

Agility, Mobility, and Versatility

By

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Impulse (im-puhls): the product obtained by multiplying the average value of a force by the time during which it acts. The impulse equals the change in momentum produced by the force in this time interval

Momentum (moh-men-tuh m): a quantity expressing the motion of a body or system, equal to the product of the mass of a body and its velocity, and for a system equal to the vector sum of the products of mass and velocity of each particle in the system.

Power (pou-er): work done or energy transferred per unit of time; the time rate of doing work

Agility is the ability to decelerate one's momentum, stop, overcome inertia and accelerate one's body mass in another direction. Clark (2001) sums it up by stating, "agility is the ability to decelerate, stabilize, accelerate and change direction quickly while maintaining proper posture and moving in the intended direction (3)." Looking at this from a physics perspective, momentum, impulse and inertia are the three critical components of agility. The ability to decelerate and stop one's **momentum** in a short distance/period of time requires great amounts of unilateral relative strength and **power**, particularly in the extensor mechanism musculature of the lower extremities. **Impulse** can be found in the period of time in which the switching from eccentric action (deceleration) to concentric action (acceleration) occurs. "Any change of running direction is caused by an external impulse to the ground. The greater and quicker the direction change during desired high running speed, the greater force and shorter time of push off to the ground in the optimal direction is necessary (8)." The ability to then accelerate in a different direction also requires a great degree of unilateral relative strength and **power**. Oftentimes in the beginning phases of agility training, these components are overlooked, and substituted for "drills", even if baseline strength and power levels are subpar.

According to Kurtz (2001), "agility is measured by the difficulty of coordination of assignments, precision of performance, the time between moment of change and the beginning of the response, and the time required for achieving a necessary level of precision (9)." With proper execution, agility skills

can create various physical benefits. “Agility training enhances eccentric neuromuscular control, dynamic flexibility, dynamic postural control, functional core strength and proprioception (3), which can lead to overall increases in athletic performance. Agility can also “help to prevent injury by enhancing eccentric neuromuscular control and improving the structural integrity of the connective tissue (3)”. These benefits can create an environment in which the development of other skills can be cultivated.

“The purpose of agility training is to increase the frequency of change of movement pattern and direction in a restricted time and area (8).” This concept holds similarities to the characteristics of reactive/elastic/plyometric activity. Both forms of movement require a rapid eccentric action (deceleration for agility), an amortization phase (the actual change of direction or impulse), and a concentric action (acceleration for agility). “The amortization phase of foot contact with the ground in changing of running direction or turning can be considered the eccentric phase. The muscle must contract concentrically to execute the take off in the desired direction. If change from eccentric muscle action to concentric muscle action is performed quickly, the resultant concentric action is more powerful than if no eccentric action was performed or if there was a pause between the eccentric and concentric muscle contraction phases (8).”

Agility often takes place in a horizontal plane (forward/backward, lateral, or combination of both), while plyometric training actions utilize both vertical and horizontal components, but the goal of each is the same: to decrease the time of amortization phase while increasing the force of the impulse. Thus, the methods of training are similar in concept, but different with regards to specificity of action and transfer of training effect.

Testing

Prior to beginning any agility training programs, an athlete should first test for structural/muscular imbalances, postural deficiencies, and baseline strength levels (both unilateral and bilateral). To gain insight on which methods of agility training an athlete should partake in, two different types of vertical jump test should be administered to ensure training is not approached blindly. Understanding that agility is a product of both impulse (reactive ability) and strength/power, both of these characteristics must be tested separately to assess which physiological characteristic needs improvement. The vertical jump test measures an athlete’s strength/power and myotatic stretch reflex, while the reactive vertical jump test (depth jump vertical jump test) measures an athlete’s

impulse/reactive ability. If there is a large deficit between the two tests, the training needs to focus in improving the weaker of the two components. Below are descriptions of the two tests:

- 1. Vertical Jump test (strength/power):** The height of our jump is determined by the vertical velocity of your body at the moment of takeoff. The faster you accelerate downward into the countermovement, the higher you will jump. It is Newton's Law which states "for every action, there is an equal and opposite reaction (6)". Stand approximately 2 inches behind with reaching hand/shoulder directly below measurement markers of a vertec device. Position your feet 5-10" apart, with knees and toes pointing straight ahead, and shoulders and hips squared. Swing arms directly overhead reaching as high as possible, coming on up onto your toes, with full extension in ankles, knees, spine, shoulders, and neck. Once you have reached this stretch position, swing your extended arms downward as powerfully as possible, initiating the movement from the abdomen. Keeping your head up and maintaining a slightly lordotic posture as you swing your arms, simultaneously bend at the hips, while bending at the knees and ankles. **Make sure you have more bend at your hips than you do in your knees.** At the bottom position of this countermovement your feet and knees should be pointing straight ahead, your hips should have more bend than your knees or ankles, your head should be looking upward/straight ahead, and your hands should be at your sides even with your hips with arms extended, and minimal ground contact at the heels. From this position, swing the arms upward while extending at the hips/low back, knees, ankles, and neck driving the body upward into the air with arms reaching as high as possible and head looking straight up. Try to touch your feet together immediately after leaving the ground to create more vertical force. Gently tap the highest vertec height marker with your dominant hand. Once you have reached your maximum height for your jump, begin to prepare the body for the landing. Make sure to dissipate the landing forces by flexing at the ankles, knees, and hips to create an eccentric load in the muscles, rather than in the joints. **Balanced quiet and controlled landings are very important in vertical jump training.**
- 2. Reactive Vertical Jump test (impulse):** Stand on a box (the height to be determined by training experience/lower extremity strength/ or actual vertical jump height) approximately the same distance from the vertec device as the actual height of the box. With your hands behind you in the propulsive phase position of jumping, step forward and fall off box. You should fall out the distance equal to the height of the box. (If you are standing on a 24" box you should land 24" away from the box). Mentally focus on jumping before you land. With a quiet, soft landing, minimize knee bend, torso flexion, and do not let the heels touch the ground. Minimize ground contact time to .3-.5s. Immediately jump upward, swinging the arms upward while extending at the hips, knees, ankles, torso, and neck to touch the highest vertec height marker.

After proper administration of pre-exercise tests, an individualized workout schedule can be created according to the results. Exercise selection should aim to correct weaknesses/imbbalances prior to any forms of heavy resistance, power, or agility drills training. As the old adage goes "a chain is only as

strong as its weakest link". This statement holds true for any athlete and the design of their training protocols.

Exercises to increase agility performance can be broken down into 4 categories: corrective, strengthening (relative or maximal and unilateral or bilateral), reactive/ballistic (unilateral or bilateral), and drills.

Corrective Exercise

Corrective exercises are used to restore structural balance and repair "energy leaks" by correcting length tension ratios, posture, and movement imbalances. These exercises should be administered first if there is a deficiency movement or posture. Repetition ranges for corrective exercises can range from 1 to as many as 50-100. One repetition may consist of an isometric hold () for a specified period of time. This method can be used to teach the body to activate the correct muscle fibers and increase neuromuscular efficiency for a specified movement. An example a corrective exercise for increases in muscle activation which may lead to enhanced performance of agility based activities is the isometric split squat hold (back foot elevated). Not only does this exercise promote activation of the prime movers and stabilizers utilized in agility activities, it also stretches the antagonistic musculature of the opposite leg.

1. **Isometric Split Squat Hold with Back foot elevated:** To perform this exercise properly, an athlete first needs to find a box/bench of proper height. The athlete will then measure the distance from the box by assuming a sprint start position facing away from the box. The athlete will kneel down on one leg with the bottom of the foot flat against the side of the box, toes on the ground (dorsiflexed). The opposite foot will be placed flat on the floor with the heel touching the inside of the knee of the measuring leg. The athlete will then stand up onto the foot touching the knee, and placing the back foot up onto the box with the top of the foot resting comfortably on the box. Keeping chest out, shoulders pulled back, and neutral/slightly lordotic posture, begin by lowering the body straight down by bending at the knee of the leg in contact with the ground and allowing the back knee to flex completely, stretching the quadriceps/hip flexors. Your torso may lean forward slightly, be sure to maintain neutral/slightly lordotic posture. Lower your body until the back knee is just above the floor, with the hips below the knees. Raise up to the point at which your upper leg is parallel or just above parallel to the floor and hold this position. As you raise, be sure to drive through the full foot on the ground, while letting the leg on the box hang, without any contraction in the quadriceps. This ensures activation of the working leg quadriceps, glutes

and hamstrings while stretching the hip flexors of the non-working (box) leg. These can be done with shoes off or on an Airex pad for added stabilization requirements and as well as to work the musculature of the bottom of the foot.

Strength Training

Strengthening exercises allow for greater potential in rate of force development, as well as stabilization of the body's joints and dynamic posture during movement. Strengthening exercises may contain either eccentric action, concentric action, or both. Typically both eccentric and concentric actions are seen in most strengthening exercises, though emphasis can be placed on either action if too great of a deficit exists between the two. The greater the eccentric strength, the greater the body's ability to decelerate its momentum while controlling posture. "Based upon the results of a study showing that in 8-week eccentric strength training program decreased contact time on the force platform when changing direction, it was concluded that agility performance could be improved through eccentric strength training (8)."

The greater one's concentric strength, the greater the potential to accelerate in a shorter distance/ period of time. The concept of strength is further broken down into maximal strength and relative strength. With greater maximal strength, the potential for relative strength becomes greater. An athlete whom can generate greater forces at a lighter body weight may possess the greater potential for increases in agility.

Specific relative strength training focuses on increasing one's strength, while maintaining or in some cases decreasing body weight. According to renowned strength coach Charles Poliquin, time under tension for increases in relative strength should be less than 20 seconds as to avoid hypertrophic adaptations from strength training. Repetitions should range from 1-5 reps, focusing on explosive concentric action. Two examples of relative strength exercises for increased agility are the weight release eccentric emphasis back squats and single leg (pistol) squats.

1. **Weight Release Back Squat:** To perform the weight release eccentric emphasis back squat place 2 benches/boxes at the sides of a squat/power rack, each about 12-24" in height. Attach weight releasers to the ends of the barbell. Place hands on the bar slightly wider than shoulder width with thumbs and fingers around the bar. Rest the bar across the rear deltoids and upper trapezius, squeezing your shoulder blades together with chest out, making sure the bar does not rest across the lower neck area. Step one foot, back then the other, to position body into proper squat position. Assume a stable lordotic posture and

rigid torso and raise the bar off the rack, keeping the weight balanced between feet, with equal distribution of weight on heel and front foot, place the feet hip width or a slightly wider pointing straight ahead or slightly out. Keep your elbows pulled down. Pull the ground apart with your feet to create greater activation of the gluteus musculature. As you begin the descent, make sure to maintain lordotic posture beginning the descent by pushing your hips back first. As you sit back push your knees out to the sides to ensure maximum hip involvement. Once you reach parallel (point where thighs are parallel to the floor) or lowest point you are comfortable squatting, the weight releasers will detach from the bar. Once the releasers are detached immediately stop the downward momentum and begin to initiate upward acceleration. Keeping the back arched and torso rigid, begin the ascent by driving the head, shoulders and chest back and upward, initiating the movement from the large muscles of the hips. Be sure to keep the whole foot on the ground, avoiding “caving” knees, rounding of the back, and knees crossing to far past the vertical toe plane. Make sure to exhale maximally after you have passed the sticking point and ascend all the way to the top.

2. **Single Leg Pistol Squats:** The technique for the single leg (pistol) squats can vary according to the athlete’s level of training. Begin by standing on a box 12-25” high with a 2.5 pound plate in each hand to use as a counterbalance during the movement. Make sure the box is stable and will not tip over. Position your left foot 1-2” from the right edge of the box, with right leg hanging off the side of the box. Completely extend the right leg out in front of you, with about a 120 to 160 degree angle at the hip. Begin by slowly bending at the left hip, then knee and ankle lowering the body down into a squat position, Make sure the torso is kept in an upright posture throughout the entire movement and the non-working leg is kept fully extended in front of you. Try to maintain the weight on the full foot/forefoot of the working leg. As you lower your body, raise your arms from your sides with palms facing down, until your arms are parallel to the floor. At the bottom of the squat (working leg upper thigh parallel to the floor or below if you are capable), begin raising the body up driving through the full foot of the working leg to recruit the quadriceps, glutes and hamstrings. During the ascent, maintain lordotic posture, allowing the arms to drop back toward their original starting position.

Reactive/Elastic/Plyometric

The reactive/ballistic component of agility relies on the impulse concept of physics. The ability to rapidly decelerate one’s momentum (store elastic energy), decrease the time of amortization phase, and release the elastic force as rapidly as possible is a highly sought after skill. By increasing the body’s ability to absorb greater impacts while concurrently increasing the rate of force development, one can enhance their potential to achieve greater levels of agility.

An added benefit of this characteristic of agility is its role in injury prevention. Teaching the body to correctly decelerate and stabilize during dynamic movements can lead to a decrease in the potential for injury. Ballistic training also has potential benefits with regards to longevity of one's structural components such as joints and ligaments. According to Dr Mark Swanepoel of the University of the Witwatersrand in South Africa, "as one progresses up the lower extremity, from the ankle, to the knee, the hip and finally to the lumbar spine, so the extent of fibrillation increases at any given age. It appears that the cartilage of joints subjected to regular impulsive loading with relatively high contact stresses is mechanically much stiffer and better adapted to withstand the exceptional loading of running and jumping than the softer cartilage associated with low loading. Thus, joint cartilage subjected to regular repetitive loading remains healthy and copes very well with impulsive loads, whereas cartilage that is heavily loaded infrequently softens.....the collagen network loses its cohesion and the cartilage deteriorates (13)."

Exercises consisting of reactive/elastic/plyometric action (fast eccentric, minimal amortization phase, explosive concentric) and high speed, ballistic movement should be the primary focus while training this characteristic of agility. "To shorten the time to switch from eccentric to concentric muscle action and develop maximal contraction in the shortest time of foot/ground contact for quick changing of running direction, various stretch shortening cycle exercises or "shock" method plyometric training is effective (8)." Two examples of highly effective reactive/ballistic exercises for enhanced agility are depth drops and kettlebell swings.

1. **Depth Drop:** Stand on a box (the height to be determined by training experience/lower extremity strength/ or actual vertical jump height) with your hands in front of you with elbows bent. Step forward and fall off box. You should fall out the distance equal to the height of the box. (If you are standing on a 24" box you should land 24" away from the box). Land with a soft landing, minimize knee bend, torso flexion, and do not let the heels touch the ground. Stick this landing for 3-5 seconds. Take a minimum of 1 minute rest between each jump.

The kettlebell swing encompasses all the characteristics of a reactive exercise in that there is a fast eccentric action, minimal amortization phase, and explosive concentric action against the resistance of a kettlebell. The swing also places stress on the musculature involved in both lower extremity deceleration and acceleration musculature, thus strengthening the joint and musculature while decreasing the potential for injury. "Repetitive ballasting loading of kettlebell snatches and clean and jerks appears to be highly beneficial to your joint. According to Verkhoshansky and Siff, joints

subjected to heavy impact are relatively free of osteoarthritis in old age and those subjected to much lower loading experience a greater incidence of osteoarthritis and cartilage fibrillation (13).”

- 2 Arm Kettlebell Swing:** It is very important to begin with a proper starting position, because the mechanics and success of the movement depend heavily on the body positioning at the beginning. Begin by creating a lordotic posture in the spine, with chest out, shoulder pulled back, eyes straight ahead, and knees bent 20 degrees to activate the hip extensor mechanism, with weight distributed over the entire foot. Be sure to bend at the waist when positioning the body into the start position. This ensures the muscle tension is created in the glutes and hamstrings, rather than the low back. Grab the kettlebell/dumbbell with two hands, palms down. Swing the bell between the legs, about shin height. At the point of full tension on the glutes and hamstrings, and the bell back behind the knees/shins you will begin the upward acceleration. Try to switch from the eccentric action to concentric as fast as possible. The upward pull is initiated through the glutes and hamstrings, while keeping the upper torso posture the same (lordotic posture). You begin by swinging the weight outward and upward, raising and extending the hips, extending the knees, increasing the torso angle, and bringing the bell in an arcing movement up above your head, while keeping the arms extended, ending up on the toes. At the top of the movement, drop the heels back to the ground, stabilize the bell and proceed downward, in the same fast and controlled manner. At the point of full tension on the glutes and hamstrings (bell behind the knees/shins) try to immediately change the direction again into an upward explosive swing.

Agility Drills

Lastly are agility drills. Once an athlete has corrected structural imbalances, increased relative strength and reactive/ballistic ability, they should then place emphasis on drills that are specific to agility. Agility drills typically involve rapid changes of direction, with maximal effort or rate of force development. “Exercises developing agility cause fatigue in a short time. They require maximum precision of muscular sensation and have little effect when fatigue set in, so the best time for agility exercises is in the first part of the workout. When developing agility, rest intervals should be long enough to allow for a complete restoration. Exercises should be continued when there is no trace of the fatigue from previous work loads (9).”

A test and training drill for agility is the 5-10-5 pro agility drill. This drill encompasses all components of agility, with completely opposite acceleration/deceleration directions, making it one of the more difficult drills.

1. **5-10-5 pro agility drill:** To perform the 5-10-5 pro agility drill an athlete will need to mark out 10 with cones or lines. The markers/lines will be placed at the 0, 5, and 10 yard distances. The athlete begins standing sideways (parallel to the lines), straddling the 5 yard marker/line with one hand placed softly on the ground. The athlete will initially accelerate laterally toward either the 0 or 10 yard maker. Once at that line/marker the athlete will decelerate momentum, and touch the marker/line with the same side hand. The athlete will then change direction (without turning around), accelerating off the leg closest to the line. The athlete will accelerate 10 yards toward the other line (0 or 10), decelerate, and touch that line with the opposite hand they used for the first touch. The athlete will then accelerate in the opposite direction once again, finishing as he/she passes through the start line (5 yard marker/line).

In the world of team sporting events, the ability to separate from one's opponent by rapidly decelerating or accelerating can lead to profound success on the athletic field. Through proper training, the foundation for this highly sought after skill is built. Once the foundation is in place, the skills and actions which make up agility can be improved. After all, "you cannot shoot a canon from a canoe".

References

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