Functional Hypertrophy

What is it? Why you need it. And how you can achieve it.

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Originally published - Issue 9 - April 23, 2002

I was sitting in a graduate level exercise physiology class one day and we were being lectured on the physiology of muscle fibers. After 4 weeks studying metabolism this was simply a breath of fresh air for me, because this is an area of exercise physiology and strength research that really interest me and in which I've done a lot of reading/research. We started out studying the outer portion of the muscle structure and gradually worked our way "inward." We learned really neat things about fascia, the epimysium, perimysium, fascicle, the axon of the motor neuron, and other big words that everyone mumbled when pronounced in class. However, one day we finally got to the good stuff! We began talking about the sarcolemma, the sarcoplasmic reticulum, sarcoplasm, the myofibrils, and the sarcomere. My professor had just gotten through explaining the significance of the sarcoplasm …when… well, what on earth is a sarcoplasm you may ask. Good question. Well, it's basically a bunch of "goo." The goo is made up of minerals, fats, dissolved proteins, a relatively large amount of glycogen (compared to the cytoplasm of the muscle cell), and some organelles. It is also home to myoglobin. Myoglobin carries oxygen to the mitochindria in a muscle cell. Therefore you can see that it is an important part of the muscle.

Anyway, as I was saying, after explaining all that my professor started talking about myofibrils and sarcomeres. Every muscle fiber contains anywhere from a few hundred to many thousand myofibrils. Within each myofibril you have sarcomeres. Sarcomeres are the smallest functional unit of a muscle fiber. Remember that, it's very important. Within the sarcomere is where the muscle actually contracts. Now, the myofibrils are lined up longitudinally (i.e., kinda like logs on a log truck) within the sarcoplasmic reticulum. Their number and diameter are important factors influencing the size of the fiber as a whole.

When I learned this, the terms functional and non-functional hypertrophy (also called sarcomere and sarcoplasmic hypertrophy) suddenly made sense to me. I understood the concept before, but now I understood some of the mechanisms behind it. I had a mental image of what it actually was and why. My brain was flooded with questions so I obviously looked to my fearless leader and asked him if my hypotheses about the different types of hypertrophy were physiologically accurate. When the words functional and nonfunctional hypertrophy left my mouth it hit him like a garter belt hitting a bachelor at a wedding reception. He didn't know what to think! Looking like a monkey doing a math problem he scratched his head a few times and said that he was unfamiliar with that terminology. I assumed ok, well maybe those are more appropriately laymen terms. So I rephrased it and asked about hypertophy of the sarcomere and sarcoplasmic hypertophy. No dice, he was still trying to carry the one.

Now what importance does all of those big words, and fuzzy word pictures have to do with getting bigger and stronger. Well, EVRYTHING! The next time your in the bookstore, grocery store, etc. pick up a muscle magazine and check out some of the pictures of the bodybuilders and models in the ads. All appear to be in great shape; muscular, 3%-6% body fat, the bodies that most people would kill for. Now ask yourself this: When was the last time any of them won a strong man, powerlifitng, or weightlifting contest? Now, I'm not trying to belittle bodybuilding as a sport and yes some bodybuilders compete and do well in powerlifting events. However my point is, if they are in as great a shape as they look and were as strong as they looked, these feats of strength would be relatively easy for them and a good way for them to "stay in shape" during the off-season. However, except for on the amateur level, you rarely see bodybuilders doing well in any of these events. Even powerlifting, although most accomplished bodybuilders use the "Big Three" in their weekly routines. Why is this? Why do bodybuilders not the relative strength (i.e., strength relative to bodyweight) of weightlifters and powerlifters? Or strongmen? Several elite bodybuilders weigh the same as some elite strongmen. Particularly in their off season when they usually put on a lot of body fat. Well, the reason is bodybuilders train in a manor that produces a greater proportion of non-functional hypertrophy. Hypertrophy of the sarcoplasm. The methods they use in training contribute to greater storage of glycogen, minerals, etc. as mentioned above. For the higher volume of training they use, this is beneficial. The adaptation caused by the high volume causes hypertrophy of the sarcoplasm because it is the greater glycogen and mineral storage that allows them to continue to train at that level of volume. In other words, they need more "goo." While to a degree that is beneficial to the athlete, traditional bodybuilder training does not contribute significantly to sarcomere hypertrophy. And what is a sarcomere? The smallest functional unit of a muscle. The sarcomere is the part of the muscle that actually does all of the contracting and therefore movement. Increase the size of the sarcomere and you will have stronger, more forceful contractions AND bigger muscles. Sarcomere hypertrophy is typically found in the legs and traps of elite weightlifters. In other words, they are as strong as they look. They achieve such hypertrophy by slaving away at the various pulls, and of course, every weightlifters' best friend…squats. But it's not so much the exercise, but the manor in which the exercise is performed that makes the difference. All are performed for multiple sets at very low reps; rarely over 6 and in elite lifters often never more than 3. Also, in the variations of the snatch and clean the lifts are performed explosively. This creates a lot of tension on the muscle and therefore recruits many of the fast twitch muscle fibers that are not recruited in high rep slow speed training. Also, such training reduces time under tension, which hinders sarcoplasmic hypertrophy and the hypertrophy of slow twitch fibers. The slow twitch fibers are moderately active in such quick/explosive movements, but they are the endurance fibers. Therefore, they have not been under tension long enough to cause adaptation to take place.

Now, that is the traditional view of functional and nonfunctional hypertrophy discussed in several excellent books on training. Two of which are: Science and Practice of Strength Training by Dr. Vladimir Zatsiorsky and Supertraining by Dr. Mel Siff. However, I would like to propose another form of functional/nonfunctional hypertrophy.

About 8 years ago, I read an article in Scholastic Coach magazine. The article was written by Thomas V. Pipes, and entitled "Strength Training and Fiber Types." This was the first article that I ever read that had a somewhat scientific approach to strength training. I had read a few books and of course a few bodybuilding magazines but this article was different. In it, Pipes takes muscle biopsies of an athlete before and after pre-determined training microcycles. His findings were eye opening to me at the time. Remember, at this point I'm more or less a newbie still. In a nut shell, he found that following a routine in which 8 reps (at the 8 RM as only one set was used) were used, the fast twitch muscle fibers of the trained muscle (in this case the quadricep via the leg press) hypertrophied. Well duh! Any body could have told him that right? Perhaps, however, he also found that the slow twitch muscle fibers atrophied (i.e., got smaller); and he also found that the number of reps the athlete could perform at 80% of his 1 RM decreased, yet his 1 RM increased! The athlete was then placed on a routine using 12 reps (at his 12 RM). Can anybody guess what happened? Well, muscle biopsy showed that hypertrophy did in fact take place, but that it was in the slow twitch muscle fibers this time. Not only that but the fast twitch fibers atrophied and the number of reps possible at 80% 1 RM went up, while his 1 RM decreased!

Now, first let me say that Pipes is a full-fledged 'HIT' advocate. Therefore this study was limited in that only one or two sets to concentric momentary muscle failure was used. Also, it used only one athlete. However, in my opinion the information is still very valid as empirical evidence and a few other similar studies back it up somewhat. However, I would like to see more thorough research using Pipes line of thinking. There are papers out there that imply these findings or that you can extrapolate, but his research is still in my opinion unique. Now what does all that mean? Well, first off don't get too caught up on the numbers 8 and 12. I will get into this in a minute, but please don't think that there is a magic number in which you can turn on fast twitch fibers and turn off slow twitch fibers and vice-versa. My point in discussing these findings is this. You can achieve hypertrophy in the wrong muscle fibers!

Too much hypertrophy in slow twitch fibers is contraindicated for the strength and power athlete. There are several reasons why hypertrophy of the slow twitch fibers may be detrimental to the strength and power athlete:

Fast Twitch fibers contract up to 10 times faster than slow twitch fibers (Siff, 2000). Because of this if there is too much hypertrophy in the slow twitch fibers they may cause too much friction for the fast twitch fibers to contract with maximal speed or force. The type of training that induces slow twitch hypertrophy is more or less opposite that which causes hypertrophy of the fast twitch fibers.

Endurance training has been shown to decrease vertical jump power, explosive speed, etc. This is believed to be a result of enzymatic and neuromuscular changes (Siff, 2000). Now please don't misinterpret this and think that slow twitch fibers are evil, and you have to find a way to shrink them. Don't think that you're slow, or can't jump very high because your slow twitch fibers are too big. There is usually another reason, one in which

we hope to change. Strength and power athletes (i.e., most: football, baseball, basketball, volleyball, and hockey players, martial artist, weightlifters, powerlifters, bodybuilders, strongmen, highland game participants, gymnasts, etc.) often need functional hypertrophy to excel in their sport of choice. However, a lot of the literature on strength training discusses getting stronger when getting bigger may or may not be achieved using the methods discussed. Then on the other hand, the literature (read bodybuilding magazines) on getting bigger may or may not lead to increased strength. Well today you can have your cake and eat it too. I have developed a method of manipulating loading parameters that you can easily modify to fit your individual needs in which you can achieve both size and strength. I based it largely on the information derived from the article mentioned above. However, my suspicions have been confirmed via extensive reading and researching of many different strength training methods that all have the same goal in mind, i.e., bigger stronger athletes! In fact, research about 2 years ago partially confirmed some of the findings of Pipes. Now let me be clear that this routine is best used in off-season and/or General Preparatory Phases of training. In other words, if you play football, and in the spring and summer you typically go on a "bodybuilding" phase to increase lean mass, then give this a try. When you transition to more specific training you will find that while being bigger you are also significantly stronger in your maximal strength. Then you can spend less time working on getting stronger and more time on becoming faster and more powerful! Using the parameters below one will selectively cause both types of functional hypertrophy.

Loading Parameters for Functional Hypertrophy

Your workout will be divided into 3 groups of sets that I will term a 'complex'. In the first one you will perform 4-6 sets, in the second 2-4, and in the third 1-3. You will choose one exercise per complex, or you may use the same exercise for all sets of the workout.

Complex 1:
Sets: 4-6
Reps: 1-5
TUT: Less than 20 seconds
Rest: 3-5 minutes

Notes: In this complex, it's my opinion that the concentric portion of each rep be performed as explosively as possible. Now the bar may move slowly, that's fine, as long as you're attempting to move it explosively. I'm not overly concerned with the eccentric tempo in this complex as the load will usually prevent you from letting it free fall.

Complex 2:
Sets: 2-4
Reps: 3-8 (6-8 unless slower tempos are used)
TUT: 20-40 seconds
Rest: 3-5 minutes.

Notes: In this complex I recommend giving serious consideration to the manipulation of tempo. Also, pay more attention to the TUT (i.e., Time Under Tension) prescription than the reps. The reason being is that if you want to perform reps on a 5050 tempo (i.e., 5 seconds lowering the weight, no pause, 5 seconds to lift the weight, no pause) performing 8 reps would take you out of the prescribed TUT bracket, as that would be a total of 80 seconds of TUT. Therefore, understand that the parameters are merely guidelines. Now, for most sports, slower tempos are generally not that beneficial. I feel that lowering weight at a moderate speed eccentrically throughout a portion of a mesocycle is fine. In fact more athletes I feel should probably take 2-5 seconds to lower the weight. However, for athletes who need to be powerful I feel that the concentric portions of all reps should be performed using Compensatory Acceleration about 75%-90% of the time. However, this being an off-season or GPP program, I feel the use of slower tempos will be beneficial to many athletes. One reason is it will cause great adaptation because most athletes rarely give attention to the speed in which they perform a rep. Another reason is that it is a great way to build strength. There is no momentum involved when lifting weights slowly. Therefore it produces great amounts of muscle tension but for greater amounts of time than many other methods. Manipulate them as you want, but tempo's that I have found that work well in this complex are:

4010 for 6-8 reps
5050 for 3-4 reps
3060 for 3-5 reps
5030 for 3-6 reps
3030 for 6-8 reps

These certainly aren't the only ones you may use, but for these loading parameters, these are some old stand byes.

Complex 3:
Sets: 1-3
Reps: 8-15
TUT: 40-70 seconds (same rules as above apply regarding tempo)
Rest: 30-90 seconds

Notes: You can manipulate tempo in this complex, but I've found that simply controlling the weight on a moderate tempo (e.g., a 2020 tempo) and hitting the TUT prescription works about as well as any specific tempo, slow or fast. Keep the weight above 60% 1 RM. If it drops below that due to fatigue, terminate the workout.

Program notes:

First let me emphasize again that this induces functional hypertrophy. You will get bigger and stronger, but frankly, as much as I like it it's not the best way to get stronger. The reason being is that using such wide rep brackets you could conceivably use anywhere from 95% down to 55% of your 1 RM in a workout and for optimal strength gains that's too big a gap. Also, while I'm on the topic of rep brackets. In each complex I have given

rather wide rep brackets. This is so you can adjust the program to your individual needs. However, when you select a weight bracket, select a 3-rep wide rep bracket for a given complex that day. For example, if you deadlift in the first complex, choose a rep bracket of 3-5 reps, 2-4 reps, or 1-3 reps. If you are scheduled for 3-5 reps and 5 sets, yet in the fourth set you only achieve two reps, terminate the complex and move on. Also, while I did say that this program was not optimal for increasing strength, it is pretty good. Each complex is given a certain rep bracket and a specific TUT that will preferentially recruit certain fiber types at certain times. Be sure that ego doesn't interfere with proper form or execution of the routine. You will be rewarded by properly manipulating the load and exercise for each complex. I have seen several athletes increase certain lifts substantially when using these parameters. However, here's another tip to maximize your desired training effect. By using this program I will assume that you want both strength and mass. But which is slightly more important to you? If you want increased strength, particularly in a movement like the squat, perform that movement throughout the workout. If you want an emphasis in size, then perform a slightly different movement in each complex. For a more or less even mixture of both, use the same movement but alter it slightly in each complex.

Allow me to illustrate! If you want increased mass in the pectoralis major muscles, you may perform incline dumb bell presses in complex 1, in complex 2 you may perform flat dumb bell presses, and in complex 3 you may perform chest dips. If you want increased size in the shoulders and better overhead pressing strength you may use the behind the neck bar bell press in complex 1, overhead dumb bell press in complex 2, and front barbell press in complex 3. If you want to increase your back squat, simply manipulate the loading parameters throughout and maintain the squat as your only movement for the entire workout. This will work I promise, no weight room gods will condemn you to an aerobics class for using only one exercise in a workout.

Also, obviously this is a relatively high volume workout, after 3-6 workouts lower the volume for a few weeks, your body will thank you for it. Also, do not perform more than 12 sets for a body part in any given workout or 30 sets total. You can alternate exercises using these loading parameters as seen in this sample workout for an athlete who needed greater upper body size and strength.

A1) Chest Dips
Sets: 4
Reps: 3-5
Tempo: 3020
Rest: 2 minutes

A2) Wide Pronated Grip Pull Ups
Sets: 4
Reps: 3-5
Tempo: 4010
Rest: 2 minutes

B1) Flat bench Dumb Bell Press
Sets: 3
Reps: 6-8
Tempo: 50X0
Rest: 2 minutes

B2) Shoulder Width Pronated Grip Pull Ups
Sets: 3
Reps: 6-8
Tempo: 40X0
Rest: 2 minutes

C1) Tricep Dips
Sets: 1-2
Reps: 10-12
Tempo: 2020
Rest: 60 seconds

C2) Close Grip Supinated Chin Ups
Sets: 1-2
Reps: AMRAP (As Many Reps As Possible)
Tempo: 30X0
Rest: 60 seconds

So you can see, you can work more than one body part or as I prefer "movement" at a time. However, for legs this doesn't work as well. You could if you performed more typical bodybuilding movements which tend to divide the leg into quad and hamstring dominant movements, but in my opinion if you truly want functional hypertrophy, then use movements that have functionality to them. I.e., that will carry over to your sport. Therefore, squats and deadlifts are in, leg extensions and curls are out. Also, where did I get thirty from? In this workout you could only do a maximum of 24 sets total. Well, feel free to tack on some ab work, calf work, rotator cuff work, etc. at the end, just realize that you will be a bit fatigued!
Also, what about the Olympic lifts? Can they be used in this program? Yes and No! Is that vague enough? You may use them in the first complex, but after it, use only "slow movements" as Zatsiorsky terms them. Therefore a routine using the Clean Pull may look like this:

A1) Clean Pull
Sets: 5
Reps: 3-4
Tempo: N/A
Rest: 5 minutes

B1) Front Squat
Sets: 4

Reps: 6
Tempo: 4010
Rest: 4 minutes

C1) Heels Elevated back Squat
Sets: 2
Reps: 12-15
Tempo: 2020
Rest: 90 seconds

There are many ways to induce functional hypertrophy please don't think that this is the only or even necessarily the best way. It just happens to be a very good way to put on quality mass quickly for a lot of athletes, a lot of the time. Finding the "best" way would be determined by about a million individual factors. However, I have successfully used this method before in many different situations. It's very versatile in the ways in which it can be adjusted for the individual's needs via loading parameters or a specific exercise. If you try it out let me know how it works for you, and of course send any questions or comments to me via email (wilson@ironmag.com) or just post them on the message board.

- Todd Wilson

References:

Pipes T.V. (1994) Strength training and Fiber Types. Scholastic Coach. March, 63: 67-70.

Siff M.C. (2000) Supertraining 5th edition. Supertraining Institute, Denver, CO.