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NATIONAL STRENGTH AND CONDITIONING ASSOCIATION

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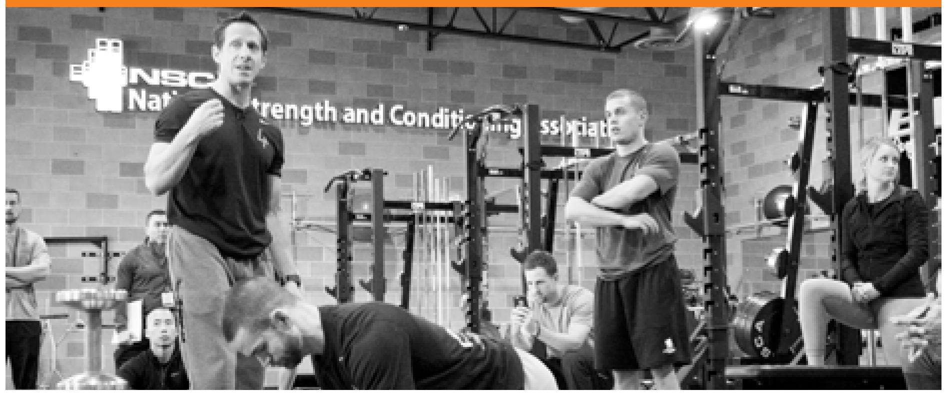

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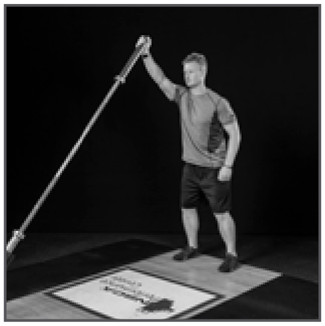

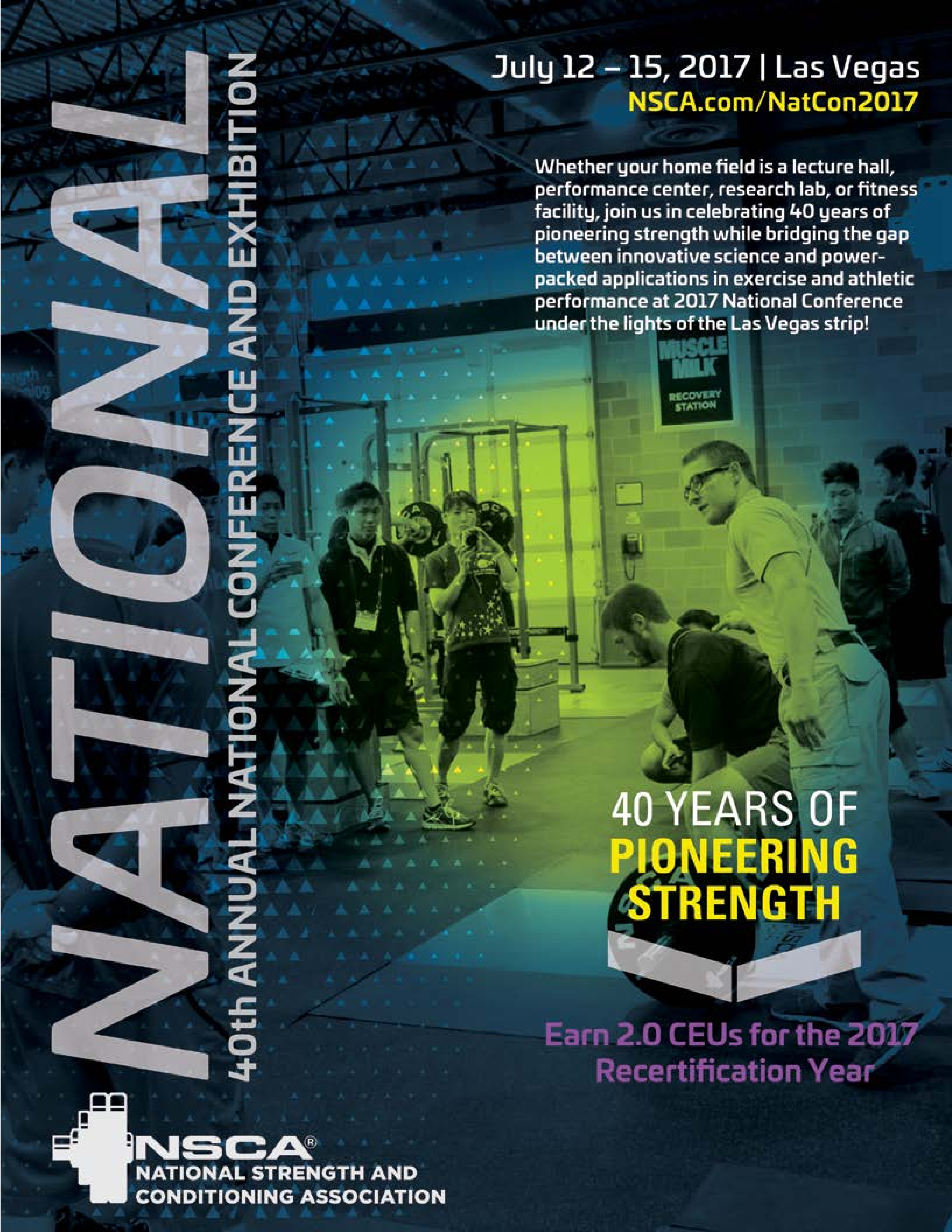

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ANDY GILLHAM, PHD, CSCS, CC-AASP

Attributions are the reasons people give to explain why something happened. An athlete executing a successful lift could believe she succeeded due to her own efforts in learning the lift because the lift was easy or because she simply got lucky. The specific attribution pattern adopted by an athlete is crucial to their long-term development and is something that coaches can directly influence. The path to assist athletes in improving their attribution patterns is filled with complexities and internal biases, both on the part of the athlete and the coach (5). Attribution stem from perceived control; the payoff of navigating the complexities of attribution patterns is an increase in perceived control. Having a sense of control is related to components of Achievement Goal Theory, Self-Determination Theory, intrinsic motivation, athlete self-efficacy and self-confidence, and leadership approaches where the development of trust between leader and follower is critical (8,9,10,13). The purpose of this article is to show some ways that coaches can directly impact the level of perceived control that athletes experience.

ATTRIBUTION BASICS

A basic depiction of an attribution model is a 2x2 framework with stability and control serving as the dimensions, leaving four possible combinations: internal-stable, internal-unstable, external-stable, and external-unstable (Table 1) (12). This basic description only scratches the surface, but it should serve well as an introduction to understanding attribution. Essentially, the model shows how each person makes a judgement about why something happened along dual-continuums of stability and controllability. Perceived control is simply the degree to which the athlete felt she personally could have impacted the situation. The stability dimension refers to how likely the same outcome will be in the future given similar circumstances. That future-looking component is why helping athletes improve their attribution patterns can lead to improved performances for both the coach and the athlete. An athlete that attributes failure to something internal-stable (e.g., "I just cannot do a power clean coach; it is too hard for me") is unlikely to devote the time and effort required to properly execute the lift safely. Conversely, the athlete that attributes the same failure to something internal-unstable (e.g., "That power clean is tough; I need to ask coach for some more tips") believes she has some control over the situation and, thus, is more likely to work to improve her performance.

TABLE 1. DEPICTION OF ATTRIBUTION MODEL (12)

	INTERNAL CONTROL	EXTERNAL CONTROL
Stable	Ability	Difficulty
Unstable	Effort	Luck

ATTRIBUTION BIASES

Adding significant complexity to understanding attribution is that all people suffer from attribution bias, which has been found across contexts (6). The base layer of the bias is that we all tend to attribute successful outcomes to something we did and failure outcomes to some external cause. There are at least two major competing perspectives for why this occurs (6). One perspective asserts this is a self-confidence preservation technique in that we all want to take credit for the things that go well, while looking to blame failures on anyone or anything not ourselves (7). Acknowledging when we accomplish something that we wanted to achieve is consistent with how self-efficacy and self-confidence are developed (13). The other dominant explanation for attributional bias is rooted in simple logic (6,7). Regardless of the task, rarely was failure the intended outcome. Therefore, if something does go wrong, it must be due to something that we could not have foreseen and could not have controlled. Athletes have this bias, but so do coaches and spectators (5). Compounding matters is that the more someone identifies with the team or school, the greater the bias (11).

Greater bias means that the more devoted a coach is, the more likely they will fall into the bias that successes, on the field or in the training facility, are of their own making, while unsuccessful outcomes are to be blamed elsewhere. When a coach is heavily biased in this way and athletes blame their poor execution of a complex lift on the fact that the task is difficult, the coach is likely to more-or-less shrug and agree that the lift is difficult. That combination rolls on together, reinforcing that this particular lift is challenging to execute. As a result, sooner or later that lift simply gets written out of the training program in favor of something easier for the athletes to execute. Conversely, the ideal response is for the coach to first look inward and attribute the athlete's poor performance to the coach's own incomplete teaching of the technique necessary for the athlete to properly execute the lift. The message this ideal scenario sends to the athlete is that with greater effort (i.e., internal-unstable) the athlete will eventually be able to execute the lift properly.

This interplay also affects the trio of sport coach, strength and conditioning coach, and athlete. It is rather common for sport coaches experiencing a losing season to look elsewhere (i.e., external-unstable or external-stable) to explain why the team is not performing well. The strength and conditioning coach is a likely target for the blame. When we experience failure and attribute the cause to something or someone external, the attribution adjustment that should take place is to try to find something that you can control and work on that aspect. This helps explain why sport coaches seek to attribute failures on the field to poor conditioning of athletes, regardless of whether that is true or not. Similarly, strength and conditioning coaches are certainly limited by the athletes that the sport coaches recruit. Also, some strength and conditioning coaches attribute lackluster athlete training gains to the quality of the recruits and not the quality of the training program or the sport coach's teaching. In reality, many factors contribute to performance success, so to avoid attribution bias, be sure you and your staff are focusing on what you can control when an athlete or a team experiences some failure. One method for accomplishing this is using questions to improve your own performance (4). Examining your own attribution pattern is a viable application of reflective questioning.

MOVING FORWARD WITH ATTRIBUTIONS

Keeping in mind that attributions are inherently about expectations for future events, the importance of improving attribution patterns for athletes and coaches cannot be understated. Every coach wants an athlete who will persist in the face of failure and diligently work to improve both form and function. Every athlete wants a coach who will tirelessly work to facilitate performance success. Attribution research has shown consequences of attributions go beyond a continual cycle of expectancies and impact the athlete's actual performance, emotions, and persistence (6). Of the two dimensions, control and stability, the degree of control seems to be the most powerfully associated with expectancies of future success (6). For that reason, emphasizing any and all aspects that are controllable for the athlete is critical to the coach's efforts to help athletes establish helpful attribution patterns. Some examples toward that end include:

1. Effort is typically thought to be internal and unstable, making it a great attribution pattern for athletes. Encouraging athletes to recognize their effort levels during training is an effective way to enhance their sense of accountability for training success. When an athlete seems to be giving sub-par effort, the first step may be just a gentle reminder to go hard when training. When that does not prompt enough change, verbal comparisons to look across the room and see how much effort teammates are putting forward may work. If the change is still not acceptable, consider using videos to explicitly show the athlete what high effort looks like. You can video other teams at your facility or find any number of videos online. Another option is to video the athlete while giving lackluster effort and full effort. Show both videos to the athlete and challenge the athlete to explain the differences.

2. Both meager training improvements and injuries can stem from poor technique. Technique execution is something largely controllable by the athlete performing the lift. Finding novel ways to teach, explain, document, and demonstrate proper technique is the strength and conditioning coach's responsibility, which is an internal-unstable attribution for the coach. Verbal explanations may not be enough for all athletes. Having other athletes demonstrate lifts could be viewed as problematic, especially if the skill level between athletes is large (3). That situation may prompt statements like "I am not that coordinated" which is an internal-stable attribution. A specific goal setting approach focusing on technique with corresponding checklists could be used (2). In that case, the lift gets broken down into multiple pieces, each that the athlete can control, instead of just the one complete lift. Going even further than simply having an athlete demonstrate a lift while you teach, is to have one athlete teach the lift to a teammate as a way to reinforce the proper technical cues. Sometimes athletes benefit from seeing poorly done examples and even demonstrations across varying levels of success. Because attributions are associated with future expectancies, it can be quite valuable for the strength and conditioning staff to have a video library of athletes performing complex lifts demonstrating varying degrees of success. For example, if an athlete's current performance is substantially inferior to the finished product on the video, only showing the finished, fully successful execution of a lift may leave an athlete responding with an internal-stable attribution such as, "I just cannot do that."

3. Finally, social modeling is an extremely powerful tool at your disposal. Common advice for coaches is to focus on attitude, effort, and performance execution, all of which are at least largely controllable by the athlete, instead of performance results, which clearly depend on a multitude of factors outside the athlete's control (1). Through the lens of attributions, luck (i.e., external-uncontrollable) is never good. Similarly, getting breaks from officials, weather, or playing an inferior opponent do not lead to athletes believing they can influence the outcome. If an athlete believes effort would be wasted, what would be the point of putting forth high effort? This is why the behavior and verbalized attributions the strength and conditioning staff makes for successes and failures are so impactful. When an athlete is successful, the coach should find something to say that allows the athlete to own that success. The following are some examples:
   - "I saw that pancake block you had in the third quarter. All of that technique work you did sure paid off on that play."
   - "The sheer power you generate in pushing off the blocks is why you are usually the first one to the first hurdle. Keep doing those cleans."
   - "Remember back when you had all those shoulder problems? Those early mornings you showed up extra early to perfect your stroke were worth it."

CONCLUSION

Though no guaranteed way exists to get athletes to train hard consistently, anything the strength and conditioning staff can do to better prepare the athletes for success is something worth exploring. Attributions are constantly being made by athletes, sport coaches, and strength and conditioning staffs simultaneously. From a professional development standpoint, the challenge is to critically examine your own successes and failures to find a way to attribute the outcomes to something you can control and can change for the future. This could be as small as how you deal with a singular troublesome athlete or sport coach, or it could be a more in-depth examination of how you provide feedback to athletes and how you work with your own staff. When utilized correctly, attributions are about putting in the time and effort to consistently identify pieces you can control and working to enhance your own coaching performance.

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Andy Gillham owns and operates Ludus Consulting, LLC, which focuses on performance enhancement for athletes, coaches, and business executives. Of specific note is his work with coaches and athletic administrators on improving systematic coach evaluation and providing targeted coach development opportunities. Gillham is a Certified Strength and Conditioning Specialist® (CSCS®) through the National Strength and Conditioning Association (NSCA) and a Certified Consultant through the Association for Applied Sport Psychology (CC-AASP). He serves as a sport psychology consultant for collegiate teams and coaches as well as individual athletes competing at high school and college levels in the United States and Canada. Gillham is an Editorial Board member for two peer-reviewed journals, the International Journal of Sports Sciences and Coaching *and the* International Sport Coaching Journal*. Gillham earned both his Bachelor of Science degree in Fitness and Master of Science degree in Human Performance from the University of Wisconsin-LaCrosse. He received his PhD in Education with a Major of Sport and Exercise Psychology from the University of Idaho.*

THE INFLUENCE OF STATIC STRETCHING ON RESISTANCE TRAINING PERFORMANCE AND MUSCLE HYPERTROPHY

VICTOR TRINGALI, MS, CSCS, AND JOSEPH GIANDONATO, MBA, MS, CSCS

The purpose of this article is to explain the relationship between static stretching and muscular fitness and to disseminate programming recommendations extrapolated from existing literature involving the subjects.

INTRODUCTION

Muscle hypertrophy, which is defined as the enlargement of skeletal muscle is a primary training objective among recreational athletes, bodybuilders, and older adults. Achieving and preserving skeletal muscle mass is vital to support a wide gamut of functions throughout the lifespan, ranging from athletic competition to completing activities of daily living. Protocols intended to yield increases in muscular hypertrophy, in conjunction with sound and healthy nutrition habits are capable of rendering improvements in body composition, metabolic health, and neuromusculoskeletal health, collectively lending themselves to potential extended life expectancy and optimized quality of life. The two fundamental adaptations essential for muscle hypertrophy are the accretion of protein and the proliferation of satellite cells. The degree of exercise-induced muscle hypertrophy and rate of development is modulated by a plethora of variables, which include but are not limited to: training methods, age, gender, training status, and health status of the individual (3,19).

Exercise-induced muscular hypertrophy is facilitated by various signaling pathways that are individually or collectively stimulated by a triumvirate of mechanisms: mechanical tension, muscle damage, and metabolic stress (19). Among these, mechanical tension has traditionally gained the greatest share of attention by coaches and athletes, because it is the mechanism that is most dependent on muscular forces. Muscular forces, in turn, can promote hypertrophy, particularly as they relate to repeated bouts of efforts or exposure through a process known as mechanotransduction.

In mechanotransduction, forces are initially exerted upon muscle cells and eventually disrupt the sarcolemma, or cell membrane that houses intricate networks of ducts and vessels collecting and dispersing constituents involved in muscular function. These structures are composed of transverse tubules which empty calcium into the muscle cells and permit depolarization to occur, which contribute to the generation of action potentials. These forces are deciphered as input by multiple components, including mechanosensitive proteins, cell organelles, stretch-activated ion channels, and transmembrane adhesion sensors that permeate the extracellular matrix and activate various signaling pathways including mammalian target of rapamycin, insulin-like growth factor 1, extracellular signal-regulated kinases, phosphatidic acid, reactive nitrogen species, and amino acids (8,23).

Mechanical tension is the primary stimulus for developing muscle growth and can be produced by applying a force or stretch. When combined, these two factors appear to offer synergistic effects (3). Contraction tension is exemplified during the concentric phase of a repetition as a muscle contracts in response to the force exerted against it. Stretching tension, as exhibited during the eccentric phase of a repetition, has been shown to provide a signal to stimulate growth (16,19,26). While the influence of different training variables has often been discussed and debated, there has been a relative dearth of attention given to the utility of mechanical stretching as a potential means to magnify exercise-induced muscle hypertrophy.

STRETCHING AND HYPERTROPHY

Mechanical stretching of muscle has been associated with a cascade of metabolic and cellular activity which contributes to hypertrophic adaptations, including the activation of satellite cells, stimulation of protein synthesis, increased expression of insulin-like growth factor and messenger ribonucleic acid, and elevations in plasma growth hormone (15). Daily stretching has been shown to increase skeletal muscle-specific gene expression and effectively induce muscular growth. Thus, when combined with other modalities, such as resistance training, it may potentially accelerate muscle hypertrophy.

It has been well-established that higher volumes of resistance training are associated with greater adaptations in strength and hypertrophy (19). Furthermore, training at higher loads induces greater mechanical tension, believed to be the principal source behind muscular hypertrophy. Hence, it is conceivable that factors which improve or impair the ability to train with greater volume or load could influence muscular gains. Therefore, before incorporating a stretching protocol, it is important to have a fundamental understanding of the influence of static stretching on muscle performance.

STATIC STRETCHING AND PERFORMANCE

Static stretches can be either active or passive. Active stretches require an individual to move a joint to the end of its range of motion and maintain the stretched position themselves. Passive stretching is a form of static stretching, which uses the force of gravity to move the joint to an extended position or uses the assistance of a partner or an assistive mechanical device. Although it is a common practice among athletes and recreational exercisers to perform some form of static stretching exercise before a strength training session, research suggests that it does not protect against injury or moderate delayed onset muscle soreness (17,25).

Moreover, static stretching routines have been shown to have a negative acute effect on strength-dependent activities. Bouts of static stretching prior to exercise have been associated with decrements in muscle torque and power output (7,13). These adverse effects have been shown to last up to 24 hr after the conclusion of stretching (9). The decrease in neuromuscular performance following static stretching has been attributed to several possible mechanisms of action. Namely, a reduction in stiffness and an increase in length between resting sarcomeres, which alters the length-tension relationship of the muscle or the autogenic inhibition reflex, promoting a decrease in the excitability of a contracted or stretched muscle-consequently reducing motor drive and decreased motor unit activation (2,20). Based on this evidence, the extent of a positive contribution towards hypertrophy needs to be measured in accordance with the potential of any concurrent hampering of performance. Although a substantial body of literature points to decrements in strength performance following static stretching, the negative influence appears to be dependent on the application of the stretching protocol, including the duration and proximity of stretching in relation to the exercise session (14).

SHORT-DURATION AND INTERSET STRETCHING

The adverse effect on performance appears to decline as the duration of the stretch decreases. A study that investigated the effect of stretching duration concluded that 30-s static stretches had no negative effect on muscle force production (16). However, the researchers did notice performance decrements when 60-s stretches were incorporated prior to exercise (16). Additional findings indicated no statistically significant impairment in jump performance following a 15-s stretching protocol collectively suggesting that short-duration static stretching may have a limited effect on subsequent resistance training performance (21).

Stretching a muscle during a resistance training bout may lengthen the time and magnitude a muscle is under loaded tension, which may contribute an added stimulus and enhance a hypertrophic response (14,15). It has been proposed that the interset recovery period may serve as an ideal time to include a short-duration stretch and heighten adaptive responses (15). Rest intervals of 1 – 2 min for training programs designed to stimulate muscular hypertrophy have been advocated among novice and intermediate trainees, while longer rest periods of 2 – 3 min have traditionally been reserved for the heavily loaded core exercises of advanced trainees (14,15,19). The review of literature suggests that the incorporation of longer interset rest periods yields greater recovery of the energy and neuromuscular systems in comparison to shorter rest period. Additionally, longer rest periods can provide ample time to perform intermittent stretching between sets, thus, encouraging increases in muscular strength and hypertrophy.

LONGER DURATION DAILY STRETCHING

While lengthier sessions of static stretching have been associated with decreased force production and muscular strength, some research suggests longer duration stretching sessions can offer significant contributions to muscle hypertrophy. Repetitive stretches, 15 min per day, of the soleus muscles in rats were shown to induce muscle gene expression and muscle hypertrophy (10). These findings suggest that daily stretches may also be a viable method worth experimentation for trained human subjects and possibly influence sequential progression of gene transcription mediated muscular hypertrophy (2,4,5).

Because performance decrements have been shown to last up to 24 hr after extended periods of stretching, it is important to consider the proximity of longer duration stretching sessions in relation to a resistance training bout (6). Stretching regimens that consist of repetitive or lengthier stretches may best be implemented separately from a resistance training bout or during the post-exercise period while allowing a minimum of 24 hr prior to the next training session.

ANTAGONISTIC STRETCHING

Recently, the application of static stretching on antagonistic muscles has shown promise for improving force production and resistance training performance. Applying static stretching on antagonist muscles has been shown to improve vertical jump performance and isokinetic torque (14,18). Significant improvements were seen in vertical jump performance and isokinetic torque following 30-s of static stretching on antagonist dorsiflexor and knee flexor muscle groups (18). A different study examined the effects of antagonistic stretching of muscles of the upper body by having subjects perform 40 s of antagonistic stretches of the pectoralis muscles. This study demonstrated an increase in the number of repetitions performed over the three consecutive sets for the seated row exercise and an increase in muscle activation of the biceps and latissimus dorsi (14).

Although the mechanisms responsible for enhancing resistance training performance have not been completely elucidated, it has been speculated that antagonist stretching may induce an increase in elastic energy storage, agonist activation, and reduction of antagonist co-activation (18). Thus, antagonist stretching may be an application worthy of consideration for enhancing strength performance and muscle activation of agonist muscles as well as a corresponding contribution to a hypertrophic response.

CONCLUSION

Strength and conditioning coaches and athletes attempting to incorporate stretching protocols with the intention of enhancing muscle hypertrophy should consider the following:

- Performance decrements often associated with static stretches can potentially be offset by limiting pre-exercise stretch duration to 30 s.
- Regular, daily bouts of static stretching may contribute to enhanced muscle growth without compromising strength training performance. However, such stretching routines may best be conducted separately from the main training regimen or during the post-exercise period and conclude more than 24 hr prior to the next training bout.
- Antagonistic stretches can be performed for their potential role in improving training performance and increasing volume load—which in turn may contribute to greater hypertrophy. Antagonistic stretches of 30 – 40 s have produced positive outcomes.
- The interset recovery period may be an ideal time to incorporate brief stretching within a training session.

Stretching of muscle tissue has been shown to elicit metabolic and cellular activity that contributes to a hypertrophic response. When coupled with a properly designed resistance training program, static stretches may enhance muscular gains without impairing performance. Although research indicates that static stretching routines can diminish force and power during a subsequent strength-dependent activity, performance decrements appear to be associated with several factors, including the mode, duration, and proximity of a stretching protocol.

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THE LANDMINE PRESS – IMPLEMENTATION AND VARIATION

MATT SZELOG

Building strength, stability, and power in the shoulder joint is a key component of some athletic skills. Traditionally, athletes accomplish this with exercises involving dumbbells, kettlebells, barbells, bands, bodyweight-based resistance exercises, and machines. One method that is becoming increasingly popular is the use of barbells attached to a stable base known as a "landmine." This article will provide steps to begin implementing the landmine press as well as a variety of exercises that athletes can use. These techniques are appropriate for clients and athletes from the ages of 13 years and up.

THE BASIC LANDMINE ATTACHMENT

Multiple companies manufacture landmine bases as an attachment for barbells. Some of these are free standing, while others are attached to rack systems or are situated as sleeves inside of large plate weights. Although the bases are manufactured and used differently, all serve the same purpose: using one side of a barbell while the other is attached to a fixed point. This allows the barbell to be used for a variety of exercises such as, but not limited to, presses, squats, lunges, deadlifts, and rows.

To begin, make sure the barbell is free of plates and other attachments. Place the landmine device in an open area with enough room to complete the desired exercise. There is potential for injury if the landmine is not set up properly. After establishing a clear and safe area to perform the exercise, insert the barbell all the way into the sleeve and make sure the base is secure.

PRESSING VARIATIONS

STANDING LANDMINE PRESS (FIGURES 1 AND 2)

To perform the standing landmine press, the athlete should begin by standing approximately 3 – 4 ft from the landmine base with the feet shoulder-width apart, knees slightly bent, and holding the bar at one end so that it is positioned 4 – 6 in. from the anterior shoulder. The athlete's body should have a slight forward lean towards the bar. Activate the abdominals by "pulling" the ribcage lightly towards the pelvis, which will engage the anterior core musculature to add more stability during the movement. Additionally, the athlete should squeeze the glutes to maintain an upright posture. The athlete should inhale as they begin, and then exhale while driving the barbell forward and up until the elbow is completely extended. Make sure the abdominals remain engaged and the low back does not hyperextend. Return to the start position by lowering the weight back down to the anterior shoulder without allowing for trunk flexion. Repeat for the desired number of repetitions.

FIGURE 1. STANDING LANDMINE PRESS – START

FIGURE 2. STANDING LANDMINE PRESS – FINISH

HALF-KNEELING LANDMINE PRESS (FIGURES 3 AND 4)

The half-kneeling landmine press is an alternative landmine press that challenges upper body strength by taking away any knee flexion and extension used to assist the standing variation. In addition, the core musculature is more engaged due to the base of support narrowing and the fact the stance is split. Additionally, as the weight of the bar shifts, the athlete will be forced to fight trunk flexion, lateral flexion, and rotation (1). To perform the half-kneeling landmine press, the athlete should begin by assuming a half-kneeling position on a mat or pad. They should hold the bar in the same position as the standing press with the working arm on the same side as the leg that is kneeling. The athlete should engage the core in the same manner described in the standing landmine exercise. Be sure to maintain an upright posture with the torso. Start by inhaling, and then exhale while driving the bar forward and up until the elbow is completely extended. The athlete should make sure to maintain proper ribcage positioning and anterior core activation. Additionally, it is important to avoid allowing the low back to arch or hyperextend. To lower the bar, slowly bring the weight back down to the shoulder without allowing the trunk to flex. Repeat for the desired number of repetitions.

FIGURE 3. HALF-KNEELING LANDMINE PRESS – START

FIGURE 4. HALF-KNEELING LANDMINE PRESS – FINISH

FULL-KNEELING LANDMINE PRESS (FIGURES 5 AND 6)
The next variation focuses on upper extremity strength and trunk stability. To perform the full-kneeling landmine press, the athlete should begin with both knees on a mat or pad. Follow the steps above for breathing, lifting, and lowering. Athletes will notice that this lift is more difficult without a large base of support and minimal lower extremity assistance.

FIGURE 5. FULL-KNEELING LANDMINE PRESS – START

FIGURE 6. FULL-KNEELING LANDMINE PRESS – FINISH

SEATED LANDMINE PRESS (FIGURES 7 AND 8)

The seated landmine press emphasizes more upper extremity strength compared to the previous variations. It is important to note that sitting on a low box can decrease the difficulty. To perform the seated landmine press, the athlete should begin by sitting on the floor with the knees bent and feet flat on the floor. The athlete should maintain an upright posture while engaging the anterior core by slightly pulling the ribcage towards the pelvis. The athlete should follow the same breathing, lifting, and lowering cues as the previous variations. This specific variation will challenge the athletes the most due to the lack of lower extremity support and assistance, as well as the extra challenge on the core to stay upright.

FIGURE 7. SEATED LANDMINE PRESS – START

FIGURE 8. SEATED LANDMINE PRESS – FINISH

SIMPLE ERRORS, CUES, AND CORRECTIONS

As with any new movements, athletes may fall victim to a variety of technique errors upon adding the landmine press or its variations to an exercise program. Table 1 provides the most commonly found errors associated with the landmine press, as well as the ways these errors can be corrected.

TABLE 1. COMMON ERRORS AND CORRECTIONS FOR LANDMINE PRESS

Wrist hyperextension	Lock the wrist to a neutral position between flexion and extension to create rigidity in the joint.
Elbow abduction	Keep the elbow adducted close to the body during both the lift and lower to make sure the shoulder joint is properly stabilized.
Lateral flexion or trunk rotation	Make sure the abdominals and glutes are properly engaged throughout the movement. Adjust the weight if it is too heavy and negatively affecting form.
Spinal flexion	Make sure the abdominals and glutes are properly engaged, specifically during the eccentric portion of the lift. Make sure the weight is not too heavy and that the barbell is not too far away.
Spinal extension	Make sure the abdominals and glutes are properly engaged, specifically during the concentric phase of the lift.

INCREASING DIFFICULTY

There are numerous ways to increase difficulty for the exercises listed above. One method that can be used includes adding a "switch." To perform the landmine press or its variations with a "switch," the athlete should explosively drive out of the bottom position while releasing and "switching" the barbell to the opposite hand. This recruits a higher amount of fast twitch muscle fibers, and increases engagement of the trunk musculature by forcing it to decelerate the weight on the opposite side. Additionally, the athlete will be required to resist lateral flexion, trunk flexion, and rotation.

Another method to increase difficulty is to add a resistance band (Figure 9). To do this, the athlete should place a looped resistance band just above the collar of the barbell. Alternatively, the athlete can step on the band with one or both feet. It is important to note that using both feet will stretch the band more, therefore creating more resistance. This variation will not only increase the load placed on the bar, but also the eccentric pull of the downward motion.

FIGURE 9. STANDING LANDMINE PRESS WITH RESISTANCE BAND – FINISH

PROGRAMMING

As with any new exercise, athletes should start with learning the movement first. Once athletes have mastered these movements, they can move on to adding more weight, or using the switch or resistance band method. Table 2 provides a sample eight-week landmine press program that focuses on hypertrophy and strength.

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TABLE 2. SAMPLE EIGHT-WEEK LANDMINE PRESS PROGRAM

WEEK	EXERCISE	SETS	REPETITIONS	% MAX
1	Standing landmine press	3 – 4	12	75
2	Half-kneeling landmine press	3 – 4	12	75
3	Full-kneeling landmine press	3 – 4	10	80
4	Standing landmine press with switch	3 – 4	10	80
5	Half-kneeling landmine press with switch	3 – 4	8	85
6	Full-kneeling landmine press with switch	3 – 4	8	85
7	Standing landmine press with a resistance band	3 – 4	6	90
8	Full-kneeling landmine press with a resistance band	3 – 4	6	90

COMPENSATORY STABILIZATION—THE EXTENSION/COMPRESSION STABILIZING STRATEGY—PART 2

RICHARD ULM, DC, CSCS

In the previous article, proper stabilization of the spine and trunk was discussed. The anatomy, mechanics, and process by which one should stabilize for sports and lifting were covered. Having a sound understanding of the mechanics and anatomy of trunk stabilization is paramount for effective programming, cuing and training. The following is a review of what was covered in Part 1.

REVIEW OF PROPER STABILIZATION

- Proper stabilization of the spine involves co-activation of the entire abdominal wall (11,17).
- Such activation is produced by coordination of the diaphragm, abdominal wall, and pelvic floor, which work together to control intra-abdominal pressure (IAP) for improved spinal rigidity (2,4,5,6,11,17).
- In most daily activities, this coordinated co-contraction is involuntary (5).
- During a focused, conscious stabilizing event, like seen in weightlifting, the diaphragm will act concentrically, which pushes the contents of the abdomen into the abdominal wall and pelvic floor, resulting in eccentric activation (11,17).
- In most instances, one should breathe between repetitions to make sure that blood pressure is not excessive and sufficient oxygen circulation is maintained.

In sports and strength training, effective spinal stabilization is crucial. It not only protects the athlete from potential injury, but due to improved stability of the trunk, it may help with performance as well (1). Stabilizing with proper strategies, therefore, is pivotal for both performance and injury avoidance. Due to the fact that the nature of sports is performing to the best of one's ability, athletes often push themselves to the limit, making it difficult to stabilize properly if not prepared to do so.

DEFINING THE EXTENSION/COMPRESSION STABILIZING STRATEGY

There is a common compensatory stabilizing strategy seen in both the athletic and sedentary populations. This article will refer to this strategy or "postural syndrome" as the extension/compression stabilizing strategy (ECSS). As the name purposefully implies, this pattern utilizes extension and compression of spine (predominantly the lumbar spine) to stabilize the trunk for locomotion, function, and movement (11). With the ECSS hyperactivity of the lumbar erectors and hip flexors is seen, which can pull the spine into hyperlordosis and the pelvis into an anterior tilt. Similar patterns have been previously identified (e.g., Vladimir Janda with the "Lower Crossed Syndrome," Pavel Kolar with "Open Scissors Position," and Ron Hruska with "Posterior Extensor Chain") (7,8,11). The commonality between these postural syndromes is hyperactivity of the spinal erectors and weakness/inhibition of the abdominal wall, producing hyperlordosis and the anterior pelvic tilt that comes with it.

While it is tempting to view the body purely as a mechanical machine, it is not entirely accurate; the body is a complex neuro-mechanical machine that utilizes movements that involve both the central nervous system (CNS) and the musculoskeletal system. Many of the discoveries of Janda can help to explain why the ECSS is so prevalent in sports. Janda observed that at birth, humans only have a small percentage of muscles activated. Janda classified these active muscles as "tonic muscles" and include, for example, the lumbar erectors, hip flexors, adductors, levator

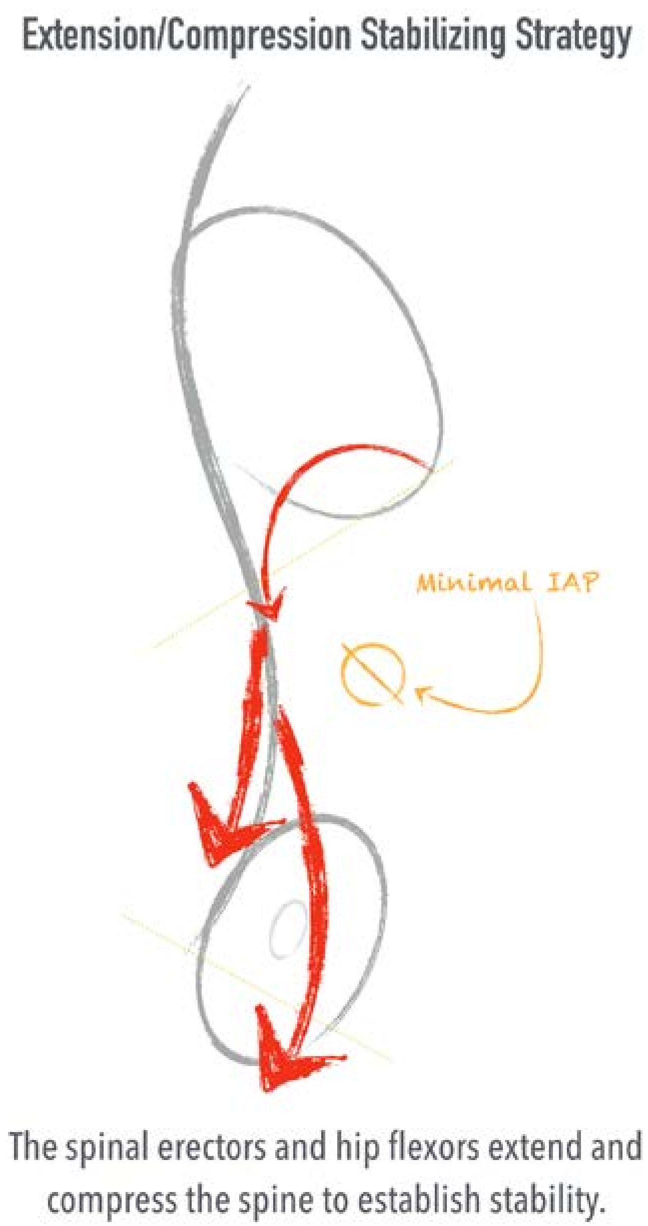

FIGURE 1. ECSS DIAGRAM

scapulae and the pectoral group (8,14). Throughout the first year of life (roughly), the CNS goes through a massive amount of maturation. During this process, muscles previously inactive become activated. These muscles activated in early development make up the "phasic muscle" group and involve such structures as the serratus anterior, abdominal wall, gluteals, and the deep neck flexors. Janda believed that the primary function of tonic muscles was stability, whereas, the phasic muscles were responsible for movement. Building upon the work by Janda, Kolar realized that the tonic and phasic muscle groups actually work together to both maintain posture and create smooth efficient movement (11).

Maintaining function of the phasic muscles tends to be more difficult than maintaining function of the tonic muscles. This is likely because they are activated later in development. Janda discovered that the tonic muscles tend to become hypertonic while the phasic muscles tend to be inhibited. The posture that results from this pattern is lower crossed syndrome. As mentioned previously, this is a common "postural syndrome" that is described by Dynamic Neuromuscular Stabilization (DNS) and the Postural Restoration Institute (PRI).

NEUROLOGICAL THRESHOLDS AND THE ECSS

In my studying the writings of Vladimir Janda and my work with Pavel Kolar, combined with my experience treating and training athletes, I have identified three different thresholds over which an athlete will resort to the ECSS: speed, force, and fatigue. Whenever one of these thresholds is exceeded, ideal function and movement is not possible. A strength and conditioning coach can ask an athlete to move very quickly to challenge their "speed threshold" (e.g., plyometrics or the second pull of a snatch). A strength and conditioning coach can have an athlete generate an incredible amount of force to challenge their "force threshold" (e.g., maximal effort back squat or bench press). Also, a strength and conditioning coach can put the athlete in an environment where they have to generate force for an extended period of time to challenge the athlete's "fatigue threshold" (e.g., 100 kettlebell swings with a 16-kg kettlebell). In each of these cases, the nervous system has a threshold over which it cannot maintain activation of the phasic muscles (the ones that activate later in development and tend to become inhibited when "challenged"). Based on this observation, understanding these different thresholds can potentially enable the coaches to more specifically and efficiently train athletes for their respective sports.

One common example of an athlete exceeding one of these thresholds is when an athlete's knees collapse inward (into a valgus position) coming out of the bottom position in a heavy squat. This is an example of a situation where an athlete has exceeded their "force threshold." In this position (bottom of the squat) and under this load (maximal), the athlete is unable to maintain full, balanced muscular activation of the muscles needed to get out of the bottom of the squat properly. This is caused by the abductors/external rotators (phasic muscles) becoming inhibited due to the fact that they are unable to maintain full activation under these conditions and the adductors (tonic muscles) taking over the load, becoming hypertonic. Without the opposing activation of the abductors/external rotators, the adductors pull the knees inward into adduction.

As often seen in the weight room, once an athlete rises 4 - 6 in. above parallel, he or she is typically able to restore proper knee position. The athlete is able to recorrect the knee position for the simple reason that as he or she rises out the bottom of the squat

FIGURE 2. VALGUS COLLAPSE

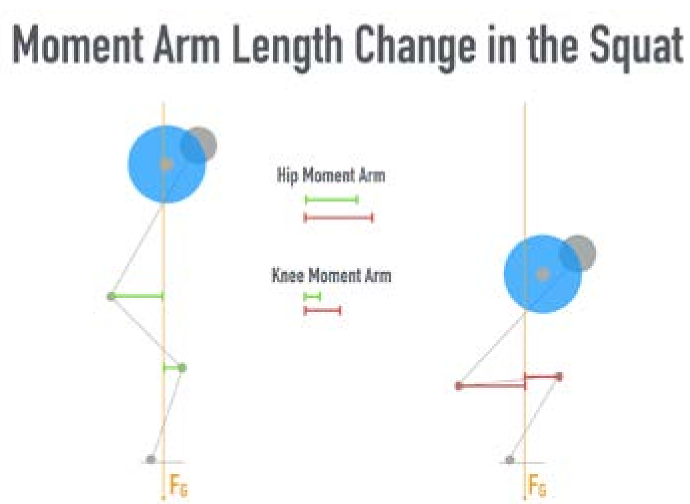

FIGURE 3. MOMENT ARM IN THE SQUAT

his mechanical leverage over the load improves. The better the athlete's mechanical leverage, the less internal muscular effort is necessary to maintain or overcome a joint position (torque = moment arm x force) (3). Once the internal effort required to overcome the position is below "threshold," the athlete is once again able to utilize co-activation of both the tonic and phasic muscles.

What is important to note here is that neither the contractile strength of the glutes or insufficient adenosine triphosphate (ATP) stores is the problem. Instead, it is the inability of the CNS to maintain activation of the glutes (phasic muscles). The force output requirements of this situation exceed the ability of the CNS to maintain balanced co-activation of the tonic and phasic muscle groups (in this case, it exceeds the force threshold of the CNS). It is neurological inhibition, not physical, contractile weakness or a lack of sufficient ATP.

The knees can also collapse inward because of the excessive speed at which a joint is asked to move. The best example of this is a non-contact ACL injury commonly seen in basketball. Typically, what happens is the athlete jumps up to get a rebound and upon landing, is unable to control the knee, which results in the knee crashing inward and damaging the ligaments. In this case, the "speed" required to control the knee exceeds the threshold and the knee crashes inward. This is because the CNS was unable

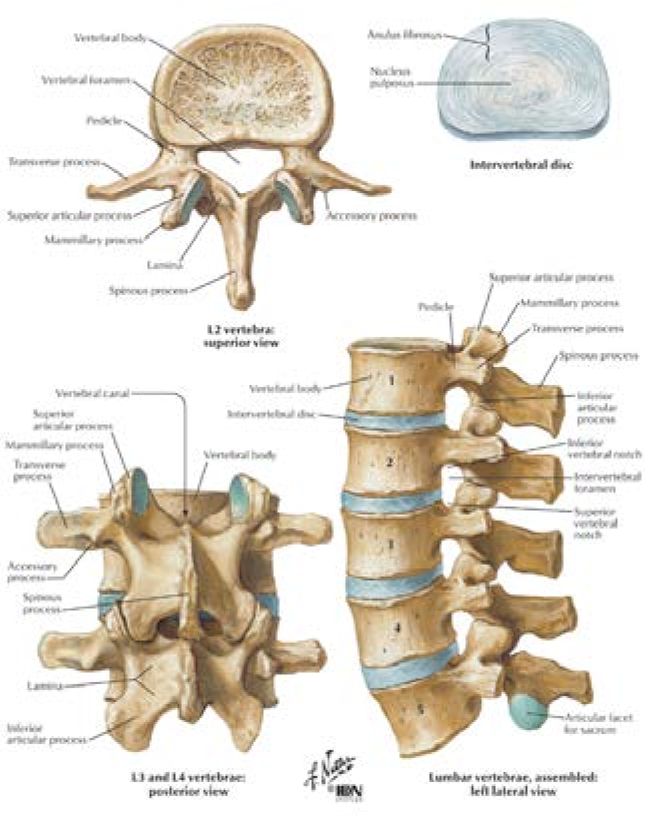

FIGURE 4. LUMBAR SPINE

to coordinate and fire the appropriate muscles to control the knee position. This is an example of an athlete exceeding a "speed threshold."

In the case of the trunk, whether it is speed, force, or duration, when a threshold is exceeded, the spinal erectors and hip flexors will become hyperactive and the abdominal wall and hip abductor/external rotators will become inhibited. This results in the ECSS. When the athlete resorts to the ECSS, the hyperactivity of the lumbar erectors and hip flexors is secondary to inhibition of the abdominals and glutes. This pulls the pelvis into anterior tilt, resulting in hyperextension of the lumbar spine. Due to the lack of trunk muscle co-activation, which acts to maintain more even joint loading, the brain will generate stability of the spine and pelvis by hyper-loading the posterior aspect of the spine (facet joints) (11).

CONSEQUENCES OF THE ECSS

In sports, athletes encounter and exceed these thresholds all the time. This is unavoidable; however, consistently training above threshold without any effort applied to improving an athlete's threshold may result in decreased performance and/or injury. The following is a list of some of the potential consequences of moving and stabilizing with an ECSS:

- **First, the ECSS is a reduction in balanced, co-activation of the trunk muscles, which results in trunk instability.** The lack of co-contraction of the trunk muscles prohibits the athlete's ability to generate stability, which potentially has a detrimental impact on performance as their force-output into the extremities and ability to transfer force through the trunk is compromised (4,5,6,17).

- **Second, when the athlete is no longer using all of the muscles available for stability (including the smaller ones such as the multifidus lumborum), the larger, more superficial muscles, such as the erector spinae, become overactive to compensate for the lack of stability (8,11).** These muscles typically have longer moment arms acting on the body (enabling them to generate more force) and have a poor ability to regulate the force they are generating and control joint positions (due to the massive motor unit to muscle fiber ratio). This all results in poor joint loading and increased internal forces acting on the body, which potentially accelerates the injury process.

- **Third, overusing a muscle results in a higher risk of injury to that muscle due to increased fatigue.** Because of the lack of co-activation of the muscles participating in stabilization, the muscles actually working to stabilize have to work extra hard, which increases the likelihood of an overuse injury to these muscles.

- **Fourth, with the posture distorted, the athlete's joint range of motion (ROM) is affected, which impacts performance.**

The most obvious impact is seen with the hips. When the pelvis is pulled into excessive anterior tilt, the orientation of the hip socket (acetabulum) changes, affecting hip ROM. Anterior pelvic tilt is typically associated with increased lordosis (extension) of the lumbar spine. What is often overlooked is the fact that anterior pelvic tilt results from closed-chain hip flexion (assuming the athlete is standing). Take an athlete with a pelvis tilted forward at 40˚ in standing posture; if this athlete wants to execute a squat, before he even starts the motion he has 40˚ less hip flexion due to the position of his pelvis and he has not even started the movement yet. If this athlete only has 110˚ of hip flexion ROM (normal range is 110 – 120˚) and he starts the motion with 40˚ less because of his ECSS, then he is starting the motion with only 70˚ of available hip flexion (15). About 100 – 110˚ of hip flexion is needed to achieve a full depth squat (defined as anterior superior iliac spine of the pelvis [ASIS] level with the knee) without loss of neutral spine position. So, if an athlete is going to get his hips slightly below parallel, he is going to have to flex his lumbar spine to do so. This is all because he lacks the sufficient hip ROM to squat to the full depth secondary to the starting position of his pelvis, all because he is using an ECSS.

THE ECSS IN TRAINING AND OVEREMPHASIS

Another contributing factor in the prevalence of the ECSS in sports is overemphasis on developing the posterior chain. The term posterior chain is tossed around a lot and has many definitions. However, perhaps the best definition is found in a book by Thomas Myers, *Anatomy Trains*, in which he defines the “posterior chain” as a fascial chain that runs from the plantar fascia, up the calves, into the hamstrings, through the sacrotuberous ligament, into the erector spinae, and all the way up to the occipital frontalis muscle on the top of the head (Figure 5) (16). Often, overemphasis of the posterior chain is seen in training, which can produce muscular imbalance resulting in the ECSS and functional limitations such as decreased hip flexion due to pelvis position or limited lumbar rotation due to both lumbar position and hyperactivity of the spinal erectors.

One such example of overemphasizing the posterior is when strength and conditioning coaches use wall squats to teach squatting. Even with optimal morphology, it is impossible to squat against a wall without excessive arching of the lower back (Figure 6). In other cases, strength and conditioning coaches are using well intended cues that, when over-emphasized, result in the athlete using the ECSS. Cues like “look up,” “sit back on your heels,” or “chest up” during the ascent of a squat might be appropriate sometimes, but often perpetuate the ECSS because

FIGURE 5. POSTERIOR CHAIN

FIGURE 6. WALL SQUAT

they may result in an athlete arching their lower back and elevating their rib cage. When an athlete is consistently cued to lift with such a strategy, that pattern may become more and more difficult to change, at some point even becoming pathological, resulting in injury or decreased performance.

Exercise selection is another example of overemphasis on the posterior chain. Many of the commonly utilized exercises for the lower body are predominantly bilateral posterior chain exercises that force the athlete to move in the sagittal plane and block motion in the coronal or transverse planes. Because of the lack of freedom to move in all three planes, athletes often compensate excessively in the sagittal plane, resulting in a more pronounced ECSS. Back squat, deadlift, Romanian deadlift (RDL), hyperextensions, good mornings, cleans, hang cleans, snatches, hang snatches, and thrusters are just a few examples of exercises commonly used to train the posterior chain.

Another strong example of overemphasis on the posterior chain is the way in which athletes perform lifts. Take for example, the clean. Figure 7 depicts an athlete in a hang clean position (the position in which the athlete has the least mechanical advantage over the weight). In this Figure, the chest of the athlete is elevated and the pelvis is anteriorly tilted (Figure 7). This is the “open scissor” position described previously by Pavel Kolar in which the diaphragm and pelvic floor are oblique to each other. In such a posture, the athlete has no alternative but to stabilize with the ECSS. This athlete may have been told: “keep your chest up,” “sit back on your heels,” or “find your hamstrings.” In any case, the cueing causes the athlete to resort to an ECSS to execute the movement. Instead, the ribs should be held down towards the pelvis (via strong activity of the internal and external obliques), the posterior abdominal wall should expand (demonstrating eccentric activation of the dorsal muscles of the trunk such as the quadratus lumborum and the erector spinae), and the pelvis and spine should be held neutral. An example of this posture can be seen in Figure 8. In this position, the athlete is better able to stabilize the pelvis and spine to generate more force into the floor through the legs, torso, and arms due to increased IAP (4,17).

FIGURE 7. CLEAN ECSS – BAD POSITION

FIGURE 8. CLEAN ECSS – GOOD POSITION

While it seems evident that the posterior chain is often overemphasized, this does not mean that it is unimportant in sports, that these exercises should be avoided at all costs in training, or even that they always perpetuate the ECSS. Proper cueing mixed with some other ECSS-breaking exercises can help to teach the athlete to stabilize properly.

CONCLUSION

Another significant contributing factor that drives athletes into the ECSS is the fact that specific, focused exercise to strengthen the ideal stabilization strategy must be utilized if an athlete is going to be able to maintain proper stabilization at high thresholds. Lifting more weight and more often will not accomplish this goal; it will not increase an athlete's thresholds as discussed above. What is necessary to improve these thresholds is proper threshold training (which involves training an athlete right at the threshold in which they will collapse into the compensatory pattern of the ECSS) and auxiliary exercises specifically tailored to train proper stabilization. Strength and conditioning coaches that temper their posterior chain exercises with some threshold training and specific trunk exercises designed to break the ECSS to restore proper stabilizing strategies may find their athletes will move better, get injured less, and actually perform better. Training is not just about lifting heavy weight. Proper strength and conditioning training involves identifying specific weaknesses in an athlete based on the needs of the sport and addressing them with specific, targeting exercises and programs. This will be the topic of Part 3.

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DRY-LAND STRENGTH AND CONDITIONING FOR PREPUBERTAL AND PERIPUBERTAL SWIMMERS

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INTRODUCTION

Swimming success depends on several factors. The ability to apply in-water force is crucial, particularly in short distances (13,15). Among others methodologies, dry-land strength and conditioning training is a common practice in competitive swimming. There are two main goals in strength and conditioing training: to improve swimming performance and to prevent injuries (2,4,5,8,9,14,16,17). Although training is often recommended to improve strength and power outputs, the swimming community has yet to reach a concensus regarding specific benefits on swim performance. Still, no negative effects on swimming performance were reported in the available literature, to date.

Lack of specificity of strength and conditioning training is one of the main reasons thought to impair results in some of the conducted investigations. Several exercises have been used to mimic in-water movement; the bench press being one of the most commonly applied. Yet, results are not convincing, because in-water movement has particular characteristics that are impossible to replicate in dry-land training, such as water tension and drag (3). For instance, neuromuscular demands are far from similar in both conditions. The more a swimmer mimics an in-water movement in a dry-land condition with resistance, the more the swimmer could be potentially disrupting motor patterns acquired in-water. Thus, in order to promote transferibility of dry-land strength gains to swimming performance, it is suggested to concurrently implement tecnhical swimming training (2). Strength and conditioning coaches should focus on strengthen muscles involved in swimming with the intent of increasing force production and to prevent muscular imbalances, according to each swimmer's needs (4).

The ability to produce a high rate of force developoment is crucial in short distances and decreases as the distance increases. Training with heavy loads (maximal strength) requires low execution velocity and likely is not related with swimming demands, particularly in short-distances bouts. Thus, dry-land training should be performed with a velocity similar to in-water movementss, trying to fulfil similar neuromuscular demands. When adding strength and conditioning training for short-distance swimming, explosiveness should be the main goal. Therefore, it is expected that movement velocity increases specificity of strength and conditioning exercises and overall power output (10).

Previous investigations have focused on older and high-level swimmers. Very few studies have been published regarding prepubertal (before puberty) and peripubertal (during puberty) swimmers. This could be due to ethical issues or unclear information available to coaches, making them skeptical toward strength and conditioning training swimmers in those age groups (3). Nevertheless, dry-land and in-water power outputs and strength have a determinant influence in youth swimming performance (12,13). It is recommended that youth athletes engage in resistance training, not only to enhance health, fitness, and performance, but also to prevent sports-related injuries (6,12). Therefore, it seems reasonable that strength and conditioning can aid performance of prepubertal and peripubertal swimmers. The objective of this article is to provide strength and conditioing coaches with practical training recommendations to improve performance through the addition of a strength and conditioning program to prepubertal and peripubertal swimmers.

TRAINING RECOMMENDATIONS

There are several aspects of strength and conditioning training: type, frequency, intensity, volume, recovery, and progression. The following training recommendations are intended to follow the National Strength and Conditioning Association (NSCA) guidelines, as well as the relevant literature on strength and conditioning training with youth athletes (6,11). Therefore, strength and conditioning training based on power is presented. The strength and conditioning program is designed for six weeks with two sessions per week. After the six weeks of strength and conditioning training, swimmers are allowed a four-week adaptation period. The goal is to allow the transferability of new strength levels acquired in the strength and conditioning training to in-water actions. In this period, swimmers engage in their normal swimming training prescription and cease strength and conditioning training. Prior to the implementation of the strength and conditioning program, a pre-test is recommended to assess each subject's tolerance to the prescribed loads, always maintaining the goal of power-based training.

In each session, a warm-up of about 10 min should be performed. The goal of the warm-up is to elevate body temperature and enhance motor unit excitability. Rope skipping and similar mobilization to strength and conditioning exercises are recommended. Based on previous observations, swimmers should follow a sets/time scheme instead of sets/repetitions for the strength and conditioning program, as seen in Table 1 (1). The goal is to perform the repetitions as rapidly as possible, maintaining high-quality movements. The time spent in each set should approach the time spent in short-distance swimming. Through controlling fatigue, participants should perform a similar number of actions as in swimming competitions, in order to be sport-specific. Rest periods between sets should be calculated by the multiplication of the execution time by four (1,11).

The strength and conditioning training presented consists of five exercises: medicine ball throw down, countermovement box jump, dumbbell fly, Russian twist, and triceps push-ups. The main goal is to workout muscles involved in swimming, especially in front-crawl stroke. It is intended to use bodyweight and materials with easy transportability, aiming to reduce time transporting training equipment. It is recommended that swimmers engage in familiarization sessions to enhance exercise technique before program implementation.

MEDICINE BALL THROW DOWN (FIGURE 1)

Execution: The swimmer starts in an upright position with the medicine ball (1 kg) above their head and the upper limbs fully extended. Then throw the medicine ball to the ground as fast as possible.

Muscle Involvement: pectoralis major, pectoralis minor, anterior deltoid, medial deltoid, serratus anterior, latissimus dorsi, posterior deltoid, teres major, teres minor, and infraspinatus.

FIGURE 1. MEDICINE BALL THROW DOWN (WITH PRIMARY MUSCLES RECRUITED IN RED)

COUNTERMOVEMENT BOX JUMP (FIGURE 2)

Execution: The swimmer starts in an upright position, squats down until the knees are bent at 90 degrees, then immediately jumps vertically as high and fast as possible, landing on the box (30 cm) on both feet at the same time.

Muscle Involvement: rectus femoralis, vastus lateralis, vastus medialis, gluteus medius, gluteus maximus, biceps femoris, semitendinosus, semimembranosus, and gastrocnemius.

DUMBBELL FLY (FIGURE 3)

Execution: The swimmer should lay on the ground and start with the upper limbs in a vertical position holding dumbbells. Then the dumbbells (1.5 kg) should be moved outward and downward, utilizing the minimum distance needed to reach to the ground without contacting it.

Muscle Involvement: pectoralis major, pectoralis minor, anterior deltoid, medial deltoid, trapezius, teres major, teres minor, infraspinatus, rhomboids, posterior deltoid, and triceps brachii.

FIGURE 2. COUNTERMOVEMENT BOX JUMP (WITH PRIMARY MUSCLES RECRUITED IN RED)

FIGURE 3. DUMBBELL FLY (WITH PRIMARY MUSCLES RECRUITED IN RED)

RUSSIAN TWIST (FIGURE 4)

Execution: The swimmer starts in a seated position on the floor with the hands grasping a medicine ball (3 kg) in the front of the chest with the feet off the ground. The ball should be displaced from the one hip to the other in a controlled motion.

Muscle Involvement: rectus abdominis, external oblique, internal oblique, and external oblique.

PUSH-UP (FIGURE 5)

Execution: The swimmer starts with the upper limbs fully extended close to the upper body and in adduction. The swimmer should lower their body until the chest almost touches the floor and return to the initial position by extending the upper limbs. The body must remain in a plank position with the upper limbs close to the upper body during the entire exercise.

Muscle Involvement: pectoralis major, pectoralis minor, anterior deltoid, medial deltoid, posterior deltoid, and triceps brachii.

FIGURE 4. RUSSIAN TWIST (WITH PRIMARY MUSCLES RECRUITED IN RED)

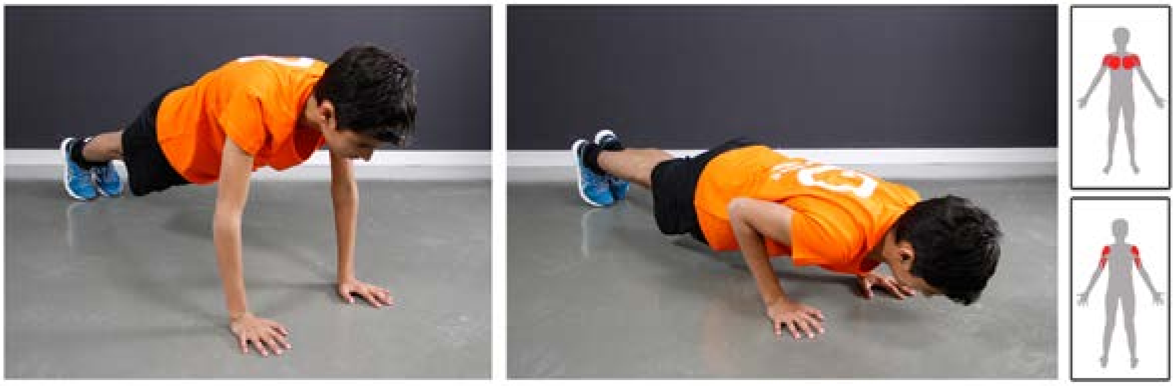

FIGURE 5. PUSH-UP (WITH PRIMARY MUSCLES RECRUITED IN RED)

TABLE 1. SAMPLE SIX-WEEK DRY-LAND STRENGTH AND CONDITIONING TRAINING PROGRAM

EXERCISE	WEEKS 1 AND 2 (RECOVERY TIME)	WEEKS 3 AND 4 (RECOVERY TIME)	WEEKS 5 AND 6 (RECOVERY TIME)
Medicine ball throw down (1 kg)	3 x 15 s (60 s)	3 x 20 s (80 s)	3 x 25 s (100 s)
Countermovement box jump (30 cm)	3 x 15 s (60 s)	3 x 20 s (80 s)	3 x 25 s (100 s)
Dumbbell fly (1.5 kg)	3 x 10 s (60 s)	3 x 15 s (80 s)	3 x 20 s (100 s)
Russian twist (3 kg)	3 x 15 s (60 s)	3 x 20 s (80 s)	3 x 25 s (100 s)
Push-up (bw)	3 x 10 s (60 s)	3 x 15 s (80 s)	3 x 20 s (100 s)

CONCLUSION

The current strength and conditioning program for prepubertal and peripubertal swimmers provides an evidence-based strength and conditioning prescription for youth swimmers that is affordable, portable, and uses minimal equipment. It is imperative that strength and conditioing coaches control swimmers' execution and fatigue in each strength and conditioning session. Additionally, strength and conditioing coaches should apply strength and conditioning programs adjusted to each swimmer's ability to avoid overreaching and prevent injuries. Finally, it is important that strength and conditioing coaches allow swimmers to have a period to adapt to new strength levels acquired in the strength and conditioning program.

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THE ABCS OF LONG-TERM ATHLETIC DEVELOPMENT

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NOT AS EASY AS ABC

Many long-term athletic development (LTAD) models include movement "ABCs" that promote athleticism (1,6). These ABCs of athleticism are intended to be initiated in the early stages of LTAD. These ABCs are basic athletic abilities, namely agility, balance, and coordination (1,11). These categories, however, often involve combinations of fundamental motor skills (which are not fundamental) in order to perform the ABCs proficiently. In other words, youngsters who have not yet developed fundamental movement proficiency in one fundamental movement pattern are being asked to combine fundamental movements instead of focusing on one at a time.

For emerging athletes to move properly and develop athletic skills, they must first develop proficiency in fundamental motor skills (8,10). Seefeldt and Ewing describes the motor skill proficiency barrier as a limitation to developing proficiency in sports and other activities if fundamental motor skill proficiency is not established by age eight (8). While many LTAD models suggest that the ABCs of athleticism be developed by incorporating fundamental motor skill into athletic development, a more explicit approach ensures that youth coaches understand that the fundamental motor skills underpin athletic skills. The ABCs, therefore, must reflect the development of fundamental motor skills first, and specific athletic skills second.

CATEGORIZING FUNDAMENTAL MOTOR SKILLS TO ESTABLISH THE ABCS

To ensure that fundamental motor skills are developed, it is helpful for coaches of youngsters to be able to identify the fundamental motor skills. While there are different ways of identifying and categorizing fundamental motor skills, one of the most common ways to differentiate the 27 fundamental skills is by placing them into the following three categories: body management (which is part of the LTAD ABCs), locomotor skills, and object control (2,9). Table 1 delineates which motor skill corresponds to which category.

THE ABCS OF FUNDAMENTAL MOTOR SKILLS

A novel approach for coaches to be able to link the 27 fundamental motor skills with basic ABCs of movement is through the following ABCs: athletic stance, body management, and cardinal planes of motion.

A IS FOR ATHLETIC STANCE

The ABCs of movement begin with the athletic stance. The athletic stance allows coaches to help young athletes establish the correct fundamental starting position. It also helps children and adolescents understand and recognize where their body segments are in relation to other body parts and in space, which is body management. The basic position for the athletic stance is for athletes to stand with feet hip-width to shoulder-width apart in a quarter squat position. The athlete's bodyweight should be evenly distributed through both feet so that the center of gravity is directly above the base of support. The shoulders should be level (i.e., horizontal) and anterior to the knees, with the torso flat and at a 75 degree incline. The eyes should be focused straight ahead and the chest should be "proud," meaning that a tall (i.e., axial) posture is maintained without hyperextending the lumbar spine.

After getting beginning athletes to understand the athletic stance and how it looks in a variety of sports and activities, the hip hinge pattern can be applied to kettlebell swings, squat patterns, and deadlift patterns. For example, one way to reinforce the athletic

TABLE 1. THE 27 FUNDAMENTAL MOTOR SKILLS DIVIDED INTO THREE CATEGORIES

Balance (dynamic)	Crawling	Bouncing
Balance (static)	Dodging	Catching
Bending	Galloping	Dribbling (feet/hands)
Climbing	Hopping	Kicking
Landing	Jumping (distance/height)	Striking
Rolling	Leaping	Throwing
Stopping	Running	
Stretching	Skipping	
Swinging	Swimming	
Turning	Walking	
Twisting		

stance as the ready position is by having the athletes assume the athletic stance as the "listening stance." To do this, the athlete is instructed to get in the athletic stance while the strength and conditioning coach explains the next exercise or while they are busy working with other athletes if it is a group training setting.

B IS FOR BODY MANAGEMENT

To begin to teach young athletes where their body segments are in relation to each other and in relation to other participants, strength and conditioning coaches can start by having young athletes assume the athletic stance and then ask them to raise their right hand. When doing so, the strength and conditioning coach should have them take note of how that changes their center of gravity (e.g., did their belly button stay centered between their feet?). As examples of body awareness exercises, the strength and conditioning coaches can then ask the athletes: "How can you adjust to keep your balance between the feet?," "How did that affect your center of gravity?," "How much effort does it take to sit and stand?," and "How do you swing your arms without coming into contact with anyone else in the room?"

Body management is one of the three categories of fundamental movement skills (locomotor and object control being the other two) (2). There are three types of movement awareness (9):

1. *Effort Awareness*: How much muscular effort is needed to initiate, sustain, and stop movement? Examples include climbing, lifting relative (bodyweight) and absolute (external load) weight, stopping, and balancing.
2. *Space Awareness*: How much personal or shared space is needed for successful movement? Examples include turning, spinning, and moving with others in a confined space without making contact.
3. *Body Awareness*: How the athlete's body movements relate to other movements around them. Examples include following the leader, raising the arms overhead, and dodging.

Body management skills can be promoted by applying balance, postural control, and equilibrium in a variety of settings using various implements under several different conditions, matching the tenets of physical literacy. Physical literacy is the mastering of fundamental movement skills and fundamental sport skills that permit a child to read his or her environment and make appropriate decisions, allowing him or her to move confidently and with control in a wide range of physical activity situations (12). The concept of physical literacy is very pertinent to LTAD, as physical literacy encourages continued engagement in physical activity throughout the life course (i.e., long term) (5).

C IS FOR CARDINAL PLANES OF MOVEMENT

The "C" in the ABCs of movement is the cardinal planes of movement, which helps strength and conditioning coaches identify in which direction(s) young athletes are moving, what joint(s) of the body are being used, the muscles responsible for the joint actions, and the awareness that strength and conditioning coaches need to program movements in all three planes of motion. Table 2 provides the three cardinal planes of motion, how they are defined in relation to the body, primary joint actions used, and sample movements in that plane.

Movement programming would be easy if athletes moved in only one plane always, but that is most often not the case (3,4). The task for strength and conditioning coaches is to understand how to instruct young athletes on the fundamental movement skills and how to properly progress their movement to include combinations of fundamental motor skills in one and then multiple planes.

TABLE 2. THE CARDINAL PLANES OF MOVEMENT AND MOVEMENT IN EACH PLANE

CARDINAL PLANE OF MOVEMENT	HOW THE PLANE IS DEFINED	PRIMARY JOINT ACTION(S)	SAMPLE MOVEMENTS IN THE PLANE
Sagittal	Divides body in left and right halves Movement occurs primarily forward and back	Flexion (two joints getting closer together) Extension (the return from flexion)	Walking Running Squatting Nodding
Frontal (coronal)	Divides body in front and back halves Movement occurs primarily side-to-side or to the side	Abduction of limb(s) away from the midline of the body Adduction to return from abduction Lateral flexion of head or trunk to one side or the other	Side bends Side steps Arm flapping (airplanes) Putting in golf Pitching a baseball Yoga tree pose
Transverse (horizontal)	Divides body in top and bottom halves Movement occurs primarily across the horizon	Rotation of the trunk, hips, or shoulders	Swinging a bat Twisting Flies Cable rotation

IT IS AS EASY AS ABC

An example of how strength and conditioning coaches can incorporate these skills regularly into sports practice and strength and conditioning programs is to incorporate fundamental motor skills that match or complement the planned sport activities for that day into the warm-up activities. This method is part of an integrative neuromuscular facilitation approach, which incorporates health fitness and skills fitness activities, as well as progressive and/or remedial motor skill activities (7).

Initially, strength and conditioning coaches should focus on having young athletes demonstrate the athletic stance. Once this reference position is well-established, strength and conditioning coaches can progress youngsters to perform single-plane movements that start from the athletic stance. Once the athletes have mastered single-plane movements, strength and conditioning coaches can gradually progress to introducing movements in two planes, and then any combination of planes. The goal for strength and conditioning coaches is to teach movement mastery, which includes physical, cognitive, and proprioceptive components. The goal for young athletes is to demonstrate movement mastery. Strength and conditioning coaches can program balance, both static and dynamic, during single-plane movements using movements that appeal to children's interest in sports and in strength-based exercises. The strength and conditioning coach can build a solid foundation of movement skills through play, exercise, and sports participation. The definition of LTAD should, therefore, be extended as an evidence-based approach to increasing physical literacy throughout the life course by emphasizing the interconnectivity of muscle strength and motor skills in play, sports, physical activity, and physical education. Pre-planned, developmentally-appropriate, and sequential development of fundamental movement skills supports movement mastery (1,2,6,7,8).

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ROLES OF ATHLETIC TRAINERS AND STRENGTH AND CONDITIONING COACHES

P.J. GARDNER, MS, ATC, CSCS

INTRODUCTION

In the complex environment of athletics today, many professionals work together in athletic departments. In any given athletic department, there will usually be athletic directors, head coaches, strength and conditioning coaches, position coaches, physicians, athletic trainers, equipment managers, and administrative personnel. Two of the key people that an injured athlete will communicate with are the strength and conditioning coaches and the athletic trainer. This article will examine the roles of these two professionals in directing an athlete from an injury through the complete rehabilitation program and back to full participation in their sport.

In most high school, college, and professional sport environments, athletic trainers and strength and conditioning coaches work together in their respective athletic departments. Athletic trainers evaluate, treat, and rehabilitate sports injuries. Strength and conditioning coaches develop and implement specific strength and conditioning programs for athletes from a variety of teams. These two professions work closely together after injured athletes have completed rehabilitation from an injury and are progressing towards full participation in a sport training program. After the athletic trainer directs the athlete through the prescribed rehabilitation, he or she can communicate with the strength and conditioning coach to begin a progressive strength training program. The athletic trainer should clearly communicate the extent of the injury and the effectiveness of the rehabilitation, that way the strength and conditioning coach can start the athlete at the appropriate level of conditioning.

There should be a protocol in place that bridges the communication between the athletic trainer and the strength and conditioning coach. This is called a treatment plan and it is individualized for the athlete. The treatment plan should involve an evaluation that includes an assessment of the injury either by the physician or the athletic trainer, or both; recommendations by the athletic trainer for training; and a time frame for the athlete's return to either full or limited participation based on the decision of the physician. This communication should be in writing with all of the parties involved signing off on the treatment plan and acknowledging the input of each of the contributing disciplines. At this point, the strength and conditioning coach can formulate a specific strength and conditioning plan based on the recommendations of the athletic trainer and physician. Clear communication is the key to a successful transition from completion of injury rehabilitation to rejoining the current sport strength and conditioning program.

THE ROLE OF THE ATHLETIC TRAINER

The athletic trainer is responsible for evaluating, treating, and rehabilitating athletic injuries. After evaluation by a physician and treatment of an acute injury, the rehabilitation can begin. Depending on the extent or grade of the injury, it could take days, weeks, or even months. All aspects of the injury are documented and the final release to return-to-play is given by a physician. It should be noted that in some programs, physical therapists are also used for rehabilitation programs. Once the athlete has completed all phases of the rehabilitation and been released to return to their sport for full participation, the athletic trainer and strength and conditioning coach can meet to design the sport-specific training program.

THE ROLE OF THE STRENGTH AND CONDITIONING COACH

The strength and conditioning coach designs and implements the specific strength, speed, and conditioning programs for the athletic teams. The strength and conditioning coach can use the information from the athletic trainer and the injury information from rehabilitation to start the athlete at the appropriate level (e.g., sets, repetitions, number of exercises, total volume) of strength and conditioning. The strength and conditioning coach is then in charge of volume progression from that point on, barring any injury. The strength and conditioning coach should progress the athlete through their various phases of the sport training program as tolerated by the athlete.

INTERIM SPORT TRAINING PHASE WITH DEFICITS

Occasionally, the athlete may have some limiting physical deficits after being released from rehabilitation. Sometimes, there can be minor range of motion (ROM), strength, or power deficits between the end of the official rehabilitation and the start of the strength and conditioning training (1,2). This is a gray area and requires the athletic training staff, medical staff, and strength and conditioning coaches to all communicate the exact deficits an athlete may have when released from rehabilitation. Some examples of deficiencies that the athlete may experience include:

- Active and passive ROM deficits for any joint
- Strength deficit of a specific muscle or group of muscles
- Exercises that may not be done until a later time (e.g., maximum squats, power cleans, or bench press)
    - This is secondary to muscular strength, flexibility, and pain
- Bracing and taping requirements
- Other medical restrictions or conditions

The athletic trainers and strength and conditioning coaches understand that these deficits will decrease as the injury heals and strength and conditioning training progresses (3). This will allow for continued progression of a physical deficit while training other areas in maximal capacity (3). There will be a period of time for a training phase that consists of sport-specific energy system training to further progress the athlete from the last phases of rehabilitation to full participation in the strength and conditioning program. The length of this phase is dependent on the extent or severity of the injury. There is usually a period of time that requires general conditioning for cardiovascular improvements between the end of rehabilitation and the beginning of sport training (3). Usually cardiovascular endurance and speed will decrease during the early rehabilitation phase of a given injury.

CONCLUSION

In all athletic departments, communication is vital for success. In regards to injured athletes, communication between the athletic trainers and strength and conditioning coaches is very important for a full return to sport participation without any restrictions. The athletic trainer's primary role is to evaluate, treat, and rehabilitate sports injuries. The strength and conditioning coach designs and implements sport-specific training programs for teams and includes speed, agility, and conditioning. Various physical deficits may exist after the rehabilitation that need to be taken into consideration for the early phases of strength and conditioning programs. Strength and conditioning coaches need to know and understand the exact deficits in order to start the athlete at the appropriate level of conditioning and progress them accordingly. Injuries will occur at all levels of sport participation and athletic trainers and strength and conditioning coaches need to continue to communicate with each other to safely progress the athlete from an injury and the required rehabilitation to the full recovery and full participation in their sport without any restrictions.

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WINDOWS OF OPTIMAL TRAINABILITY

BEN FLETCHER, MS, CSCS, FMS

There is a theory called the "10-year" rule that states it takes about 10,000 hr of deliberate practice to become an expert in a sport (4). That equates to three hours of practice daily for about nine years. The long-term commitment required to reach elite levels in sport is well known. There are no shortcuts in this process; however, there are ways to maximize the benefits of training youth. Therefore, the focus of this article is to introduce windows of optimal trainability as a way to support long-term athletic success.

WHAT IS TRAINABILITY?

Trainability refers to a period of time in which youth are more susceptible to certain training modalities (2). One approach for describing trainability is to discuss the "five Ss" of training and performance. For the purposes of this article, the "five Ss" include speed, skill, suppleness, stamina, and strength (2). They all have a window of optimal trainability that strength and conditioning coaches should be aware. This is important because athletes who train for speed in the speed window will likely achieve greater results than athletes performing the same training outside of that window (2).

SPEED

The first window of optimal trainability, speed, occurs in the "FUNdamental" stage of the long-term athlete development (LTAD) model. Females aged 6 – 8 and males aged 7 – 9 will have an accelerated adaptation to speed development (2). This window has also been called the agility, quickness, and change of direction window (1). Linear, lateral, and multi-directional speed should be emphasized in this window. From my experience, it is best if the strength and conditioning coach makes it a game for the youth to enjoy to keep them engaged. Repetitions should last no longer than five seconds and the volume should be low. Due to the high intensity of this training, always allow full rest between sets. The focus is on training the central nervous system rather than anaerobic power or capacity.

The second speed window is when anaerobic power and capacity should be emphasized. This window occurs in females aged 11 – 13 and males aged 13 – 16. Balyi et al. suggest energy system training and block loading during this window (2). The repetitions should last 5 – 20 s with low volume. When a strength and conditioning coach creates a training program for youth athletes, it is important that they understand the athletes. The program should be tailored to their habits. From personal experience, incorporating ladder drills or other speed work as part of the warm-up can be successful with youth athletes during this training window.

SKILL

Skill is the next window that occurs in the "learn to train" stage of the LTAD model (2). Females aged 8 – 11 and males aged 9 – 12 are ready to learn fundamental sport skills in this window. During this window, youth have an accelerated adaptation to motor skill and coordination development (1). Balyi et al. suggest this window is the most important for long-term athlete success (2). Jumping, throwing, catching, and other fundamental sport skills are critical for successful participation in a variety of sports. Without a solid foundation for skill learning, learning these skills later in life becomes more difficult (1). After age 12, skill trainability declines, so this window is important in long-term youth athletic development (1). During this window, strength and conditioning coaches should include a wide variety of skills, as specializing too early can potentially lead to negative consequences, such as burnout or overuse injuries (6).

SUPPLENESS

Suppleness, or flexibility, is emphasized across all sports for adults; however, recommendations on flexibility training in youth are not widely discussed. Females and males aged 9 – 12 have an accelerated adaptation to flexibility training (1). Balyi et al. suggest dynamic mobility and static stretching 2 – 3 times per week for improving flexibility (2). It is important to tailor flexibility training toward the sport of the athlete. For example, a football player may not need to be as flexible as a gymnast.

STAMINA

Before puberty, youth improve running form, which reduces the amount of oxygen needed for physical activity (2). During puberty, or the onset of the growth spurt, is typically when VO_2max will be able to greatly improve for boys and girls (2). The stamina window occurs for females aged 12 – 15 and for males aged 14 – 16. To avoid overuse injuries and develop muscular endurance, strength and conditioning coaches should utilize a variety of aerobic activities, such as rowing, cycling, swimming, and running (6). Other recommendations include playing games or designing competitions to build a solid aerobic base, such as ultimate Frisbee. Keep in mind the needs of the sport, because, for example, gymnastics or diving athletes may not require a strong aerobic base, so their training should be more sport-specific and avoid an overemphasis on aerobic training.

STRENGTH

The window of optimal trainability for strength differs from the others. This window is based on biological age. The strength and conditioning coach can measure an athlete's arm span, sitting height, and standing height to determine the onset of the growth spurt and peak height velocity (2). These measurements are crucial in order to determine a youth athlete's window of optimal trainability for strength because everyone matures at different rates. Once the onset of the growth spurt and peak height velocity are determined, then a plan can be created for strength training. Females actually have two optimal strength windows: the first occurs right after peak height velocity and the second is when the menstruation cycle begins (2). Males only have one window, which begins one to one and half years after peak height velocity. It is recommended that strength training occur 2 – 3 times a week for no more than 30 min during this time (1).

CONCLUSION

The "five Ss" of trainability and performance are critical periods of development that all youth strength and conditioning coaches should consider when creating a training program. Coaches should take advantage of each window to maximize a youth athlete's potential and help ensure a long athletic career.

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STEVE HESS, MED, MATS

COACHING PERSPECTIVE

I love what I do. I eat, sleep, and breathe health, and my beautiful wife and kids can attest to that fact. This passion for health not only drives my personal life, but my professional career that I have been blessed to lead. I have been coaching athletes at every level for 31 years and have called the National Basketball Association's (NBA) Denver Nuggets home for 20 of those years. My one objective in writing this article is to show that to truly excel at what you do, there needs to be a burning passion for self-betterment and the betterment of others. I believe coaching with passion and purpose are without a doubt the most vital components of any strength and conditioning program at any level.

This is easily the most important thing there is to know about coaching and life in general. Not only is authoring a piece for the National Strength and Conditioning Association (NSCA) an incredible honor, but it is a perfect outlet to spread the practical knowledge I have attained through my many years. My experience should be treated loosely as a longitudinal case study constructed over 20 years. Coaching with passion is the single key component of each of my programs, which have been consistent throughout my entire career, regardless of who I coach or when I coach them. While the tools of my craft have evolved, my passion has remained the same. My passion for training athletes is without a doubt at the forefront of every session, every time I have the honor of coaching.

Passion can be defined as an intense emotion; it is a deep desire for something, or a compelling enthusiasm. This is exactly how I want all of my training sessions to be described. As our field has advanced, sports science now plays a vital role in every aspect of training and coaching. However, it is imperative to not become over-reliant on it. I feel it can dull our skills as strength and conditioning coaches and harm our ability to coach our athletes. Often, we spend less time assessing our athletes and become too reliant on the results. I am arguing that there needs to be a greater focus on the process. While I absolutely love and utilize many aspects of sports science, I pride myself of being highly passionate and involved in every aspect of each athlete's development process. The majority of my work is dictated to me by what an athlete's body shows me, which proves to be challenging in a team setting because of time constraints. I do not believe in creating a program without seeing the athlete and assessing their strengths and weaknesses first. This gives a much better viewpoint into how to correctly design a program with appropriate progression and regression, ensuring the best results. How could I design a program without considering the athlete's abilities, experience, composition, segments, range availability, and inhibitions as all independent factors within themselves? There are many different ways to coach an athlete, many different routes to take to achieve maximum ability, but without passion and drive, there is no way to adequately accomplish that goal.

PASSION

Passion is a transferable entity that needs to be present in every aspect of life to rub off onto others. Through my years of training athletes, this is the single most important aspect to my approach. The words I use may not be eloquent, but each and every word is carefully chosen to convey the passion my actions exude.

ENERGY

Energy is the strength and vitality required for sustained, strenuous physical or mental activity. It is, in my opinion, the essence of what makes you unique. It is the vitality that you bring to life, it is way beyond what you do. Energy is who you are, so make sure it is authentic. Legitimate energy is easily repeatable and easily communicates your training philosophies. It is important that you have an understanding of your energy so it can be applied consistently. Your energy is individually created by you, so be original, and be true.

ENTHUSIASM

Enthusiasm is to enjoy what you do, and this needs to be present in every aspect of life. Every task in life should be tackled with an enthusiasm unmatched by anyone. When we train athletes, they are the priority, the coach is not. This is a field where the balance of creating optimal performers and finding pleasure is the goal. It is a fact of the business, strength and conditioning coaches are right by their athletes' sides. No matter what happens, whether it is nail-biting wins or crushing losses, the camaraderie must never change. Emotions need to be harnessed and work needs to be done. My philosophy concerning life is if you can do right by yourself and do right by others, happiness is a guarantee. Do what you do with nothing but enthusiasm. Not every day is going to be smooth sailing, but do not let that taint the joy there is in helping someone achieve their best self.

INTENT

Train everyone with intention and create an environment where your athletes want to participate with intent. If the coach exudes focus and passion, so will the athletes. I encourage my athletes to train with intent at all times. This is difficult when coaching in a team setting, but it needs to be accomplished regardless. Everybody needs to find some way to be active in a training session. It is vital that each athlete's training regimen is prescribed according to their individual specifications and is unique to their particular goals. This is ultimately dictated by almost innumerable factors, but the key focus points include the center of mass over base of support, the "what's working, what's stabilizing" conundrum, the manipulation of each of the individual body segments, range of motion, joint requirements, and muscle function, just to name a few.

It is important to understand that structure ultimately dictates function. The coach is fully responsible for every athlete's specifics. The ultimate goal is to train the athlete on such a precise level that performance becomes automatic and everything, including compensation patterns, is functioning at the most optimal level. To perform at this level, I believe there needs to be intention behind the work.

KNOWLEDGE

Knowledge, in this field, is the strength and conditioning coach's best tool in shaping the human body. Both theoretical and practical knowledge is vital to creating a balanced regimen. The human mind is the most important piece of machinery on the planet. Why waste the potential that the mind holds by not constantly trying to cram it with knowledge? Studying what relates to your field often is very important. It is imperative to have a clear grasp of how the body works and how exercise affects the body. With advancements in technology and the growing field of sport science, I believe that strength and conditioning coaches often become too reliant on protocols. Progress is never made doing the same thing over and over. Energy, enthusiasm, intent, and knowledge are all the driving forces behind living a life of passion.

CONCLUSION

Passion, while imperative to training, must be paired with energy, enthusiasm, intention, and knowledge to truly make a difference and create your "sonic boom." Utilizing these skills, while having the ability to be adaptive and creative, puts you in a position to succeed in what I consider the most amazing career on the planet. Being an effective strength and conditioning coach is a lifestyle, not a job, and with continued passion you can affect many lives positively.

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