

“The Law of Repetitive Motion and How It Pertains to Sports”

Or

“Why you should lift heavy things”

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About a year ago I was at a conference at Mike Boyle’s facility where I heard Eric Cressey present on “The Art of Hardcore Corrective Training: Ten Lessons to Keep Athletes Healthy”. During the lecture EC touched briefly on something called the Law of Repetitive Motion created by Dr. Michael P. Leahy, the founder of Active Release Technique (ART). The Law of Repetitive Motion states:

$$I = NF/AR$$

I = Insult or injury to the tissues

N = Number of reps

F = Force, as measured as a percentage of one rep max

A = Amplitude of each rep

R = Rest between reps

I liked the equation because I think of training as one big equation. If you control all (or as many) of the variables, then you control the outcome of training:

$$R = D[(S+M)ST/(N+R)G]$$

Until recently my training was centered around full body workouts three times a week. However, it wasn’t until I switched to more of a WSB template and revisited this model that the full implications of it became apparent. As I lifted heavier weights I noticed something started to occur...I felt great! I would normally cycle front squats with back squats on 4-6 week rotations with variations of each. I cycled them because of various injuries I have had due to MMA and BJJ. I would also stray away from any type of benching, instead, favoring push up and pull up variations, again because of injuries. However, as I started to get stronger I realized that I was able to bench and squat pain free!

My background is a mix of Applied Functional Science and traditional strength and conditioning with the emphasis placed more on the AFS side. My normal course of action for fixing problems or “break downs” in a person is to take more of a 3 dimensional, neuromusculoskeletal (NMS) mobility approach.

In other words, find out what isn't moving in all 3 planes, what mobility it's lacking and which part of the NMS is not allowing the particular area to function as it should. However, after adopting more of a WSB template I started to realize how important max strength is in relation to injury prevention/rehab. You can have a 160 lb freshman wide receiver that moves great down the field in all 3 planes of motion, but as soon as he is touched by a 200 lb blocker he goes flying and has to sit the next few downs out. In all sports speed kills. However, you can't be fast without being strong on some neurological and muscular level.

“The man behind the equation”

Dr. Leahy is most popular for the creation of ART and his Law of Repetitive Motion. In his paper, “*Improved Treatments for Carpal Tunnel and Related Syndromes*” he presents a more simplistic view of the formula:  $I = N/A$  (injury = total number reps divided by amplitude).

“As “**N**” is increased, the total insult goes up. As “**A**” is increased, the total insult goes down...In treating a world-class cycling team over a period of 3 years, repetitive motion injuries rarely developed in a manner such as on a keyboard. This is thought to be a result of the increased amplitude of motion involved.” (1)

However, it turned out that the simple equation was too simple. So he came up with a more detailed one.

“A more complete law must include additional factors, e.g., the force exerted for each repetition “**F**” and the relaxation period between repetitions “**R**”. A high-force requirement is difficult for the tissues to sustain and a minimal or nonexistent relaxation time does not allow sufficient circulation and cellular respiration to occur. Relaxation of the tissues involves not only a lack of muscular contraction but also joint position. This is why the term “rest” is not used here. Total insult is directly proportional to force and inversely proportional to relaxation time. Expanded law of repetitive motion:  **$I = NF/AR$** . Vibration is a motion with a very high N, a low A, and a low R and therefore is a severe insult to working tissues.”

With this new equation he went on to explain how, by using this equation, one could reduce CTD's or cumulative trauma disorders by manipulating the four factors. Great reading if you're interested.

### "The Law simplified"

As stated earlier  $I = NF/AR$

I = Insult or injury to the tissues

N = Number of reps

F = Force, as measured as a percentage of one rep max

A = Amplitude of each rep

R = Rest between reps

That doesn't make a lot of sense to me as it's stated so let's simplify it. The more times (N or reps) you interact with something (F or force) with little rest (R or recovery) at a fast rate (A or amplitude) the more prone to injury you are.

The majority of the equation, i.e. "I", "N" and "R" are pretty simple. However, I feel that a lot of misunderstanding surrounds "A" and "F".

### **What is amplitude?**

I didn't know what amplitude meant in his equation so I looked it up on the internet. Below are some answers I found.

(Physics) the maximum displacement of a periodic wave

The property of copious abundance

Greatness of magnitude

Often the greatest magnitude at a given point of any spatially and temporally varying physical quantity governed by a wave equation; can also mean the spatial part of a time-harmonic wave function. .

[mkwc.ifa.hawaii.edu/glossary/index.cgi](http://mkwc.ifa.hawaii.edu/glossary/index.cgi)

The distance from the midpoint to the crest or trough of a wave  
[activities.macmillanmh.com/science/ca/grade6/glossary/a.html](http://activities.macmillanmh.com/science/ca/grade6/glossary/a.html)

Amplitude describes the magnitude of a signal.  
[www.bionicear-europe.com/en/glossary/glossary.html](http://www.bionicear-europe.com/en/glossary/glossary.html)

The maximum value of a periodic curve measured along its vertical axis with reference to the horizontal axis.  
[www.smoothpavements.com/content.aspx](http://www.smoothpavements.com/content.aspx)

The height or degree of execution of a move.  
[en.beijing2008.cn/43/51/article212015143.shtml](http://en.beijing2008.cn/43/51/article212015143.shtml)

## **Amplitude as speed**

I really don't know what the hell all that means. I mean seriously, I have no clue what any of that means. To tell you the truth I still don't really know what amplitude means, but I will tell you how I think of it. Amplitude is speed or velocity expressed in waves or curves. Everything has a beginning and an end. The lower the amplitude the quicker the journey, the slower the journey the higher the amplitude. For instance the greater the speed of something the lower the amplitude and therefore the higher the potential for injury. If that makes sense to you...you should be writing this, not me. Here is another way to look at it. Dribble a basketball from hip height to the floor for 30 seconds. Notice how long the basketball takes to reach the floor and then back up to your hand. Now dribble a basketball from knee height to floor for 30 seconds and watch how quickly the ball returns to your hand. The higher the ball bounces the longer it takes to reach your hand, hence a high amplitude. The lower the ball bounces the shorter the time it takes to reach your hand, thus lower amplitude. Got it? Good, now email me a better way to understand it.

## **Amplitude as ROM or distance**

I have heard of amplitude in this equation referred to as distance or range of motion, i.e. the greater the distance/ROM the higher the potential for injury. I personally do not like to use amplitude as ROM/distance (referred to as ROM/D) because of two main problems. One, distance is set, i.e. in all sporting events the distance is set, a mile is a mile, a stride is a stride, a squat is a squat, etc. You can move through those distances faster if you become stronger, however, the distance in most cases will not change by any drastic measures other than what is afforded by technique/physiological changes, i.e. wider stance gets you closer to the ground. Number two, ROM is also set in terms of terminal end range and beginning range. Can you increase someone's ROM by increasing tissue length/quality via different modalities if they are limited...yes, you can. However, ROM can only go so far, I have yet to see someone touch the ground with their head when trying to touch their toes standing up, or someone scratch the back of their head with their hand when reaching for their opposite side scapula, in back of their body.

Therefore, ROM/D is set with little to no factors in the equation affecting it. My ROM does not increase markedly if I get stronger, nor does the actual distance I need to travel decrease if I change my reps. But if I increase my strength thus decreasing my reps which then enables me to finish the job FASTER or at a LOWER AMPLITUDE. Therefore, I am sticking with amplitude as speed until Dr. Leahy tells me otherwise.

## **What is Force?**

Most people think force is fairly simple in this equation. The heavier the object, the more prone to injury you are. Not 100% accurate. It's true the heavier the object the harder it is to move, however, that does

not necessarily equate to having a high injury potential. In fact in the Law of Repetitive Motion total injury potential is “directly proportional to force and inversely proportional to relaxation time.” (1)

In other words, the lower the load (and therefore the higher speed) and the shorter the rest between reps equals a higher potential for injury. Think of a pitcher throwing 30 fast balls in succession as quickly as possible. He would be lucky if it was just his shoulder that blew out! This would also explain why, to a certain point, it’s safer to max out at low reps (below 3) than higher reps. Taken another way, the greater the force with little rest between would lead to a higher injury potential.

FALSE! By definition, when moving max loads, you must rest longer because you must give your body (neurological and muscular system) a chance to recover. It is true, if by some miracle you could hit a 1-5 rep max and then turn around with little to no rest and hit that same weight again for the same reps you would be at a very high potential for injury. However, unless you’re a beginner that is just physiologically not possible.

“How all of this relates to power lifting and sports in general”

In power lifting the goal is to move an incredibly heavy load (100% of your 1RM) very fast, one time. That’s why in the conjugate system there are days devoted to speed and days devoted to increasing limit strength. I always like the analogy, “Try to jump slowly”. If you look at powerlifting in the Law, we have a very small potential for injury because the load is high, the amplitude is high (remember slow bar speed because you cannot move a heavy load, i.e. 100% 1RM as quickly as something weighing less, i.e. 70% of 1RM), the rest is high and the reps are low. I am only talking about your main movement in a session. Supplemental and auxiliaries are handled a little differently in terms of loads, reps, etc., but the Law still applies for the most part. All things being considered, power lifting is a fairly repetitive injury-free sport according to the Law of Repetitive Stress. Acute injuries, not so much free of those, but that’s true of most sports. And yes I understand that shoulders, elbows, knees and lower back take a pounding but for the most part I believe you can do the sport of Powerlifting with little to no repetitive injuries as long as your periodization is sound.

However, let’s look at a soccer player sprinting down the field, or any sport involving sprinting for that matter. The forces the muscles are exerting are high, but not near 100%, for various reasons (energy system utilization, fatigue, etc.). Let’s call it 85-95%. The reps are many! Think how many foot contacts you make in a 30 meter sprint. Now consider that you have little to no rest in between each bout. The recovery time is minimal. Soccer is a game of constant movement unless you’re watching little kids play, then there’s much more rest...mostly on the ground...and mostly on their butts or knees. The amplitude gets a little tricky to nail down depending on the stride length and frequency of the athlete or whether or not there is control of the ball. So let’s just keep it simple and look at someone sprinting down field after someone with the ball and let’s assume that the person sprinting has an equal blend of stride length and frequency. That being the case their amplitude is relatively moderate, i.e. not very high (slow)

and not very low (fast), its smack in the middle. That soccer player has a higher potential of repetitive injury (all things considered) than the power lifter based on the Law, mainly due to the increased amplitude and reps, and decreased recovery time.

### “Strength as it pertains to the Law”

Strength is the governing principle of the Law. If you make someone stronger, they are able to produce more force and thus sustain more force. They are able to get the job done in fewer reps because they are able to exert more force. And they need less recovery time between bouts because they are not as fatigued due to the increased force production. Amplitude is the only negative when looked at singularly, because, the stronger you are, the faster you are, and thus decreased amplitude. It's a fair trade off, especially when you consider that if we increase our max strength by 50%, the reps to do a job would be decreased by 50% and the recovery would be decreased by 50%. So, speed (amplitude) would have to increase by 150% just to break even! Not likely.

If you make that soccer player STRONGER, i.e., if you increase his muscles ability to apply force you will drastically decrease his injury potential as well increasing his performance! A stronger soccer player (athlete) will produce more force when sprinting (doing any activity) thus needing fewer steps (reps) because they are covering more distance. In addition that athlete will get more recovery because they were able to move faster down the field, decreasing the length of the play. The amplitude (speed of the movement) will most likely increase, however, because fewer steps/reps are taken the overall time of the event will decrease, which according to the Law sets us up for a higher potential of injury because of the decreased rest we now have. But, if everything else goes down in terms of injury potential, speed (amplitude), as noted earlier, would have to increase (decrease) something fierce to make up for the other decreases. Remember amplitude is essentially just speed. Get faster, increase your speed = lower amplitude; get slower, decrease your speed = higher amplitude. Got it? Don't lie, read it again. I wrote it and I still had to reread it about 10 times.

So what's the take home point? A stronger soccer player is a better soccer player and a less injury prone soccer player! That's not just soccer either, obviously. This applies to everything in life. Get stronger, decrease your injury potential. It's that simple.