but for the most part when hypertrophy training is implemented, very few other things can be done effectively.

Conflicting Force-Velocity Characteristics

In strength and power sports, Specificity demands that training accentuates specific regions within the force-velocity curves of any given activity. This can be high force low velocity regions for developing maximal strength, low to moderate forces and high velocity regions for maximizing power (usually between 30-70% of max force depending on the movement), low force high velocity regions for developing speed, and low force low velocity sustained efforts in the case of endurance training. Unfortunately, for the most part hypertrophy training does not accentuate any of these regions specifically, as velocity is often not controlled (and indeed might be varied for hypertrophy specific Variation reasons rather than to develop a particular aptitude). The 5-10 repetition range does not train maximal strength directly, the 10-20 range uses loads that could be used for maximizing power but are not performed at high enough velocities (and even if they were the power would drop after 5 reps or so), and the 20-30 rep range really doesn't train anything sport related particularly well, not even endurance.

Faster twitch fibers are generally stimulated preferentially by either high force or high power activities. Most strength and power sports require the athlete to generate large forces and explosive movements. Hypertrophy training for the most part trains the muscle under moderate force and relatively low velocity and controlled conditions. This would be a Specificity violation for strength and power sports, as it is promoting outcomes that are too far removed from the those desired. Although hypertrophy training can make a muscle larger and thus, in the long-term, stronger and more explosive, the acute hypertrophy training stimulus tends to fall outside of the Specificity of training for most sports due to the forces and velocities it is trained at.

Opportunity Cost

All training comes with an opportunity cost; every time you train for something it means you are not training for something else, or at the very least that time that could be spent recovering from any other training. Although hypertrophy training can be great for novice and beginner athletes, it should represent a relatively small composition of the training done for intermediates and advanced athletes. Beginners can do very little training and reap a huge reward from it, while still being able to dabble in other areas of fitness, skills, and tactics without much interference. Beginners will also be experimenting with their body weight and body composition trying to determine if they need to gain or lose size to be competitive.

Intermediate and advanced athletes do not have the luxury of being able to dabble in all things at once. Training for hypertrophy will mean distinctly not training for other areas of fitness, skills, and tactics for a period of time. That does not mean hypertrophy training is inherently bad, but that the cost is often simply too high for sport athletes. At the intermediate to advanced stage, body weight and body composition issues should be largely realized, and only tidied up periodically. These athletes should be spending a large majority of their training time enhancing their fitness in appropriate force-velocity spectrums, and energy systems. They should be cultivating their strengths, addressing their weaknesses, and outlining paths to victory (or at least paths to avoid defeat), rather than spending hours in the gym seeking pumps.

Incorporating Hypertrophy Training into Sports and other Activities

Although hypertrophy training for sport will be different than training purely for physique, there is still quite a bit of overlap in practical application. The first and most obvious is that training should be carried out from MEV to roughly MRV for all of the muscles being trained during a hypertrophy period. If the athlete is balancing other training modalities for fitness, skills, and tactics, the local and systemic MRV values will be lower than if they were being trained purely for physique purposes. For sports and activities with a significant cardiovascular component, the systemic MRV will likely become a larger limiting factor than it would be in physique-based training. For these reasons, finding high SFR exercise choices is crucial for preventing systemic fatigue spillover and keeping the limiting factors to training peripherally based, rather than systemically based.

Mesocycle length, progressions in volume and intensity, and deloading will all follow typical recommendations. The volumes, intensities, and frequencies of training however are likely to be different from both physique training and typical sport training. As previously mentioned, the weight training volume landmarks being used will likely be adjusted down slightly from baseline physique training but adjusted up significantly from baseline sport training. More simply put, weight training volume for hypertrophy in sport is slightly less than what we would see in a physique program, but a lot more than what would be seen in a typical sport training program. Although sporting athletes can absolutely use the explicit sets per muscle group per session per week values seen in physique training, its often slightly easier to use more generalized categories such as ‘push’, ‘pull’, ‘posterior chain’, ‘anterior chain’, and the like.

On a similar note, the exercises chosen should be mainly barbell bilateral compound movements, with only a small portion of work dedicated to single joint or accessory type movements (unless deemed otherwise by the needs analysis).

The intensity of training is where some significant differences can be seen in physique versus sport training. Due to targeting preferential hypertrophy of faster twitch fibers, athletes should generally be working in the 5-10 repetition range. Of the effective hypertrophy ranges, this range will generally have the best carry over to strength and power due to its higher forces. RIR can still be an extremely effective tool for both regulating relative intensity and monitoring week to week performance. Unlike those focused solely on physique, athletes should also make a conscious effort to move with maximal movement intent, which means trying to move the bar as fast as they can on every repetition. Although this sounds easy enough, it will need constant attention and reinforcement, as going through the motions and not thinking about movement speed is an easy trap to fall into.

As you have likely already guessed, training in the 5-10 repetition zone does come with more significant wear and tear on the joints, as well as systemic fatigue spillover. This again highlights the need for making good SFR choices, and individualizing the athlete's training as training volume becomes an incrementally more precious resource. The athlete may also have to adjust their understanding of RIR under maximal movement intent conditions, which will feel differently from normal RIR type training.

Lastly, the frequency of training is another area that might be significantly different in hypertrophy for sport rather than physique. Due to the fact that athletes will likely be pursuing other fitness, skills, and tactics during this time, the frequency that each muscle group or region is trained will likely be lower than in normal physique training. Athletes will still have a normal training load of running, jumping, passing, catching, tackling, blocking, or whatever their sport entails that they must fulfill, all of which can interfere with hypertrophy training, or be interfered with by it. Thus, if an athlete is taking a fairly normal sport training load and is incorporating hypertrophy training, they likely will need to reduce the frequency of any given muscle group or region by 0.5-1x per week less than our typical hypertrophy recommendations. For example, if chest was normally trained three times per week, a reduction in one day of frequency would result in just training chest twice per week. A 0.5 reduction would mean that if chest was normally trained three times per week with an average of 8 sets per session it would instead be trained with two normal training sessions of about 8 sets each, and one lighter session of about 4 sets. How much frequency should be reduced will largely depend on how much other training the athlete is concurrently doing and should be individualized and autoregulated, but a reduction of 0.5-1x per muscle group per region per week is a safe place to start.

The need for cardiovascular training can also complicate hypertrophy training. You may see the often polarizing views on concurrent training all over the internet, but the simple truth is this: cardiovascular training can interfere with muscle growth potential to a small degree. Some of the reasons for this are not unique to cardio training, while others are. Either way, the end result is slightly less hypertrophy. To be very clear, cardiovascular training under normal conditions does not cause muscle loss, but rather slightly less muscle gain than would have otherwise been expected. In sport this is an essential trade-off for all activities, as a lack of sport specific conditioning is more disastrous than gaining slightly less muscle during hypertrophy.

There are a few things than can be done to minimize some of the interference effects when cardio training for sport must be paired with hypertrophy. The first is to prioritize training according to the goals of the phase. In the case of incorporating hypertrophy training, that would mean weight training comes before any cardiovascular training so that it receives the largest potential Overload. This of course will mean that cardio will be performed under more fatigued conditions, but that's ok because it was not prioritized for this period. Another important practice is keeping strength training and cardio in separate sessions as much as possible.

This notion has often led coaches to make a well-intentioned mistake in sport training; they will often separate weight training days and sport or cardio sessions by alternating them throughout the week. This seems like a good idea, and it fits well with keeping the sessions separate, but ends up causing some muscles (particularly the legs) to be trained virtually every day. The legs in these cases never truly get any time to recover. So, in addition to keeping the sessions separate, it is also a good practice to pair them up on the same days in many cases for sport athletes. This has been eloquently called the 'consolidation of stressors' by our friend and colleague Chad Wesley Smith, and is a great way to ensure that concurrently training hypertrophy and cardio is done productively, with dedicated days for recovery. When training hypertrophy and cardio in the same day, its usually good practice to leave no less than two hours between and preferably more like 4-8 hours between and to eat a meal or meals during this break.

Generally, if hypertrophy is the goal, cardio sessions should be moved to MV. A poor use of time would be to simultaneously prioritize hypertrophy and cardiovascular fitness within the same block or mesocycle of training. The net result will generally be too much peripheral and systemic interference for either to be trained productively.

Key Points for Including Hypertrophy Training in other Sports and Activities:

- Focus on compound barbell movements in the 5-10 rep range
- Encourage the athlete to move with maximal intent
- Be sure to reduce training volumes from other areas of fitness, skills, and tactics to accommodate the increased resistance training volume
- Reduce baseline muscle group training frequency recommendations by 0.5-1x per week

- Avoid having resistance training and cardio or sport training within the same session
- Consolidate some resistance training sessions and cardio or sport sessions within the same day (in different sessions separated by 4-8 hours), so that dedicated recovery days occur during the week

Closing Statement

The authors sincerely hope that the information and explanations in this book help you better understand and execute your hypertrophy training, whether you are a professional bodybuilder, a new physique enthusiast, a coach, or anyone else interested in hypertrophy. Keep in mind that the recommendations in this book are for absolute optimal results and adhering to them perfectly is not realistic for everyone. We hope that the degree of detail we have provided will not cause you stress—perfect training is not necessary for progress. Unless your sights are set on a professional bodybuilding career, take the basics and do the best you can. Even if you don't have the time or psychological resources to pull off optimality, understanding best practice under best circumstances should help you design training that is as optimal as possible given your situation and limitations. If you feel overwhelmed, keep it simple: Make sure your training is specific to your muscle growth goals and use the various algorithms in this book to confirm that you are progressively overloading and managing fatigue. Employ Variation, Phase Potentiation, and Individualization as needed, but know that if you have Specificity, Overload, and Fatigue Management in order and eat enough, you will make gains! If you want a simple rundown of some of the concepts covered in this book, please check out our Hypertrophy Made Simple YouTube series!

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