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WHY YOUR HIGH SCHOOL NEEDS A QUALIFIED STRENGTH AND CONDITIONING PROFESSIONAL

Why Your High School Needs A Qualified Strength and Conditioning Professional

BENEFITS TO THE STUDENTS

1. **Reduce injuries**: A qualified strength and conditioning professional can play a pivotal role in preparing young athletes for sport, and thereby minimize or offset the incidence and severity of sport-related injuries common to young athletes (7,10,16,18,20).

2. **Improve long-term athletic development**: A qualified strength and conditioning professional understands the many variables that go into designing training age-appropriate programs, and can produce more positive results (3,7,11,21).

3. **Improve performance**: Athletes who participate in a well-designed strength and conditioning program may be faster, stronger, more powerful, move more efficiently, and be more athletic than they would be without it (8,9,10,12,25).

4. **Improve confidence**: Athletes who invest time in strength and conditioning tend to develop confidence through desired changes in their body composition, increased physical literacy, and the knowledge that the development that occurred because of their training prepares them for competition (1,17,23).

5. **Improve health**: In addition to increasing muscular strength, power, and endurance, regular participation in a youth resistance training program may positively affect many health- and fitness-related measures and alleviate many adverse health-related conditions (2,9,10,15).

BENEFITS TO THE SCHOOL

1. **Limit liability**: A qualified strength and conditioning professional can help limit a school’s liability and implement procedures that support risk-management (4,15,16,19,24).

2. **Increase professionalism and safety**: For the same reasons schools require a certified athletic trainer to work with their injured athletes or a certified lifeguard on pool decks, a coach who is designing and supervising the strength and conditioning program should be qualified to do so (4,6,24).

3. **Extra coach on staff for all sports**: A strength coach allows the sport coach more time to focus on the day-to-day sport practice schedule, while the strength coach oversees the strength and conditioning of the team (15).

4. **Due diligence**: Demonstrates the school’s due diligence in properly preparing athletes for the physical and mental demands of sport and establishes a greater commitment to injury prevention (22).

5. **Gender equity**: Assists an athletic department with implementing strength and conditioning programs that are gender specific (22).

WHAT IS A QUALIFIED STRENGTH AND CONDITIONING PROFESSIONAL AT THE SECONDARY SCHOOL LEVEL?

1. **Certification**: A qualified strength and conditioning professional should achieve and maintain a professional certification credentialed by an independent accreditation agency—for example, the National Strength and Conditioning Association (NSCA) Certified Strength and Conditioning Specialist® (CSCS®) certification—as well as standard first aid, cardiopulmonary resuscitation (CPR), and automated external defibrillation (AED) (4,6,19).

2. **Education**: A qualified strength and conditioning professional should acquire expertise and have a degree from a regionally accredited college/university in one or more of the “scientific foundations” of strength and conditioning (e.g., exercise science/anatomy, biomechanics, pediatric exercise physiology, nutrition), or in a relevant subject (e.g., exercise/sport pedagogy, psychology, motor learning, training methodology, kinesiology) (11,13,14,15,22).
REFERENCES


INTRODUCTION

In strength and conditioning, the standing hip hinge (athletic position) and the back squat movement pattern are the basis of a large majority of essential exercises (2,9,12,15,17,22,25). The hip hinge is an important movement pattern because it displays competency relative to horizontal directional movement (12,25). For example, the hip hinge occurs when weight is moved from the hip region to the bottom of the knees and back. During the movement, the spine can maintain a natural posture by activating the glutes and hamstrings while establishing a position where the shoulders are over the toes (12,25). During many sporting events, an athlete is required to maintain a bilateral or split stance hip hinge position before the extension of the hips takes place (12,22,25). During the hip hinge movement, forces are applied against the ground to allow extension of the ankles, knees, and hips (12,25). By simultaneously extending the three joints, the athlete can optimally perform movements such as sprinting, jumping, and other movements needed for them to optimally perform in their respective sports (5).

Producing vertical force, to push away from the ground, is critical to many team and individual sports (1,5,9). The squat is essential for training the movement pattern used to create vertical force production (8,19,26,27). During the squat, force must be applied in the vertical direction, occurring when the weight is lowered and the feet are pushed against the ground to return the weight to the starting position (8,19,26,27).

The purpose of this article is to provide practical methods in which progressions for the standing hip hinge and squat may be implemented in the high school strength and conditioning setting. This article will also include a sample exercise program based on personal experience on how the movement patterns are currently implemented into the program. In this article, the strength and conditioning facility used for the development of the athletes is approximately 1,200 sq ft and is equipped with four squat racks, free standing benches, and four in-ground lifting platforms. The athletes also use a gymnasium directly outside of the facility. The equipment available includes barbells, dumbbells, kettlebells, polyvinyl chloride (PVC) pipes, free weights, resistance bands, and medicine balls. Although program development varies based on age and technical proficiency to perform a movement, each athlete involved in the strength and conditioning program is introduced to the progressions mentioned in this article to ensure safety and objectively monitor advancements.

STANDING HIP HINGE (ATHLETIC POSITION)

The standing hip hinge (athletic position) is a movement pattern taught to athletes for the purpose of athletic development (7,22). Before an athlete is taught the hip hinge, the strength and conditioning coach conducts a screening to assess the current ability to perform the movement. To assess whether the athlete has the capability of performing a hip hinge, the athlete is taken through the trunk stability push-up, which is part of the Functional Movement Screen (FMS) (10). During this screening, the coach is looking for core stabilization and ensuring that the athlete is...
not experiencing pain specifically in the spine and/or hips, before participating in the program. Once the movement is screened, if the athlete is unable to execute the movement pattern on their own, they are taught proper technique. During the movement, each athlete is taught these coaching cues: feet on the ground with toes forward, knees relaxed (slightly bent), push the glutes back, keep the ribs down (back neutral), shoulders over the toes, and eyes focused forward (18,22). In the initial training sessions, the goal is to explain the importance of the movement and its application to performance. Specifically, an explanation is given on how the hip hinge allows each athlete to establish the proper position to make a play during competition and its relevance to exercises in the weight room (7,12,22,25).

HIP HINGE PROGRESSION—STICK RDL
When teaching a proper hip hinge, the athlete goes through the following progression: stick Romanian deadlift (RDL), dumbbell or kettlebell RDL, and barbell RDL. During the stick RDL, the athlete is required to use a PVC pipe. With the other RDL movements, the athlete uses the corresponding implement.

PROPER TECHNIQUE
During the stick RDL, the strength and conditioning coach monitors the athletes from the front and the side to ensure that the movement pattern is completed with proper technique. As the stick is lowered, the strength and conditioning coach checks to confirm that the athlete’s knees are slightly bent, the spine is neutral, and the shoulders are over the toes (12,25). Once the athlete has established a position where the stick is directly below the knees he or she holds a brief isometric pause. To complete the movement, the athlete applies force against the ground by firing the hips and the glutes to return to the upright position (12,25).

INSTRUCTION AND FEEDBACK
The detailed instructions used for this exercise include (12,25):

- Lower the stick down the legs to a position directly below the knees
- Keep the shoulders over the toes
- Keep the arms straight
- Keep the head up, chest up, and hips back
- Push through the balls of the feet
- Stand up by firing the hips and glutes

The following abbreviated version of verbal cues are used to communicate with the athletes:

- “Push the hips back”
- “Push through the ground”
- “Fire the glutes”

PRACTICAL IMPLEMENTATIONS AND RECOMMENDATIONS
Common mistakes seen during this exercise are arching or rounding of the back, and overextending the lumbar spine at the conclusion of the lift (25). When any faults are recognized, the strength and conditioning coach repeats the verbal instructions while physically correcting the movement. The strength and conditioning coach may choose to use cues based on the movement qualities of each athlete (26). It is highly recommended that athletes learn to consistently execute the movement before they are allowed to increase the intensity of the movements (23). The progression to the dumbbell RDL allows for an increase in intensity and/or volume, which is determined by the strength and conditioning coach, based on the needs of the specific athlete (23).
FIGURE 3. STICK RDL – START (SIDE VIEW)

HIP HINGE PROGRESSION—DUMBBELL RDL
After the athlete can perform the stick RDL on a consistent basis with little to no flaws, they then may progress to the dumbbell RDL. The dumbbell RDL is taught after the stick RDL because it is the transitional phase between the very minimal resistance of a stick and the 45-lb resistance of the standard barbell. Theoretically, the dumbbell RDL will allow for a small, but progressive overload that will allow the athlete to gradually adapt to the barbell RDL (11,12).

PROPER TECHNIQUE
During the dumbbell RDL, as compared to the stick RDL, the resistance changes, but the technique will remain the same. The primary goal of the athlete is to lower the dumbbells below the knees while keeping the spine neutral, knees slightly bent, and shoulders over the toes (12,25). As the athlete stands, he or she applies force into the ground by activating the hip extensors in order to return to the starting position (12,25).

INSTRUCTION AND FEEDBACK
The detailed instructions used for the exercise include (12,25):
- Lower the dumbbells down the front of the thighs while pushing the glutes back
- Pause for a one second count
- Return to the starting position by firing the hips and glutes

FIGURE 4. STICK RDL – PAUSE (SIDE VIEW)

The instructions for the dumbbell RDL are similar to each RDL movement, with the exception of the dumbbells moving independently of each other. An example of the specific cues used for the dumbbell RDL include:
- “Grasp both dumbbells with an overhand grip”
- “Allow each hand to remain on an even plane with one another”

PRACTICAL IMPLEMENTATIONS AND RECOMMENDATIONS
During the dumbbell RDL, the athlete is required to hold one dumbbell in each hand. Typically, the progression is to change the intensity of the exercise by increasing weight in increments of five pounds with each dumbbell. For example, upon successful completion of the sets and repetitions, the strength and conditioning coach may allow the athlete to transition to the next progression and increase each dumbbell by five pounds (23).
FIGURE 5. DUMBBELL RDL – START (FRONT VIEW)

FIGURE 6. DUMBBELL RDL – PAUSE (FRONT VIEW)

FIGURE 7. DUMBBELL RDL – START (SIDE VIEW)

FIGURE 8. DUMBBELL RDL – PAUSE (SIDE VIEW)
PURPOSE AND METHODS OF THE HIP HINGE AND SQUAT IN HIGH SCHOOL STRENGTH AND CONDITIONING—WITH PERSONAL PERSPECTIVE AND SAMPLE PROGRAM

HIP HINGE PROGRESSION—BARBELL RDL
Once there is an established consistent movement pattern with the dumbbells, the athlete is allowed to continue the progression by moving to the barbell RDL. The barbell RDL is a critical link in this progression because it is the initial exercise taught before learning many common Olympic-style lifts, which are critical to applying efficient hip hinge movement during competition (11,12,14).

PROPER TECHNIQUE
The technique for the barbell RDL follows the same principles as the previous exercises; however, the sole difference is in the instrument used to create the resistance. The primary change is that the athlete is taught specific techniques to grip the bar properly. Upon approaching the bar, the athlete should make sure to grip the bar using an overhand grip slightly wider than shoulder-width apart (25).

INSTRUCTION AND FEEDBACK
The detailed instructions used for the barbell RDL include (12,14,25):
- Lower the barbell down the thighs by using the hips and allowing the arms to relax
- Pause while positioning the barbell directly below the knees at the bottom of the motion
- Activate the hips and glutes to return the bar back to hip level

PRACTICAL IMPLEMENTATIONS AND RECOMMENDATIONS
Similar to the stick RDL and the dumbbell RDL, during the barbell RDL, the strength and conditioning coach should monitor the arching and rounding of the athlete’s back. Athletes are allowed to increase the intensity of the movement based on the approval of the strength and conditioning coach (23). After the barbell RDL becomes an efficient patterned movement, the strength and conditioning coach may choose to add another movement to the barbell RDL to promote simultaneous triple extension of the ankles, knees, and hips. An example of triple extension is the clean pull and its progressions, consisting of the hang clean and power clean (12,25).
SQUAT PROGRESSIONS
Alongside the hip hinge progressions, the squat progression is another staple movement pattern that is commonly used in the field of strength and conditioning (4,15,17,22,24). The squat progression includes three exercises: air squats, goblet squats, and front squats. The intensity of the exercises increases as the athlete is able to learn and complete the movement in an efficient manner for the sets and repetition assigned by the strength and conditioning coach (5,17).

Before an athlete is taught the squat progression, the strength and conditioning coach allows the athlete to perform a bodyweight squat in order to assess the current ability to perform the movement. During the movement, the ankle, knee, and hip joints are the main joints that the strength and conditioning coach should be monitoring (17). Proper ankle mobility is important because it allows for the athlete to balance and control the squat (6,16). During the squat, the ankles are dorsiflexed which allows the feet to maintain a flat and stable position (6,16). Along with the ankles, the hips also support the movement of the squat (21). The hips connect the lower limbs to the pelvis allowing optimal forces to be achieved during the squat (21). The joints located between the ankles and the hips are the knees (3). During the squat, it is important that the knees remain aligned with the hips and the ankles. If this does not take place, the knees are then in a valgus position causing dysfunction and suboptimal transfers of force of the ankle and the hip joints (3,7). The valgus knee position can further lead to tendon and ligament injuries of the lower leg, including anterior cruciate ligament (ACL) ruptures, iliotibial band tendonitis, patellofemoral syndrome, along with a list of other injuries (3,7).

CORRECTIONS BEFORE THE SQUAT
A specific squat correction used to support the mobility and stability of the joints during the squat is the assisted rack squat (ARS). During the ARS, the athlete is instructed to stand in front of or beside the squat rack and grab one side of the rack with both hands and keep the same grip placement throughout. Before descending, the athlete is instructed to keep the toes forward and the head straight. As the athlete descends, he or she pauses at the bottom of the squat position for five seconds while keeping the knees over the toes and heels down. The hands are now above the head and grasping the rack to initiate the stretch in the shoulders and the thoracic spine. To stand up, the athlete pushes through the midfoot and activates the glutes and hips. This movement pattern can be done as part of the warm-up before the squat. Over time, the ARS movement can help assist the athlete in developing the appropriate mechanics to perform the air squat (16).
SQUAT PROGRESSIONS—AIR SQUAT
During the setup for the air squat, athletes are taught the following: feet should be shoulder-width apart, torso should be upright, and arms should stay straight in front of the body (24).

PROPER TECHNIQUE
Once the athlete is taught the setup, they are then taught the proper technique to perform the rest of the exercise. Strength and conditioning coaches should observe the athletes to ensure that they have: a neutral spine with the eyes straight ahead, flexed hips, flexed knees that are over the toes, feet are flat on the ground, and the toes are forward or slightly turned out (17,24).

INSTRUCTION AND FEEDBACK
The detailed instructions used for the exercise include (17,24):
- Unlock the hips and lower the body at a two-second count
- Chest stays up
- Eyes are forward
- Ribs stay down so that the back can stay neutral
- Knees are apart and over the toes
- Once the hips are slightly below the knees, pause for a one-second count
- Push through the balls of the feet to stand with activated glutes

The following abbreviated version of verbal cues are used to communicate with the athletes:
- “Sit down slowly”
- “Look forward”
- “Keep the knees out, pause, and drive up”

PRACTICAL IMPLEMENTATIONS AND RECOMMENDATIONS
The progression to the air squat is to increase the intensity while continuing to demonstrate proper technique. The main benchmark used in the progression from air squat to goblet squat is the athlete’s ability to perform quality repetitions (10). Quality can be defined as the athletes’ ability to squat at or below 90 degrees of knee flexion while being able to control the movements through the entire range of motion (10). Once this is accomplished, the athlete may then start the next step in the progression of the squat pattern.
SQUAT PROGRESSION—GOBLET SQUAT

PROPER TECHNIQUE

The goblet squat is the next progression following the air squats. Typically, the athlete is taught to hold the kettlebell by the bell portion, with the hook turned down perpendicular with the chest; however, the strength and conditioning coach has the option to manipulate this based on individual capabilities (15). During the positioning of the kettlebell, the athlete must make sure that the bell is at chin level and the elbows are close to the ribs (15). Once the athlete has established the proper technique for holding the kettlebell, he or she will then perform the same patterned movements as noted in the air squats (15,17).

INSTRUCTION AND FEEDBACK

For consistency, during the squat pattern, the same instructions are used for both the goblet and air squats (15,17). The difference in the two exercises is that the goblet squat involves holding a kettlebell and the air squat does not. By positioning the kettlebell properly during the squat, the athlete is able to better support the weight of the kettlebell with the hands and arms (15). The detailed instructions used for the exercise include:

• Position the elbows inside the knees and close to the ribs
• Lower the body in a controlled manner before pausing and returning to the starting position

PRACTICAL IMPLEMENTATIONS AND RECOMMENDATIONS

The progression of intensity commonly used during the goblet squat starts with the 8-kg (17.6-lb) kettlebell, then the 12-kg (26.5-lb) and 16-kg (35.3-lb) kettlebell, and culminates with the 20-kg (44.1-lb) kettlebell. The 20-kg kettlebell is the standard due to the fact that the size of a common barbell is also 20-kg. Once the athlete is able to perform the appropriate sets and repetitions established by the strength and conditioning coach using the 20-kg kettlebell with technical proficiency, he or she is then progressed to the front squat (1,11).
SQUAT PROGRESSION—FRONT SQUAT
PROPER TECHNIQUE
The front squat shares similarities, but is slightly different from, the goblet squat and the air squat (15,17). Unlike the previous squat exercises, the athlete uses a barbell as the instrument of resistance. Because the barbell is resting on j-hooks in a racked position, emphasis is placed on properly unracking and positioning the bar to begin the exercise (4). The athlete approaches the bar and positions the feet and shoulders directly under it (4). The barbell is positioned across the chest while resting on the anterior deltoids and the clavicle, the elbows are flexed with the upper arms parallel to the floor, and the wrists are hyperextended with palms facing the ceiling (1,4). The grip is equal to the width of the shoulders or at a position in which the athlete is most comfortable. The athlete then takes one step back with each foot and repositions the feet to shoulder-width apart (4). Once the athlete is in place, he or she will perform the front squat by flexing the hips and knees while keeping the back neutral and allowing the elbows to stay up (4,17). The athlete then pauses at the bottom of the movement before applying force into the ground to return to the starting position (4,17).

PRACTICAL IMPLEMENTATIONS AND RECOMMENDATIONS
Since there are differences between the three squats mentioned, specific instructions of the front squats are used to teach proper technique (1,15,17). The detailed instructions used for the exercise include (17):
• Position the body under the bar and unrack it from the resting place
• Once the bar is in position, lower the body in a controlled manner
• Keep the back neutral and allow the knees to track over the toes
• Come to a brief one-second pause after lowering the barbell
• Apply force into the ground to return to the starting position

The abbreviated verbal cues used to communicate with the athletes include (17):
• “Elbows up”
• “Lower the body slowly”
• “Pause at the bottom of the squat”
• “Drive up to return to the starting position”

IMPLEMENTATION AND RECOMMENDATION
When programming exercises into a strength and conditioning plan, the strength and conditioning coach typically sets standards that each athlete must meet before progressing to other exercises (23). After being able to perform front squats by using only the bar, it is important that the strength and conditioning coach gradually increases the intensity and/or volume (23). Gradual increases in training volume and/or intensity allows for the athlete to reduce the likelihood of injury due to overtraining and the athlete is more likely to continue to develop in the program (14,19,23).
FIGURE 23. FRONT SQUAT – START (FRONT VIEW)

FIGURE 24. FRONT SQUAT – PAUSE (FRONT VIEW)

FIGURE 25. FRONT SQUAT – START (SIDE VIEW)

FIGURE 26. FRONT SQUAT – PAUSE (SIDE VIEW)
SAMPLE PROGRAM FOR THE HINGE AND SQUAT
When an athlete enters the strength and conditioning program for the first time it is the strength and conditioning coach’s duty to screen and assess the hinge and squat pattern, along with other movement patterns. There have been instances where athletes are allowed to progress through both the hinge and squat patterns, leading up to the front squat and hip hinge within two weeks because they possessed the technical proficiency and relative strength to do so. Contrary to that situation, there are instances where athletes do not possess either the strength or technical proficiency to progress the movement until four weeks or sometimes longer. There is not a definitive timeframe on how long it may take for athletes to learn and complete the movement progressions. The strength and conditioning coach should allow the athletes to become comfortable and proficient with the movements before they are allowed to progress. Typically, the athletes are excited to progress and they are allowed to understand the importance of progressing in a safe manner. The progressions, in this article, are not concrete and many coaches may use what works best for their unique situation.

Along with the personal perspective, a sample program is provided below. This simplified program spans over a period of eight weeks and it is written for the squat and hinge. In this scenario, the athletes are new to the strength and conditioning program and they are training for the first time. The consideration is that the athletes are high school freshmen who are training four days per week on Monday, Tuesday, Thursday, and Friday. Within the four-day timeframe, the athletes are training both the squat and the hinge twice, on alternating days. The exercise progressions used are the: air squat, goblet squat, front squat, stick RDL, dumbbell RDL, and the barbell RDL (Table 1).

CONCLUSION
The hip hinge and squat exercises, and their variations, are used in many strength and conditioning programs to develop athletes of many sports (2,9,12,15,17,22,23,25). Before any exercises are prescribed, it is important that the strength and conditioning coach screens the athletes to determine any limitations that may exist (19). Then, the strength and conditioning coach may progress the athletes in an appropriate manner (23). The listed progressions are examples of practical implications used to develop athletes, but there may be additional practical and effective methods used by strength and conditioning coaches for similar purposes. Besides the exercises selected, sets and repetitions of each exercise are determined by the strength and conditioning coach based on a needs analysis of the athletes (13,19,23). The ultimate goal of developing a program for the athletes is to allow increases in confidence, strength, speed, balance, coordination, and motor development while ensuring that they are performing in a technically proficient manner (13,20,23).

TABLE 1. SAMPLE 8-WEEK HINGE AND SQUAT PROGRESSION PROGRAM

<table>
<thead>
<tr>
<th>MONDAY/THURSDAY</th>
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<tbody>
<tr>
<td><strong>Week 1</strong></td>
<td></td>
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<tr>
<td>Air Squat</td>
<td>Stick RDL</td>
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<tr>
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</tr>
<tr>
<td><strong>Week 3</strong></td>
<td></td>
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<tr>
<td>Goblet Squat (12 kg)</td>
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<tr>
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<td>Sets/Reps: 3 x 12</td>
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<tr>
<td><strong>Week 4</strong></td>
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<tr>
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<td><strong>Week 5</strong></td>
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<td><strong>Week 7</strong></td>
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<td>Front Squat (45-lb bar)</td>
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REFERENCES


ABOUT THE AUTHOR

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Trunk stabilization or “core” stability is a topic discussed by virtually everyone in strength and conditioning, and yet much confusion still exists about the pervasive topic. Spinal stability is important, but the exact mechanics and anatomy of stabilization are more often glossed over and referenced in obscurity than discussed in detail. Given the importance and pervasiveness of spinal stability in sports and training, a sound understanding of the detailed mechanics and anatomy of stability are paramount to effective training. In this article, part one of a four-part series, the focus will be on providing a detailed analysis of the mechanics and anatomy of stabilization. In the subsequent three articles, the focus will shift to clarifying aspects of spinal stability as they pertain to function, training, and weightlifting.

Muscles generate force by pulling. When a muscle contracts, the attachment points move towards each other (sometimes one end moves more than the other and sometimes both ends move evenly). When this occurs, the muscle shortens, creating a “pulling” force onto whatever it is attached. Whether open or closed-chain; eccentric or concentric; isotonic, isometric, or isokinetic, a muscle must have a stable point from which it can generate force to function effectively. In the body, an important stable point is the spine. Most movement in sports and competition is preceded by activation of the spinal stabilizers (3,4,5,9). Without such activation, movement as complex as throwing a javelin to as simple as picking up a weight plate would not be possible.

Stabilization is a complex, continuous, and instantaneous neuro-mechanical process that requires the analysis of a massive amount of sensory-motor information (e.g., tactile, proprioceptive, vestibular, visual) to dictate bodily movements (6). This process is so fast and so complex that the central nervous system must use virtually all of its components (e.g., spinal cord, brain stem, sub-cortex, and cerebral cortex) to maintain stability for movement and function (6). In sports, perhaps more than any other time in our lives, we depend on and challenge our body’s limits of stability. So what is stability?

DEFINITION OF STABILITY

Stability is the ability to maintain a desired position (static stability) or movement (dynamic stability) despite motion, force, or control disturbances (12). For the purpose of this article, stability can be thought of as the ability to resist unwanted change in position or motion. In regards to static objects, those that require more force to move (either because of better structural integrity [i.e., lower center of mass and/or wider base of support] or from shear mass [inertia]) are more stable. For example, in Figure 1, Triangle A is more stable than Triangle B because it has both a wider base of support and its center of mass is closer to the ground, making it more difficult for an external force to tip it over. The body, however, is a dynamic object whose stability must also be dynamic. We are not simply talking about maintaining a static position (in most cases). In sports, we are asking our brains and our bodies to stabilize and maintain positions and/or movements simultaneously as we execute complex tasks such as hitting a forehand with a racket while running laterally in a tennis match (Figure 2). In this example, the player must stabilize with his left foot, knee, and hip so that he is able to rotate his trunk to strike the moving ball with precision; all as he manages his own momentum and tracks the path of the opposing player.
Much of the body’s stability depends on the stability of each joint within the body, especially those along the kinetic chain supporting the execution of the movement. If each joint is able to maintain the desired joint positioning or path, then the entire movement should also be stable and produce the desired results. When you consider the complexity of the movements seen in weightlifting (i.e., hang squat snatch) or in other sports (i.e., executing a slap shot in hockey while balancing on one skate), maintaining proper positioning or “stability” is a rather daunting task.

The foundation or “keystone” of stabilization of the body is pressure within the abdomen, or as it is commonly called intra-abdominal pressure (IAP). This pressure stabilizes the spine, pelvis, and ribcage, creating a solid fixed point from which muscles can pull in order to create, control, or even prevent movement. The amount of pressure in the abdomen at any given moment is dependent on the stability requirements for the task being executed (2,3,4,8,9). If the force output for the task is small (e.g., sitting on a couch) then the IAP will be minimal. If, however, the task is very demanding and the force output is high (e.g., attempting a one-repetition maximum [1RM] deadlift) then the IAP must be elevated (2,4,8,9). The amount of pressure in the abdomen is regulated constantly to meet the demands of the movement being executed. Researchers have demonstrated in multiple studies the occurrence of subconscious stabilization of the trunk for movement (2,3,8,9). Powerlifting and Olympic-style weightlifting are slightly different from other sports because athletes often consciously focus on bracing or stabilizing prior to initiating movement. Whereas in other sports, like tennis, basketball, or marathon running, stabilization is a complex process running in the background as the athlete focuses on external tasks. In each of these cases, the brain must continuously work to regulate IAP to preserve spinal stability for movement and function, regardless of its complexity or stability requirements. An appropriate question to now pose is, “how is this pressure generated?”

**MECHANICS OF STABILIZATION**

Pressure and volume are inversely related, so to increase or decrease the pressure within a container, without changing the contents or having a significant change in temperature, involves altering its volume. In sports and in resistance training, or in regards to spinal stability, this concept applies to the abdomen. If we want to increase the pressure within the abdomen, we need to decrease the volume. Therefore, the more IAP required for execution of a task, the smaller the intra-abdominal volume (IAV) must be.

In its simplest form, the abdominal cavity (or container) is comprised of both static and dynamic, non-contractile and contractile components. Static structures are mostly rigid and cannot actively change shape or length without external force. Static structures in the body typically include bones, cartilage, and most ligaments. In the abdomen, static structures include the pelvis, spine, and ribcage. Dynamic structures, on the other hand, typically refer to muscle and can change shape, shorten, and generate force. The dynamic structures in the thorax involved directly with stabilization include the thoracic diaphragm, the abdominal wall (external oblique, internal oblique, and the transverse abdominis), the quadratus lumborum (QL), erector spinae, the thoracolumbar fascia, and the pelvic floor (Figure 3). All of these structures work together to control IAV and therefore IAP to meet the stability demands of a task (3,7).
THE DIAPHRAGM’S ROLE IN STABILITY

The initiating event in generating IAP (particularly in resistance training) is concentric contraction of the diaphragm (7). The work of Pavel Kolar, physical therapist of the Prague School of Rehabilitation, has looked at the diaphragm’s role in stabilization. Understandably, the focus was on the superficial (more visible) muscles like the erector spinae or the abdominal wall (namely the transvers abdominis). The superficial structures obviously play a vital role in stabilization, but they do not represent the full stabilization system.

The diaphragm is a dome shaped muscle comprised of a flat, horizontally-oriented, non-contractile central tendon surrounded by vertically oriented muscle fibers (Figure 4). Attaching to the lower four ribs and the spine at the thoracolumbar junction, the diaphragm sits in the torso with the central tendon located around the level of the xiphoid process (at the bottom of the sternum), separating the thoracic cavity from the abdominal cavity (1,13). When assuming proper postural alignment (which should be maintained in most weightlifting and resistance training movements) the diaphragm concentrically contracts and the central tendon is pulled towards the pelvis (7,13). This action compresses the fluid, tissue, gas, and other contents in the abdomen, creating an outward-pushing force that pushes into and eccentrically activates the abdominal wall, pelvic floor, and posterior stabilizers (erector spinae, quadratus lumborum, and thoracolumbar fascia) (7). It is important to understand that the abdominal wall, pelvic floor, and back musculature should be eccentrically activated in response to the outward-pushing force created by the diaphragm approximating with the pelvis. These structures will often concentrically activate to stabilize the trunk (i.e., drawing the belly inward via concentric contraction of the transversus abdominis [“hollowing"] or arching the lower back with concentric contraction of the spinal erectors). Concentric activation of these structures blocks full movement of the diaphragm, distorts posture, and prevents optimal generation of IAP (7). This topic will be discussed in detail in Part 2.

As the central tendon of the diaphragm drops towards the pelvis and the contents of the abdomen are pushed into the abdominal wall, the brain has a choice: allow the abdominal wall (including the posterior structures such as the erector spinae) and the pelvic floor to expand or increase contractile activity of these structures to resist this outward-pushing force. This choice depends on the stability demands of the movement being executed. If the demand is low (e.g., laying on the floor after a difficult workout), then the abdominal wall will allow the abdomen to expand to preserve IAV at the necessary level to maintain proper IAP. If, however, the demand is high (e.g., an athlete in the bottom position of a 1,000-lb back squat), then the abdominal wall will increase contractility to minimize lengthening and work with the descending diaphragm to shrink the IAV as small as necessary to generate the proper amount of IAP (Figure 5).

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**FIGURE 4. DIAPHRAGM**

**FIGURE 5. PRESSURE IN THE ABDOMEN**
Another major contributor to spinal stabilization is the thoracolumbar fascia, which is a large diamond shaped piece of fascia on top of the lower back (Figure 6). The thoracolumbar fascia relates to stabilization in that it blends with virtually every contractile and non-contractile structure in the area including erector spinae, latissimus dorsi, external oblique, internal oblique, transverse abdominis, and the serratus posterior inferior, in addition to the pelvis, lumbar spine, and even the lower ribs (13). As the central tendon of the diaphragm descends and the abdominal wall reacts to regulate IAP, two things happen: 1) the outward-pushing IAP increases, pushing not only forwards but posteriorly into the lumbar spine, and 2) the increasing IAP results from and causes increased tension in the abdominal wall. Because the thoracolumbar fascia blends with the abdominal wall, increasing tension in the abdominal wall causes an increase in tension of the thoracolumbar fascia. Essential to this process is the fact that the thoracolumbar fascia attaches to the posterior aspect of the spine, creating a facial sling (Figure 6) (13). This sling traps the spine between the posterior-pushing IAP and the anterior-pulling force of the thoracolumbar fascia (Figure 7). The thoracolumbar fascia essentially blocks and locks the lumbar spine in a neutral position against the IAP in a way that does not increase axial compression (squishing) of the spine and requires minimal activity of the spinal erectors.

In order for the stabilization process to occur properly (Figure 8), the thoracic diaphragm and pelvic floor must be positioned parallel to each other (7). In this position, the thoracic spine will have a mild kyphosis, the ribcage will be down with the sternum vertically oriented, the lumbar spine will have a gentle lordosis, and the pelvis will be in a neutral position. When the central tendon of the diaphragm is horizontally oriented, the body is able to efficiently and effectively generate IAP. Since the diaphragm is a dome shaped muscle with the muscle fibers vertically oriented around the central tendon, concentric action of the diaphragm will pull the central tendon directly towards the pelvis, maximizing change in IAV. If the diaphragm is oblique to the pelvic floor (e.g., the ribcage is elevated) then concentric contraction of the diaphragm will move the central tendon more anteriorly (forwards) than downward, towards the pelvis. Malpositioning of the diaphragm prohibits significant change in IAV, which may result in an inadequate amount of IAP for the task being executed (i.e., pulling a 1RM deadlift off the floor), and forcing the athlete to use less efficient, compensatory stabilizing strategies. This will be elaborated upon in Part 2.
Maintaining the diaphragm in horizontal orientation is no easy task; it requires activation of the abdominal obliques (external oblique [EO] and internal oblique [IO]). In addition to working with the diaphragm and pelvic floor to regulate IAV, the abdominal obliques are responsible for pulling the ribcage into a downward position to maintain proper orientation of the diaphragm. Without activation of the abdominal obliques, activation of the diaphragm and pectoralis muscles will pull the ribcage upward, creating obliquity between the diaphragm and pelvic floor. Such positioning is not ideal may prohibit optimal performance in training and in sport.

In addition to helping regulate IAV and pulling the ribcage into a downward position, the abdominal wall is also responsible for stabilizing the costal (rib) insertions of the diaphragm. As mentioned above, the diaphragm attaches to the spine at the thoracolumbar junction and to the lower four ribs (Figure 4) (13). Structurally, the spine is a naturally stable insertion point; the ribs, however, are not. They require considerable muscular activity to stabilize. When the abdominal wall is functioning correctly and the diaphragm is in proper position, the full circumference of the diaphragm’s muscle fibers will work together to pull the central tendon directly toward the pelvic floor. If the abdominal wall is not working properly, then the insertion of the costal fibers of the diaphragm will be unstable, resulting in inefficient activation of the costal fibers of the diaphragm and/or the contraction of the costal fibers of the diaphragm, which will elevate the ribcage. If the ribs are not properly stabilized by the abdominal wall, then the diaphragm will drop toward its spinal insertion, which causes elevation of the ribcage (7). As identified, a muscle will always approximate towards the most stable insertion.

SUMMARY OF KEY POINTS
In summary, proper stabilization of the spine and pelvis centers on generating pressure within the abdomen. It is the diaphragm, pelvic floor, abdominal wall, and dorsal erectors (namely the quadratus lumbarum, the erector spinae, and the thoracolumbar fascia) that work together to regulate IAV to achieve the necessary IAP to meet the demands of whatever movement the body is executing. To optimize our ability to generate IAP, we need the diaphragm and pelvic floor to be parallel to each other. This requires considerable activation of the abdominal wall to maintain proper positioning of the ribcage and to stabilize the costal fibers of the diaphragm necessary for maximal and efficient force output of the diaphragm.

IMPLICATIONS IN STRENGTH TRAINING—BRACING
So how does this understanding of stabilization affect training? First, it changes the way in which we consciously stabilize the spine and pelvis for a lift or movement. We know now that when preparing for a maximal (or even sub-maximal) lift, “bracing” or “tightening up the core” should focus on generating IAP instead of concentric contraction of the abdominal wall (“abdominal hollowing”) or the erector spinae, pulling the pelvis into an anterior pelvic tilt. This enables us to better cue and coach our athletes to stabilize for training. It is important to note that generating maximal amounts of IAP (via the Valsalva maneuver) should only be done for short periods of time—one should breathe between each repetition. Generating maximal levels of IAP elevates blood pressure significantly (2,10).

BRACING FOR A LIFT—USING THE SQUAT AS AN EXAMPLE
1. Breathe into (pressurize) the abdomen. Concentric contraction of the diaphragm creates an outward-pushing force, which eccentrically activates the abdominal wall and pelvic floor. This is actually rather difficult. Many people are “chest-breathers” and struggle with activation of the diaphragm, which is necessary for both abdominal breathing and generating IAP. These individuals will elevate the ribcage as they breathe in, which does not increase IAP optimally. Specific exercises are often necessary to teach athletes how to breathe into their abdomens.
2. Without expiring, activate the abdominal wall and pull the ribs downward into a caudal position. This ensures that the diaphragm is positioned properly and the abdominal wall is adequately activated. It is important to note that expiration should not occur at this time because expiration elevates the central tendon of the diaphragm, causing an increase in IAV and, therefore, a reduction in IAP (remember, pressure and volume are inversely related). For this, we need full activation of both the abdominal wall and the diaphragm, not just the abdominal wall. I must also emphasize that bringing the ribs into a caudal position should happen without any spinal flexion. Often, because athletes struggle with separating rib motion from spinal motion, in an attempt to pull the ribs downward, they will flex the spine instead of downwardly rotating the costovertebral joints (the joints where the ribs meet the spine). Flexion of the spine gets the ribs into a downward orientation (approximates them with the pelvis), but it does so at the cost of proper and safe spinal positioning. As mentioned above, for both performance and safety, the entire spine from the skull to the pelvis should be in a neutral position throughout the bracing process and the movement.
3. Once the abdomen has been pressurized and the ribs pulled downward, the athlete is properly stabilized and can begin the movement. In most pressing exercises (particularly in the squat) the transition position between the eccentric and concentric phases is the weakest position in the entire movement. This weakness is the result of an increase in torque output necessary to maintain or move through the position secondary to increasingly longer moment arms acting on the body. In Figure 9, you can see how much longer the moment arm acting on the hip is at the bottom of the squat (right) compared to the top of the squat (left).
4. As the athlete completes the transition and moves through the concentric portion of the lift, he or she can slowly expire through pursed lips (or through the common yell) to reduce the magnitude of the brace (via elevation of the diaphragm). The athlete is able to lighten up the brace as he or she continues through the concentric phase of the lift because the leverage over the resistance improves (the length of the moment arms decreases) (Figure 9).

5. Athletes attempting a maximal double, triple, or even sets of five, should breathe out at the top of the movement and breathe in again, setting for the subsequent repetition. Athletes often do this without intent when they break up their heavy sets into singles. This allows the athlete to breathe in between sets and brace properly for each repetition.

6. For loads that do not require intense bracing (i.e., sets with a relative intensity less than 85% or longer sets, greater than six repetitions), the athlete should maintain respiration throughout most of the movement other than perhaps the transition. To stay with the squat as an example, athletes should maintain respiration on the descent until they reach a depth which they will need to brace temporarily (increase IAP) through the transition until they begin the concentric portion and can resume breathing again. Because of the increased torque demands, athletes will often feel an involuntary increase in the intensity of their brace (more IAP, more abdominal activation), even without focusing on it as they descend. This is the sub-cortex regulating the IAP to meet the demands of the task (3,4,5,9).

**CONCLUSION**

In both training and sport, we must remember that movement is preceded by stabilization of the spine (2,3,4,5,8,9). In this article we have covered the anatomy and mechanics of spinal stabilization and how to properly brace for both maximal and sub-maximal lifts. Because of the forces that are generated by and transmitted through the body during resistance training, having a sound understanding of stabilization is paramount for safe and effective training. Part 2 of this four-part series will cover a common compensatory stabilizing strategy that I call the Extension/Compression Stabilizing Strategy. This stabilization strategy is endemic in the weightlifting population. We will also discuss how this new understanding of stabilization and posture affects weightlifting technique and training.

*Richard Ulm will be presenting on this topic at this year’s 2017 NSCA National Conference in Las Vegas, NV on Thursday, July 13 at 8:30 a.m. and then will do a follow-up workshop later in the day with Drew Dillon at 2:00 p.m. to cover auxiliary exercises to improve spinal stability and technique.*

**REFERENCES**


**ABOUT THE AUTHOR**
Currently the owner and treating physician at the Columbus Chiropractic and Rehabilitation Center in Dublin, OH, Richard Ulm works with a wide variety of patients ranging from professional athletes to those trying to avoid serious surgery. Prior to becoming a chiropractic physician, Ulm competed on a national level in track and field for many years (2004 and 2008 Olympic Team Trials qualifier), and was a Division I strength coach in the National Collegiate Athletic Association (NCAA). Ulm is an international instructor of Dynamic Neuromuscular Stabilization (DNS) for the Prague School of Rehabilitation and is a certified DNS Exercise Trainer (DNSET). He is also the creator of Athlete Enhancement, an organization through which he teaches seminars and clinics on weightlifting, rehabilitation, and manual therapy to strength coaches, physicians, physical therapists, and chiropractors all over the country.
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Transfer of training to athletic competition remains one of the ultimate goals of all strength and conditioning coaches. Performance improvement, regardless of the skill, is ultimately determined by adaptation. Simply put, in order to improve any skill or performance quality, an athlete must be exposed to that stimulus, or stressor, and adapt appropriately. The key to performance improvement is continued adaptation to the stress, or stimulus, and the timely removal of that stress for recovery before reapplication of an increased stress, often termed progressive overload (5). If the training completed does not cumulatively improve performance, or stress a specific skill required on the competition field to a high enough degree, training time may be wasted and optimal performance may never be achieved. Transfer of training is achieved through many methods that are implemented throughout an annual program. Appropriate exercise selection, as well as implementation, is essential for performance improvement to be realized.

The sport of lacrosse, like the majority of athletic competitions, requires rapid changes of direction, sprinting, and transfer of force through the kinetic chain, all of which must be reactive in multiple planes of direction. These are just a few of the physical requirements of lacrosse. However, they must be specifically improved in order for performance enhancements to be realized to the greatest extent.

Performance improvement can be accomplished in the weight room through the improvement of specific physical parameters, or training adaptations. These include the ability to rapidly and safely decelerate, the ability to produce peak power levels, and the ability to accomplish each of these in multiple planes of motion. It should be noted that these are just a handful of the possible adaptations that can be improved through training, and there are many other skills required to be successful in competition. Keeping the parameters required for performance in mind, selected exercises must target desired adaptations based on the athlete’s sport.

The jump to hop, or “JOP” Matrix, allows the training of multiple physical variables/movements with a single exercise; thus, it has potential utility as an exercise that could benefit the training of lacrosse players. The JOP Matrix is described as a jump into a hop, which means it is completed using a double-leg jump followed by a single-leg landing. This JOP is then completed in each of the three planes of motion: sagittal, frontal, and transverse. By completing this exercise in all three planes of motion, a strength and conditioning coach is able to determine whether or not athletes are capable of producing and absorbing force in all planes, which are commonly experienced during competition.

The JOP Matrix is composed of three different explosive jumps with single-leg landings. This exercise is capable of not only being progressed, but also regressed, based on an athlete’s needs. A youth athlete can begin with only the vertical component of the jump and then add the movement (forward, lateral, or rotational) as they become capable of decelerating safely. Each movement
within the JOP Matrix is demonstrated in Figures 1 – 3. Arrows are utilized to display the direction of the movement, with the solid athlete depicting the start position and the faded athlete depicting the final position.

**FIGURE 1. THE JOP MATRIX MOVEMENT – SAGITTAL PLANE**

The athlete jumps forward as far as possible while maintaining control and then sticks the landing on a single leg. The athletic, controlled position upon landing is critical for appropriate force absorption.

**FIGURE 2. THE JOP MATRIX MOVEMENT – FRONTAL PLANE**

The athlete jumps laterally as far as possible, sticking the landing on the outside leg. Once again, coaching appropriate landing position is crucial for force absorption.

**FIGURE 3. THE JOP MATRIX MOVEMENT – TRANSVERSE PLANE**

In this jump, the athlete completes a 90-degree turn and sticks the landing on the outside leg. Appropriate takeoff and landing cues should be utilized for optimal force production and absorption.

During the JOP Matrix, an athlete can begin in the same square, or area, for each of the jumps. They will begin with the forward JOP (sagittal plane) for the prescribed number of repetitions on a single leg (right, for example), and walk back to the starting position for each repetition. The athlete will then continue to use the right leg and complete the lateral JOP (frontal plane) for the prescribed number of repetitions, returning to the starting position after each repetition. Finally, the athlete will complete the rotational JOP (transverse plane) on the right leg, jumping as far as possible before sticking the landing on a single leg and absorbing the produced force. By returning to the starting position with each repetition, an athlete is able to set goals for improvement based on how much distance they are able to cover while remaining in control of their body and decelerating on a single leg, as is commonly required in competition.

The sport of lacrosse, like many athletic competitions, requires rapid change of direction, sprinting, and transfer of force. These movements require rapid eccentric to concentric muscle actions and in multiple planes of direction. When considering the physical performance requirements of lacrosse, the JOP Matrix improves an athlete’s ability to safely decelerate and stabilize on a single leg upon landing. As sports are primarily played in this single-leg fashion, this exercise matches that need and requires an athlete to rapidly absorb, and produce high levels of force through a single leg. This ability to quickly decelerate is affected by one’s rate of force absorption (RFA). Rate of force development (RFD) (i.e., the ability to produce force rapidly) receives the majority of attention in training but RFA is critical to sports performance, more specifically lacrosse, because athletes are constantly required to absorb and overcome forces. If an athlete’s RFA is inadequate, he or she may not have the ability to decelerate properly, and the likelihood of injury is dramatically increased (3,6).
As all coaches for lacrosse are aware, the game is played at extremely high velocities; therefore, speed is a critical component to improve and transfer onto the field. This ties back to the RFD concept introduced earlier. RFD becomes important in the sport of lacrosse due to the limited time an athlete has to produce force. Explosive movements in lacrosse such as running, reacting to opponents, and shooting all require a high RFD. The time available for force development in athletic movements is much smaller than the time needed for the body to produce maximal force, which takes up to 0.3 – 0.4 s (2.9). Sprinting is a simple example. The ground contact time in maximal velocity sprinting is typically between 0.08 – 0.12 s in elite level runners (2.9). Movement quality and effectiveness in lacrosse can be affected by how much force can be produced in the limited time allowed (1,2,4,8,9,11). Training programs or exercises that place focus on explosive strength, or high velocity movements, improve early force development by increasing neural drive (1,2,7,8,10). By emphasizing the jump portion of the JOP Matrix, an athlete may be able to improve their RFD and be able apply greater forces in the limited time allotted for each respective movement (7.9). It is important to note the transfer of RFD is listed second, behind RFA, as an athlete will not be able to reach these peak power outputs if they are not able to safely decelerate their body.

Returning to the transfer of the JOP Matrix to the sport of lacrosse, anytime an attacker is in lacrosse cuts or dodges, and anytime a defender shuffles or moves dynamically to match an offensive player’s movements, there is constant undulation between producing and absorbing force. On the field, athletes are speeding up or slowing down with every movement. As an athlete speeds up, RFD plays a major role as ground contact time decreases; however, as he or she slows down, or decelerates, the athlete’s RFA ability plays the most significant role. When implemented correctly, the JOP Matrix improves both RFA and RFD in all three planes of motion, which can potentially affect both performance and injury prevention.

Ultimately, there is no “one magical exercise” that can be programmed to appropriately develop all physical training adaptations required in competition, but the JOP Matrix can be used to help address several necessary adaptations needed for lacrosse players. Strength and conditioning coaches must continue to understand the physical requirements of their sport, then select exercises specifically and systematically to ensure each determined parameter is adequately stressed. Movements must be prioritized to produce training programs that are transferrable and will lead to significant improvements on the playing field.

The author would like to acknowledge Gary Gray for coining the term “JOP Matrix.”

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Matt Van Dyke is the Associate Director of Sports Performance at the University of Denver, where he is responsible for designing and implementing performance training for men’s lacrosse, alpine ski, volleyball, and swimming. Prior to his position with the University of Denver, he was the Assistant Director of Strength and Conditioning for Olympic Sports at the University of Minnesota. Van Dyke completed his Graduate Assistantship at St. Cloud State University, where he earned his Masters of Science in Exercise Physiology and Nutrition in 2015. He earned his Bachelor’s degree in Exercise Science from Iowa State University in 2012. He completed internships with Iowa State and the University of Minnesota under Yancy McKnight and Cal Dietz, respectively. Van Dyke most recently released the Triphasic Lacrosse Training Manual, presented at the 2015 Collegiate Strength and Conditioning Coaches Association (CSCCa) National Conference on Advanced Triphasic Training Methods, while also writing for his professional website, vandykestrength.com. Also, he holds the Strength and Conditioning Coach Certified (SCCC) certification through the CSCCa.
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The prevention and reduction of concussions continue to be in the forefront of athletic injuries at every level of competition. Concussions are one of the most high profile sports medicine topics of the last decade. A great deal of attention has been given to concussions in terms of recognition, evaluation, and management techniques—and rightfully so. It is a topic that has gained national attention from the medical community and the general public. This includes both male and female athletes at lower levels of participation to the professional ranks. Many changes are occurring to help reduce the number and severity of concussions, including monitoring systems, improved technology, and better equipment. However, this article will focus on the role of cervical and upper trapezius isometric contractions as a possible means of reducing the occurrence and severity of concussions in sports.

**MECHANISMS OF INJURY**

In general terms, concussions can be considered neurological disruptions in brain function resulting from direct or indirect blows to the head or neck area that cause a variety of symptoms, including headaches, problems with concentration, memory, balance, and coordination (6). Concussions can also be called traumatic brain injuries. A head injury can be considered any other type of injury to the head that is not a concussion. It is not within the scope of practice of a strength and conditioning coach to diagnose an athlete for concussion, only a qualified healthcare professional is able to make such a diagnosis. Concussions can occur from blunt forces to the head with a full spectrum of forces from small to large amplitude (6,7). While most concussions are thought to occur from direct shots to the head, they can also be caused from impact to the body where the forces are then transmitted to and absorbed by the head and neck (6,7). Whiplash is a common mechanism of injury whereby the head is forced violently in one direction and then recoiled in the opposite direction (i.e., coup-contrecoup). This type of injury can cause both sides of the brain to be injured. Many aspects are involved with forceful movements, including flexion, extension, rotation, and oblique or diagonal angles. Because unexpected forces (blows to the head) and changes in velocity of the head can produce the greatest forces on the brain, they are thought to be one potential cause of concussions (1). Some examples of unexpected forces include:

- Head contact when the neck musculature is in a relaxed state or not isometrically contracted and prepared for contact.
- Helmet to helmet hits (especially in football) where angular velocity is high.
- The head hitting or bouncing off the ground or other hard surfaces. This is sometimes seen in football when quarterbacks get tackled behind the line of scrimmage.

**CERVICAL MUSCULATURE**

There are six muscle groups that are primarily involved in all the cervical spine movements. The major muscles around the cervical spine are the sternocleidomastoid (SCM), scalenes, longus colli, and longus capitis (3). The upper trapezius and levator scapulae...
also play a role in cervical movements. The SCM is a thicker muscle running diagonally from the mastoid process to the medial one-third of the clavicle. Its primary purpose is to concentrically flex, rotate, and laterally flex the cervical spine (3). The scalenes are thin muscles originating at the C3 – C7 vertebrae and inserting on the first and second ribs (3). These muscles stabilize the cervical vertebrae isometrically as well as flex, extend, rotate, and laterally flex the cervical spine (3).

The longus colli and longus capitis are small thin muscles on the anterior and lateral aspects of the cervical spine that assist in movements (e.g., cervical and lateral flexion) and they are the innermost muscles stabilizing the cervical spine (5). The levator scapulae flexes, extends, and laterally flexes the cervical spine. In addition, the levator scapulae is responsible for contralateral rotation and assists in stabilizing the cervical spine during isometric contraction. The upper trapezius is a larger, more superficial muscle on the posterior aspect of the cervical spine and is also responsible for all the motions of the cervical spine. It forms the base of the neck and plays an important role in cervical stability (2). The upper trapezius flexes, extends, rotates, and laterally flexes the cervical spine concentrically and eccentrically. These muscles also stabilize the cervical spine and dissipate forces to the head (2,3).

The following are exercises that could be integrated into a workout program to help strengthen the musculature around the neck.

**CHIN TUCKS**
Standing chin tucks are excellent neck strengthening exercises for the neck extensors, in which the athlete pushes the chin forward to “tuck the chin” toward the chest and then retracts the chin while maintaining a neutral position. A low volume starting point can be 2 – 3 sets of 8 – 12 repetitions 2 – 3 times per week. This movement may also be performed from an inclined or flat position, because the required movements are very similar and the same muscle groups are involved in both positions. The longus colli and longus capitis muscles can be developed with these chin tucks.

**FOUR-WAY ISOMETRICS**
Training isometric contractions in frontal and sagittal planes may help to stabilize the cervical spine during movements. In Figures 1, 2, and 3, contractions in the frontal and sagittal planes of motion are held isometrically. It is important to remember that isometric contractions should be held with moderate pressure to maintain a neutral cervical position. Pressure should gradually increase until the proper amount of steady, consistent pressure can be maintained for 5 – 10 s in order to avoid sudden forceful contractions that could cause a muscle strain. There should be no pain or cervical movement with isometric contractions. These stabilization exercises should be the first part of any neck development program. Performing these in the first part of the workout ensures the athlete is not fatigued, as opposed to the end of a workout when fatigue may come into play and decrease effectiveness.
THE ROLE OF CERVICAL MUSCULATURE AND UPPER TRAPEZIUS ISOMETRIC CONTRACTIONS IN THE REDUCTION OF CONCUSSIONS

CERVICAL FLEXION, CERVICAL EXTENSION, AND LATERAL FLEXION

Cervical flexion (Figures 4 and 5) targets the longus colli, longus capitus, anterior scalene, and SCM. The longus colli muscle is the most responsible for resisting head-on collisions that would knock the head backwards in the sagittal plane. Cervical flexion with resistance should be performed in a pain-free range of motion (ROM) from a neutral position to approximately 60 degrees of flexion. A low volume starting point can be 2 – 3 sets of 8 – 12 repetitions and athletes can progress as tolerated.

Cervical extension (Figures 6 and 7) targets the neck extensors including the upper trapezius and SCM muscles, which can keep the head from being forced into flexion. Many times, these muscles will be isometrically contracted to resist any forces from behind the head. Again, a low-volume starting point can be 2 – 3 sets of 8 – 12 repetitions and progression based on tolerance.
The SCM is the primary mover for lateral flexion (Figures 8 and 9 depict lateral flexion to the right). Development of this muscle involves resistance of lateral forces to the head when isometrically contracted. A low-volume starting point can be 2 – 3 sets of 8 – 12 repetitions for each side and progressed as needed.

PROGRAM DESIGN
A comprehensive neck strengthening program is designed to include a full ROM and the four-way isometrics. It is of the utmost importance that neck strengthening programs be progressed in an appropriate manner to avoid injuries during training or competitions. Static stretching of the muscles should be done prior to strengthening exercises. As a strength and conditioning coach, it has been my experience that not every athlete will be able to do all the exercises using the same resistances, repetitions, and sets. Programs may need to be implemented in groups that are based on training level to avoid overtraining for some. For example, there could be three separate training groups based on ability level, which may dictate program design considerations.

REHABILITATION FOR CONCUSSION OR NECK INJURY
Any neck or head injuries should be evaluated and diagnosed by a qualified healthcare professional. Additionally, the entire coaching staff (including athletic trainers, strength and conditioning coaches, and sport coaches) should be involved with the advised medical rehabilitation program. Cervical sprains and strains are common in contact sports and need to be evaluated and treated as soon as they occur. Any athletes rehabilitating a current neck or shoulder injury should also complete the prescribed rehabilitation program and be medically released before beginning a neck strengthening program. Any athlete who is currently being treated for a concussion should not start a neck strengthening program until they are cleared by a qualified healthcare professional.

DISCUSSION
In an article in Complete Concussion Management in 2013, a question was asked: “Can neck strength reduce the risk of concussions in sport?” (4). The author answered by stating that “concussions are a result of acceleration and deceleration of brain tissue within the skull,” (4). In 2007, Viano and colleagues examined impacts that occurred in professional football and neck stiffness was identified as a determining factor in reducing forces that caused concussions (4). This illustrates the important of isometric contraction of the deep neck muscles as it can increase neck stiffness and therefore, reduce the transmittance of forces.

The anticipation of and preparation for impacts of higher forces may help protect an athlete from possible concussions (8). One coaching cue that can be helpful is to tell athletes to “keep your head on a swivel,” meaning see the field and anticipate what may happen. Seeing the action in the area around an athlete is critical in anticipation and preparation for the next movement. For example, in football, when a running back runs through the offensive line, they are likely expecting contact and therefore may voluntarily contract muscle groups in anticipation of an attempt to be tackled. If an athlete anticipates impact to or around the head, he or she will typically be able to isometrically contract the neck muscles to protect the head from violent motions. However, if an athlete is “blindsided,” or hit when they are not expecting it, and does not have a chance to isometrically contract the neck
and shoulder muscles, then even a low-force hit may prove to be very damaging. This could lead to a whiplash motion or greater acceleration and deceleration forces to the head and neck region, possibly causing a neck injury and/or a concussion.

CONCLUSION
The evaluation, treatment, and management of concussions are an ongoing evolution in sports injury management and medicine. Strengthening the neck and shoulder region has been one way of trying to reduce head and neck injuries. Neck strengthening exercises going through full ROM and four-way isometrics to the cervical muscles are a sound program combination to improve an athlete’s ability to stabilize the head and neck. Another important component is isometric contraction of the cervical and scapular muscles. This can help stabilize the head and possibly reduce the severity of impact forces, thereby reducing the likelihood of sustaining a concussion. It is the anticipation of and preparation for those forces that also seems to be necessary to prevent a concussion. The amplitude of forces will determine if an actual concussion happens or not.

If a concussion or neck injury should occur, the athlete should be evaluated, fully rehabilitated, and medically released before returning to play or participating in a neck strengthening program. This is where the athletic trainer and strength and conditioning coach should work together to be sure the athlete is ready to begin a strength training program. It is up to all strength and conditioning professionals associated with the team to educate their athletes on the best ways to train and protect themselves from concussions.

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Achievement Goal Theory (AGT) has grown in size, scope, and applicability across the sporting landscape as a viable explanation for athlete behaviors (1). While many of the intricacies of the theory fall well beyond the scope of this article, the foundation of the theory is that individuals behave in an intentional and rational manner and are goal-directed in those behaviors (1). Unfortunately, this might cause a problem in that a coach may not inherently see the athlete’s behavior as rational. In addition, different athletes on the same team may have different goals from each other and the sport or strength and conditioning coaching staff.

**MAJOR COMPONENTS WITHIN AGT**

As AGT has received more attention in the literature, the theory has become partitioned and exponentially more complex. The complexity has developed by combining of pieces and not necessarily from the individual component pieces. The first major component involves Dweck’s work on growth mindset, which has exploded in recent years within the education and sport settings (2). This work clearly falls beneath the umbrella of AGT and, while “growth mindset” has become a popularized term of late, Dweck has spent the last 30 years building a research base for her conclusions (3). According to Dweck, individuals have implicit beliefs about whether talent and intelligence are fixed (i.e., capacity, innate) or whether they are malleable (i.e., earned, learned) (2,3). Specific to coaching, consider a hypothetical athlete that adopts a fixed mindset about his or her strength. How hard is that athlete going to train if he or she inherently believes she is already as strong as she will be? A parallel in education, both at high school and collegiate levels, is when students report, “I’m just not good at math.” In both cases, the individual puts forth reduced effort and the innate belief of not being able to get stronger or better at math is confirmed. This is obviously a problem, and the longer those beliefs go unchallenged, the more evidence the athlete has that their original belief was correct.

The second major component within AGT that has received substantial research attention is the dichotomy between task- and ego-oriented athletes (4). In brief, task-oriented athletes adopt self-referenced attitudes, give consistently high effort, and are willing to make mistakes for the sake of long-term development. Ego-oriented athletes are concerned with how they compare to others, their effort and intensity fluctuate wildly, and they adopt a today-is-most-important mentality over anything long-term. Perhaps the single biggest distinction to note is the long-term impact of an athlete being self-referenced or other focused. The self-referenced (i.e., task) athlete simply tries to get better each day, and as long as he or she feels progress toward something (e.g., learning a new lift, getting stronger or faster, or improving technique), the day can be viewed as a success. The other-referenced athlete essentially looks around the room or team, or considers opponents, and makes a judgement about their comparative ability in the moment, and only those instances where he or she compares favorably are judged as a success. Given those examples, it is no wonder why task-oriented athletes have been shown to yield the most positively valenced variables over a season or career (4).

The third major component of AGT has received comparably less attention (4). Nonetheless, this component is perhaps more important to the strength and conditioning professional compared to others. Athletes tend to adopt either an approach or avoidance disposition toward challenges. Approach-minded athletes are readily willing to learn new lifts or variations of old lifts while attacking the challenge with effort and energy. Avoidance-minded athletes will be pessimistic, grumble about the task, delay until possible, and generally dodge the task at hand.

**COMBINATIONS LEAD TO COMPLEXITY**

None of the major AGT dichotomous components occur in a vacuum. Instead, they are occurring simultaneously within every athlete and coach. One of the current trends in AGT-themed research is to combine these components to get a more complete picture of athlete behaviors (5,6). There has also been substantial debate regarding how stable those beliefs are, and the general consensus is that each component is malleable, which is an aspect that is critical for coaches to understand (4). Additionally, each coach has personal beliefs for each major component that directly impacts the coach’s behaviors.

At the coach-to-athlete level, different coaching terms are thought to promote either a mastery-focused climate or a performance-focused climate. The impact coaches have on athletes across those two coaching climates have been well documented across both the individual and team levels of analysis (4). In nearly all cases, the positively valenced variables increase for athletes coached in a mastery-focused climate including intrinsic motivation, enjoyment, satisfaction, effort, persistence, self-confidence, team cohesion, and collective efficacy. Going beyond the positive increases, there are negatively valenced variables that increase with performance-focused climates including anxiety, worry, tension, pressure to perform, maladaptive coping strategies, reliance on other-focused goals, poor sportsmanship, and amoral behavior.

For each of the three major components (e.g., beliefs about ability, task or ego orientation, approach or avoid mentality), we could place an athlete somewhere on a continuum between the two extremes (i.e., all task-oriented versus all ego-oriented). You, the coach, have your own individual beliefs along the same major component continuums, which influences how you coach a group of athletes or run your facility. That is stacked layers of complexity and as a strength and conditioning coach, the challenge is even more extreme because at different points in each day you have entirely different rosters of teams coming into your facility with each one coming from, or going to, the coaching climate established by the sport coaches which may or may not be consistent with your own coaching climate.
PUTTING THIS KNOWLEDGE TO WORK

There really is no debate about whether a mastery- or performance-focused climate is better for athletes. If you are finding yourself unsure of the type of climate you want to foster, then pause and reflect on your own beliefs and values regarding competition and achievement. There is nothing in AGT research that says mastery-focused coaches do not coach with passion, yell, or challenge their athletes to reach new heights. Much of this will simply come down to fundamental world view questions. Do you believe mistakes are acceptable, normal, natural, and can be fixed? If you answered “yes,” then you believe in a mastery focus. Do you believe that consistent effort over time will yield the best results? If you answered “no,” then you believe in a performance focus. Helping athletes establish more productive achievement belief patterns can be a challenge for coaches, and many coaches need some help figuring out how they can be better at it. A first step is to consider what you say to the athletes. Here are a couple common examples of coaching comments followed by the problem with the statement and options for how to approach the athletes.

1. “Look at Jenny! She can do it, why can’t you?” A coach screaming this statement in frustration just told the athlete to focus on someone else’s performance and did not provide any instruction or help for the struggling athlete. What is it that Jenny is doing so well? The coach’s question of “Why can’t you?” also changes the athlete’s focus to make note of a deficiency without any way to fix or improve it. Conversely, a mastery-focused coach will focus on something controllable by the athlete and provide a specific technique cue that needs to be improved.

2. “Big game this week, give it some extra effort in training.” This sets up the pattern of fluctuating effort levels based on entirely uncontrollable aspects unrelated to the actual training. Coaches try to get more effort out of their athletes all the time (e.g., the week before test-out week, the last microcycle of the season, before a big match). If increased effort for a short duration worked so well, the national obesity rate would plummet every January when all the new gym attendees stick to their New Year’s resolutions for two weeks. Consistent effort applied to a sound training program over time will yield the best results. This does not mean coaches should avoid increasing the intensity level of training for their athletes. But increasing that intensity level could be done through more challenging goals, modifying the exercises, or adding in some twists to the normal routine (7). So, in the example statement, the problem is less about giving more effort and more about why that increased effort is needed. That may sound like a trivial detail, but those sorts of changes are exactly what determine the difference between a mastery and performance climate and why coaches should be aware of how their communication affects athletes.

3. “Head sport coach told me that if you cannot lift ‘x’ amount, you will not play.” This example can also apply to running or agility scores. First, strength and conditioning coaches should not get into the middle of playing time issues between the athletes and sport coaches. If you have a rule and can enforce that rule, then own it; do not throw the blame elsewhere. Second, placing all the emphasis on the outcome of a lift, run, or test encourages athletes to cut corners and otherwise devalue the process and technique. Safe training is a principle supported by leading strength and conditioning coaches, and anything that negatively impacts safety is ill-advised (8). Finally, statements like this only target a sub-sample of the athletes and the interplay between self-confidence, the objective you just gave the athletes, and their own ability levels can be problematic (7,9). It is most likely that some of the athletes can already achieve “x” and some are nowhere close to “x,” leaving only a relatively small subset of the athletes that have a reasonable chance of achieving “x” at the prescribed time. Changing the statement to be something self-referenced immediately speaks to all the athletes, as every one of them should be trying to improve their own marks.

In each of the above examples, it is fair to assume the coach had positive intentions; namely, to motivate athletes to achieve more. Motivation is the essence of coaching, which presents the obvious challenge of how best to go about motivating athletes to improve performance levels. Becoming a better coach will allow you to help more athletes improve their potential. If you believe you are as good a coach as you can be, check your own beliefs relative to a fixed or growth mindset. If you believe measuring your own success should be determined by the performance of other coaches, it might be time to consider your own task-ego balance. If reaching out to someone to help you learn more about coaching with a better mastery focus seems too hard, consider whether you are approach or avoidance inclined.

CONCLUSION

In sports settings, a vast majority of athletes you coach will not become professional, but these major components of AGT carry-over outside of sport into any achievement-based setting. So, the athlete that adopts a fixed mindset as a high school basketball player is likely to have a fixed mindset about work tasks as an adult 20 years later. The football player only concerned with how he compares to his teammates is likely to view his coworkers in the same fashion two decades later. It can be argued that coaches helping athletes adopt a more productive set of achievement orientations is the single greatest contribution that coaches can make to the athletes’ lives.
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ABOUT THE AUTHOR
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.
He's determined to push his limits. And you won't rest until he gets there. From the energy you put into his training to the never-ending development we put into his sports fuel, we're all in this together.
INTRODUCTION TO PLAY

Preparing young athletes for the rigors of athletic competition is an important task for strength and conditioning coaches. Coaches need to recognize that play for youth extends beyond the realm of athletics. Coaches should understand how different types of play are important to helping youth enhance athleticism and positive youth development. The works of classic child development theorists, like Piaget, Vygotsky, Bruner, Freud, and Erickson, have advocated for positive youth development through play (7). Games with rules have a place too, helping children control their behavior within limits. Coaches play an important role in developing the whole child. This article will help strength and conditioning coaches consider how to integrate different types of play into a coaching toolbox.

CATEGORIZING PLAY

In order for coaches to include the various types of play into practice and strength and conditioning sessions, an understanding of play categorization will be helpful. Although there are many ways to categorize play, this article will focus on two methods: structure of play and types of play (3).

STRUCTURE OF PLAY

Play can be categorized as structured play, such as sport participation; semi-structured play, as is often experienced in physical education class or recess; and unstructured play, in which there are no adult rules or supervision. The lack of adult direction in unstructured play has given rise to the term “free play.” The degree of adult involvement, therefore, determines the category of structured play (1).

While the value of free play tends to be valued less than structured play, free play is critical to the development of youth. According to Ginsburg, free play has been shown to benefit the cognitive, physical, and social development of children and adolescents in the following ways (2):

- **Cognitive**: creativity, decision-making skills, and independence
- **Physical**: healthy development of the brain, motor planning skills, and opportunities to discover skills and interests
- **Social**: collaboration, sharing, conflict-resolution, and self-advocacy

A recommendation for youth is that they should engage in structured play for no longer than the hours per week equivalent to their age in years (5). For example, a 10-year-old should participate in sports practice and competitions no more than 10 hr per week. Likewise, youth should participate in unstructured play in a 2:1 ratio to structured play (5). So, the same 10-year-old should participate in 20 hr of unstructured play per week.

REFERENCES


ABOUT THE AUTHOR

Rick Howard helped start the National Strength and Conditioning Association (NSCA) Youth Special Interest Group (SIG) and served this year as Immediate Past Chair. In addition, Howard serves on the NSCA Membership Committee and is the NSCA State/Provincial Program Regional Coordinator for the Mid-Atlantic Region. Howard is involved in many pursuits that advance knowledge, skills, and coaching education to help all children enjoy lifelong physical activity and sports participation.
<table>
<thead>
<tr>
<th>TYPE OF PLAY</th>
<th>DESCRIPTION</th>
<th>STRUCTURE OF PLAY</th>
<th>APPLICATION FOR STRENGTH AND CONDITIONING COACHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Motor Play</td>
<td>Engage in all three types of motor skills (body awareness, locomotor, and object control).</td>
<td>Unstructured, semi-structured, and structured</td>
<td>Give youth instruction in developmentally-appropriate motor skills, such as integrative neuromuscular training (4). Provide time within the structured practice/training session for unstructured play.</td>
</tr>
<tr>
<td>Small Motor Play</td>
<td>Use dexterity, small object control, and other small movements.</td>
<td>Unstructured, semi-structured, and structured</td>
<td>Change the size of objects and give young athletes the opportunity to learn the differences between them.</td>
</tr>
<tr>
<td>Mastery Play</td>
<td>Repeat an action and persevere until it is mastered.</td>
<td>Unstructured, semi-structured, and structured</td>
<td>“Practice makes permanent”—be sure to coach the movements properly and provide developmentally-appropriate learning and practice.</td>
</tr>
<tr>
<td>Rules-Based Play</td>
<td>Youth make up their own rules and social negotiations to adapt the rules for each play situation.</td>
<td>Unstructured and semi-structured</td>
<td>As part of semi-structured play, encourage young athletes to think through and create scenarios related to the practice/movement.</td>
</tr>
<tr>
<td>Construction Play</td>
<td>Youth build things with their hands.</td>
<td>Unstructured, semi-structured, and structured</td>
<td>Youth can build equipment to use and/or setup/breakdown equipment for practice.</td>
</tr>
<tr>
<td>Make-Believe Play</td>
<td>Youth-directed focus on using language and imagination to help problem solve. Often starts with “let’s pretend....”</td>
<td>Unstructured</td>
<td>Coaches can be mindful during the unstructured portion of practice whether language is being used to problem solve. Coaching cues in the weight room or on-the-field communication may be used for older children.</td>
</tr>
<tr>
<td>Symbolic Play</td>
<td>Object converted to be what youth need it to be. Often starts with “imagine that....”</td>
<td>Unstructured, semi-structured, and structured</td>
<td>While originally intended for infants and toddlers, this is a great way for coaches to help youth discover role play in a new way at different positions, or in different areas of responsibility.</td>
</tr>
<tr>
<td>Language Play</td>
<td>Use words, rhymes, verses, songs, etc.</td>
<td>Unstructured</td>
<td>A creative way to teach rules of the game, team chants, weight room safety, etc.</td>
</tr>
<tr>
<td>Playing with the Arts</td>
<td>Integrate art into play to express feelings and ideas.</td>
<td>Unstructured and structured</td>
<td>Useful approach for free play and also for checking on feelings of youngsters.</td>
</tr>
<tr>
<td>Sensory Play</td>
<td>Explore different materials, textures, sounds, and smells to develop the senses.</td>
<td>Unstructured</td>
<td>Encourage play on a variety of surfaces and under a variety of conditions, increasing awareness of the senses in the process.</td>
</tr>
<tr>
<td>Rough and Tumble Play</td>
<td>Use of rounding of their body gestures to play roughly without injury. Dominating other youth is not the goal. Sometimes this type of play needs adult supervision.</td>
<td>Semi-structured</td>
<td>Young athletes learn differences in body sizes, strength levels, fitness levels, and how to control their bodies with other youth.</td>
</tr>
<tr>
<td>Risk-Taking Play</td>
<td>Youth learn to master challenging environments through risky play.</td>
<td>Unstructured</td>
<td>With risk-averse parks, schools, and recreation programs, encouraging kids to master their surroundings with tasks that are just out of their reach builds confidence, self-efficacy, and skill mastery.</td>
</tr>
</tbody>
</table>

Note: Coaches should introduce the 12 types of play into practice and strength and conditioning programs, integrated with the appropriate structure of play (e.g., unstructured play, semi-structured play, and structured play). Modifications to the “Application for Strength and Conditioning Coaches” should be made based on the developmental level of the specific youth. For example, in language play, the rhymes should be more elementary for children; whereas, adolescents should create their own rhymes, raps, etc.
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