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Velocity Based Training In-Season

Dr. Bryan Mann

"…there are so many things that the S&C coach cannot control, it is important to control what they can…"

In-season is one of the most vital times to utilize velocity based training (VBT). The stress is abundant upon the athlete. There is not just the stress of strength training, but sports stress, earning/keeping a position stress, life stress, academic stress dependent upon the level, among many other stressors. Since during the season, you win or lose games based on how you play when compared to the opponent rather than how much you bench press or squat, the sport skill should be the main stressor for the athlete.

As shown by Selye and later Sapolsky in their lay books "Stress of life" and "Why Zebra's Don't Get Ulcers" respectively, stress is a syndrome. A syndrome means that it has a specific response to nonspecific inputs. It doesn't matter what the stressor is, if it is eustress or distress (think good stress like a promotion or bad stress like your dog dying), your body will respond the same way from the adrenal cortex releasing glucocorticoids and the rest of the reactions. Selye outlined his General Adaptation Syndrome (GAS) in "Stress of Life" and basically stated that there are three phases. There is the alarm phase, the resistance phase, and the exhaustion phase. The alarm phase is the phase in which your body goes wild. Let's say you introduce a new exercise to an athlete- for the sake of example- it's the first time the athlete ever squatted in their life. What happens? The body goes nuts trying to accommodate the movement through the neuromuscular system with motor unit recruitment, sequencing, proprioception, mechanoreceptors among many other things and the next day the athlete can neither walk, stand, sit, nor get on or off the toilet. The alarm phase blew them up. After a few sessions of this, they cease to get sore to the squat any longer. As long as the stressor is at a moderate enough level, the person will be fine. This is the resistance phase. The person can handle everything as they go along. Until they can't, in which case excessive soreness, illness or injury rears their ugly head and this is the exhaustion phase of the GAS.

Each person has a different level of stress that they can handle as well as different means to handle it. Research has shown that in times of high non-sport related stress, increases in injuries and illness are rampant (4, 7, 8). The athlete becomes overstressed because of either the amount of stress or the way that the athlete deals with the stress. Interestingly enough, the effect of social support on injury was found to be extremely important. Petrie found that those with the most intact social support systems were able to work through or process various events, making a huge impact on the outcomes of injuries (8). Some athletes come from situations that are not

good and they have no safety net of people at home to help them. They have no one they can call if they falter and need aid. If we even go so far as to look at Maslow's hierarchy of needs we see that safety is the number one need (11). If they have no one to support them and provide safety, to provide shelter, to provide a safety net of sorts, then they don't have that basic need met and the other needs up the hierarchy will never be met.

An interesting thing that I have heard recently from "The Smarter Team Training" podcast with Coach Andrea Hudy was, "*When athletes deserve love the least, that's when they need love the most."* This fits well with Maslow's hierarchy of needs. People don't go from trusting well rounded individuals to acting like little brats for no reason. There is a reason and it often falls into this hierarchy. They aren't getting a basic need met. Something has happened and they don't know how to deal with it. While they deserve to get punished for their actions (whatever they might be), what does that do for the athlete? Often it introduces a stressor when an overstress is what caused it. Essentially what needs to be done is sit down and talk with the athlete, see if they'll open up about what's bothering them. Hopefully you've developed a good relationship before this so they will trust you that you're not someone else trying to be out to get them. This may show enough of a social support and you are the person that they walk through the situation with that allows them to get back to normal.

I have gone on this long rant about stress because of this; there is more than one thing that stresses the athlete. It's not just what you're doing in the weight room, but what they're doing in practice, what they're doing in the classroom, what they're doing nutritionally, and a whole other gamut of things that decide how they respond due to how much stress resistance they have left in the bank. Since there are so many things that the S&C coach cannot control, it is important to control what they can- and that is what is in the weight room and ensuring proper loading.

A paper from Jidovtseff et al. shows us that there is a great relationship between velocity and percentage of 1RM from any given testing period (3). There was an R of .98 for the relationship between mean velocity and % of 1RM for bench press, indicating that it was good enough to train off of velocity rather than % of 1RM. Later papers by Gonzalez-Badillo and Sanchez-Medina further reinforced that information as well as provided us with the knowledge that the changes between velocity and percentage of 1RM were very solid with little change (2). The greatest difference among the individuals at a corresponding velocity between pre and post-test

was 0.01m/s. on average. What is interesting is that the average change for the athletes was a 9.7% increase in strength over the six week training cycle yet the velocity at the actual load changed drastically (meaning a pre-selected weight such as 80kg for instance), the % of 1RM and the corresponding velocity did not change at all. What this indicates to us is that utilizing velocity on any given day is far more accurate than a previously tested 1RM. For a great percentage of the athletes, 0.8m/s equated to 60% of the 1RM. What this allows is any time the athlete is moving the barbell at a mean velocity of 0.8m/s, they are moving the bar at 60% of their 1RM for that day. The utilization of this can best be illustrated by a Jovanovic and Flannagan paper from the ASCA where they demonstrated the changes in predicted 1RM vs the previously tested 1RM (3). For the athlete there was a wide range of 1RM for any given day, sometimes the athlete was up 18kg over the previously tested 1RM, sometimes they were 16kg below. This is a massive swing. By utilizing the previously tested 1RM the athlete would be lifting loads that were way off on some days. Some days they were right on, some days they were too light, some days they were too heavy. In high level sports, things that are left uncontrolled and up to chance increase the risk of injury, overtraining, and underperforming- all of which can lead to a strength coach getting fired.

Utilizing velocity aids in utilizing the appropriate loads for any given day. As the strength coach can't control many of the stressors, they need to account for them. Overreaching and overtraining can be detrimental to the athlete (1). Fry and Kraemer showed the relationship of the neuromuscular system to the strength training movements in 1997, and by showing a decreased velocity at a given load indicates that the nervous system is in a depressed state (1). If this is combined with the research by Jidovtseff et al, Gonzalez-Badillo, and Sanchez Medina, more information shows that the nervous system is depressed not by being the same strength and moving the barbell at a slower velocity, but that the persons entire strength level is down on that given day. Since 1RM can be predicted by velocity, it can be used as a sort of means of quantifying readiness and fatigue rather than monitoring it. By quantifying the work that is already done, and the predicted 1RM being used from week to week as a readiness score; the potential for this system allows the practitioner to see the trends of the athletes muscular system. More research is needed in this area to make a definitive statement on this.

Now that we have come this far, it is truly up to the coach on how to proceed. Some coaches prefer to do heavier loads in-season, some prefer to do more bodybuilding training in-season, and some prefer to do more power training in-season. Utilizing velocity though, allows us to apply whichever load the practitioner feels is appropriate.

Utilizing pre-established velocity zones for different traits, the practitioner can simply move through and progress just as they would with percentage based training. The only point where many practitioners trip up is that descending velocity is ascending load, so utilizing 0.3m/s allows the athlete to utilize a heavier load than 0.5m/s.

One key advantage of VBT is that it allows coaches to ensure that they are developing the trait they want to develop. Every specific strength has a speed. So if an athlete isn't in the zone of that speed, he isn't developing the strength desired (9). For instance, to develop dynamic strength on the bench press, an athlete needs to move the bar at approximately 0.8–1.0 meters/second (m/s). If an athlete is moving the bar too slowly or too quickly, he isn't developing the desired trait.

The different strengths are as follows: absolute strength, accelerative strength, strength-speed, speed-strength, and starting strength.

TRAIT	MEAN VELOCITY
Absolute Strength	< .5m/s
Accelerative Strength	.5 - .75m/s
Strength-Speed	.75 - 1.0m/s
Speed-Strength	1.0 - 1.3m/s
Starting Strength	1.3m/s

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By understanding what strength is being developed, it allows the coach to better employ the principle that governs all training which is known as the Specific Adaptations to Imposed Demands (SAID) Principle. This principle states that the only adaptations made are the ones directly related to the type of training. For instance, if all of the training that is done is to improve the athlete's aerobic capacity in terms of a three mile time, there will be no positive adaptation, and possibly a maladaptation of alactic power.

- Absolute Strength: is developed from 0.5m/s and below. Absolute strength is defined as the absolute maximum of what someone can do on any given day. Absolute strength is the strength that is developed when training for, or determined when testing, a 1RM. Absolute strength is most commonly referred to as strength. While it is a fundamental portion of strength training and the basis for all traits that follow it, it is not the sole capability to develop. This is a thought of the past, and research has found that continuing to increase absolute strength beyond a threshold or training age did not increase the transfer to sprinting, jumping and change of direction (2, 10). During the first year of strength training with massive increases in strength on the back squat, clean, and bench press there was improvements in speed, agility, and explosive power as measured by the 40-yard dash, the proagility shuttle, and the vertical jump. After this first year, while there was continued improvement on the strength movements, there was no improvement on the speed, agility, or power tests. On the bench press by contrast is 0.3–0.45 m/s. Again, if the athlete is moving the bar too slowly or too quickly, he isn't developing the desired trait.

- Accelerative Strength: is when the barbell is moving from 0.5~0.75m/s. Common vernacular has led people to believe that this is the strength that improves an athlete's sprinting ability. While this may be true at the lower levels of development, that is not the true depiction of this strength. This strength is best depicted as acceleration through a load. Think of an offensive and defensive lineman in a football game firing off of the line of scrimmage and the offensive lineman dominates the defensive lineman. This offensive lineman was accelerating through a load that was provided by the defensive lineman.

There was a very common misconception on Strength-Speed vs Speed-Strength, and I am partly responsible for propagating this. In Carmello Bosco's original strength continuum, which will be discussed later, there was a non-quantifiable zone. In this zone there was an overlap of various capabilities: namely strength-speed and speed-strength. It wasn't a non-quantifiable zone because no sporting results came from training those percentages of 1RM (40-60%); it was non-quantifiable because the research team was unable to discern the split of the percentages between the two traits. Strength-speed and speed-strength were often seen as the same since they existed in the non-quantifiable zone, and many (myself included) treated them as such.

However, when looking at velocity instead of % of 1RM, there is a clear delineation between the two. Independently, several different researchers have found that there are two different traits of strength-speed and speed-strength and their velocities are 0.75-1.0m/s for strength-speed and 1.0-1.3m/s for speed-strength.

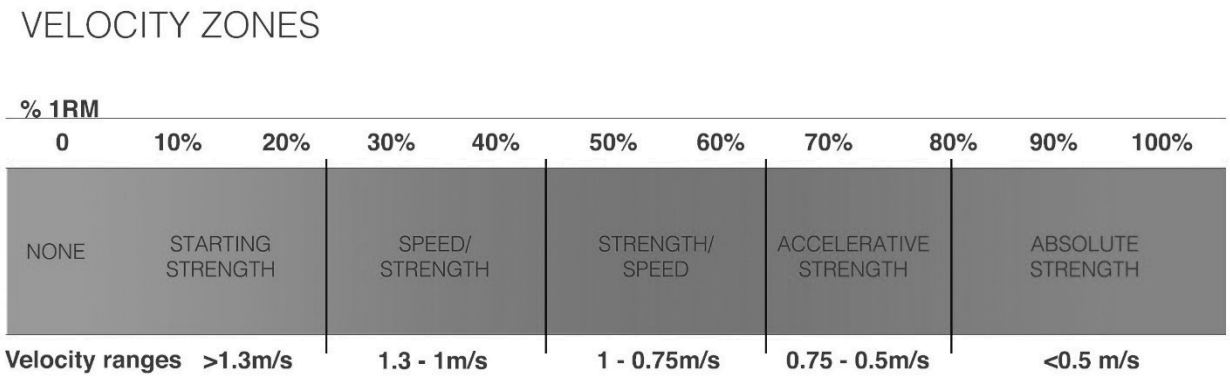
- Strength-speed: is strength in conditions of speed. It is moving a moderate weight as fast as possible. It has a higher rate of force development than accelerative strength. Again, this is moving an implement in the ranges of 0.75-1.0m/s.

- Speed-Strength: is speed in conditions of strength, or moving a lighter weight as fast as possible. This trait has the 2nd highest rate of force development of all of the traits and often requires special equipment in addition to the free weights in the forms of accommodating resistance to achieve these velocities as those alter the acceleration curve allowing the lifter to stay in acceleration for a longer period and thus achieve higher velocities. The bar would need to move between 1.0-1.3m/s to train this trait.

- Starting-Strength: is another trait that is often misunderstood most likely due to the different meanings in the common vernacular. Many people think that starting-strength is developed by exercises like deadlifts, or squatting from pins, etc. What this is, in fact, developing is absolute strength in the concentric portion of the lift only. This is NOT starting strength. What starting-strength is, is the ability to rapidly

overcome inertia from a dead stop. For this, think of a wide receiver beginning his route at the start of the play. The receiver rapidly overcomes inertia to be able to start running his route as fast as possible and leave the defensive secondary in his wake.

Once the practitioner isolates which trait they wish to develop, the loads selected should remain within that trait's particular zone. For instance, if a coach wishes to develop strength-speed in-season which is often seen to be around 40-65 or 70% 1RM, they simply utilize 0.75-1.0m/s, the corresponding loads selected within that zone will develop that trait. Just like what has previously been done with waving in traditional periodization, the coach selects a velocity that the athlete moves a load. For instance, the coach may assign velocities for the first week at 1.0m/s, week two at 0.9m/s, and week three at 0.75m/s. The coach has increased in load over the course of those three weeks just as they would have increased 1RM. Essentially, the coach just switches out the percentage of 1RM with the velocity to allow the athlete to utilize the correct load on any given day.



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One thing to remember is that the actual load may not change or may decrease over the course of the weeks. The load for that day is the load necessary to elicit the desired response. If the athlete is overstressed at that time, they will not be able to move the load at the desired velocity, and thus will have to decrease the load to train the desired trait.

Athletes are human. They are subject to many stresses that may be outside not only the realm of control of the coach and the athlete, but outside of the realm of understanding of the coach. The college coach may not even be able to fathom all of the stresses that an athlete has been going through. These athletes are away from their families for the first time (which may be a good or bad thing), open to a world with a freedom of choice they are not accustomed to, are undergoing academic stresses that are far beyond what they have been previously exposed to, are undergoing new social schemas, and on top of all of that are having to strength train and compete at a high level in athletics. Even one step beyond that is the pressure and unintended consequence that social media has as a stress on the athletes of any level. Back when I was in college, it was one thing for people to sit around in a coffee shop and talk crap about a player, but now those people have access to the athletes 24/7 through things like Twitter. Instead of the spectator thinking something or talking about it with their buddies, they are directly telling this 18 year old kid what a piece of crap they think he is. It's funny to me how often adults are the ones doing the name calling on this too, but that is another aside. With stress being a finite quantity that the organism can assimilate and still adapt to, might there be some other things other than strength training to account for? The utilization of velocity is the only way that this can be achieved while on the fly in the weight room without doing other prior testing. The velocity with which the barbell moves is a neural capability as it is dependent upon the speed of the recruitment of the individual motor units in a synchronous manner to move the barbell as quickly as possible. If the nervous system is depressed due to fatigue from outside stressors, motor units will not be able to be recruited as quickly and thus the load that is moved will be done so at a lower velocity. In laymen's terms- when the athlete is experiencing fatigue they are not able to move as heavy of load on some days as compared to others.

All too often coaches take a myopic view of the athlete. What did the athlete lift yesterday, what are they lifting tomorrow, or the rest of the week? The coaches often fail to take into account the other stressors, and this is a problem. For instance, in a study done at the University

of Memphis following the football team over the course of a spring semester where the athletes had periods that were only resistance training, combined resistance training and coach led conditioning, spring practice, and a final period of just resistance training, very interesting results were found. From the initial testing through the resistance training only session, the athletes saw improvements in speed and power. After that, however, the proverbial wheels started to fall off. The athletes were undergoing the same resistance training program while adding on the additional stressor of the sport coach led conditioning session. Neither party made concessions to the other in order for the athlete to still be able to recover. This led to a negative impact on all things speed, power, and strength related over the course of the spring. The athletes actually saw a decrease in power to the point where it was below the initial baseline testing, and did not return to baseline until the end of post-spring practices. Essentially- the entire semester was lost due to a lack of communication (6).

Another study from the University of Missouri examined the isolated effect of academic stress and its impact on illness and injuries (5). While most tout the fact that the athletes were twice as likely to get hurt during a test week as a non-test week that is the lesser of the breaking news of the story. For the athletes who were on the two deep- those athletes that actually played- they were more likely to get hurt during a test week as they were during training camp. The athletes were 3.29x as likely to get hurt during a test week as compared to a low academic stress week, and the training camp weeks were 2.84x as likely to get hurt as compared to a low academic stress week. This study was completely retrospective and thus did not have a reporting of sleep, altered nutritional intake, heart rate variability or questionnaire data to give greater insight. However, this information is still very powerful as it indicates that the simple knowledge that an athlete has a test that week will have a far greater impact to their training loads and recovery times than a normal week.

Another example to illustrate the utilizablity of VBT in-season is a review article from Jovanovic and Flannagan. In this paper, they have the following figure.

(3)

This figure shows the tested 1RM which was taken before the season which is denoted by the dotted line, and a velocity predicted 1RM which was determined for each sessions training. Over the course of the season, there were some days when the predicted 1RM was nearly 30kg (66lbs) over the previously tested 1RM and there were days when the predicted 1RM was nearly 22kg (48lbs) below the previously tested 1Rm and there were days when the predicted 1RM was near the previously tested 1RM. Armed with this information, we can see that some days using a % of 1RM would utilize a weight that was far beyond the capabilities of the athlete on any given day and would increase the risk of injury. Conversely, we can see that there are days when the load would be far too light and would not elicit the desired training response. The utilization of velocity ensures that the practitioner will have a load selection that will be appropriate for that given athlete on that given day to train the physical quality desired, reduce the risk of injury, and improve the chance of the desired adaptation taking place.

In conclusion, it is clear that the utilization of velocity based training can greatly impact the training for an athlete in-season. The practitioner can select the proper load to develop the proper trait with the given circumstances they are dealing with. The load will not be too heavy or too light, provided the athlete is giving full effort.

When I was younger, I had a road atlas (a map) that I kept in my car. I drove all over the Midwest with this road atlas, and in fact I drove from Springfield, MO to Phoenix, AZ with that atlas. If I knew where I was at that moment, and knew where I was going, I could do a very reasonable job of getting myself there. That being said, sometimes I thought I knew where I was, but in reality I had no clue and got myself lost. Now, with my cell phone and the wonders of GPS, I can pull out my phone and know exactly where I am at any given time within 3 feet. I don't have to know where I am, I simply punch in my destination and it tells me where to turn, when to turn, what's coming next, etc. I don't have to worry about a single thing because it tells me exactly where I am, and does so with a lovely British accent. The map is the percentage based training. It is time tested and proven. Flat out- it works. The GPS on my cell phone is VBT. It is fantastically convenient, accurate, and right every time regardless of what previously happened. You DO NOT NEED to have VBT to have a successful program. Coaches have done wonders without it for centuries. But when you do have it, some magical things seem to happen.

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Who is Dr. Bryan Mann?

Dr. Bryan Mann was hired first as a Graduate Assistant in 2004 and then promoted to Assistant Director of Strength & Conditioning in 2006. On top of his duties in the department of Athletic Performance, Mann is also an Assistant Professor of Physical Therapy and Athletic Training since 2012.

As an Assistant Director of Strength & Conditioning, Mann is responsible for assisting with the player development program for football and baseball as well as being responsible for Missouri's women's soccer teams. In addition to these team duties, he is also the Director of Research & Development, as well as being the Coordinator for On-Campus Academic Relations.

Prior to his arrival at the University of Missouri, Mann attended Southwest Missouri State University where he served as a student assistant as well as a Graduate Assistant Strength and Conditioning Coach from March 1999-May 2004. He assisted in the player development of football, men's and women's basketball, baseball, and volleyball. He developed the programs for field hockey, softball, men's and women's soccer, swimming and diving, and men's tennis. He also trained 2004 Barbados Olympic triple jumper Greg Hughes.

Mann also helped in producing some great achievements for the athletic department at SMSU. These include a Final Four appearance by women's basketball and a College World Series appearance by baseball.

Throughout high school and college, Mann was a four-time national and two-time world champion in powerlifting for the Natural Athlete's Strength Association and was considered among the top 20 athletes in the world for his age.

Mann is also an accomplished author and researcher. He has published three books, most notably "Powerlifting" which was published by Human Kinetics, and numerous journal articles. Mann is most well-known for his research on autoregulation of training with the first athlete training article ever done on the Autoregulatory Progressive Resistance Exercise (APRE) protocol as well as assessment of training improvements.

Mann received his degree in Health Promotion from Missouri State University in 2003, a Graduate Certificate in Sports Management from Missouri State University in 2004, a Master's Degree in Health Education and Promotion in 2006 and his PhD in 2011. Mann is recognized as a Certified Strength and Conditioning Specialist (CSCS) through the National Strength and Conditioning Association (NSCA) as well as Strength and Conditioning Coach Certified (SCCC) from the Collegiate Strength and Conditioning Coaches Association. Mann is married to Corinne Schoppet Mann and they currently reside in Columbia.