Training Agility over 60 to 180° turns:

Manipulating base of support, centre of mass, and direction of force

Professor Anthony Turner a.n.turner@mdx.ac.uk @anthonyturneruk

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Abstract

For many athletes, being agile is the end goal of physical performance training. It represents their capacity to change velocity and direction in response to the actions of their opponent and the opportunities and constraints of their environment. The aim of this paper is to describe the pitch-based development of agility, focusing on 60 to 180° turns. This ensures all turns have the demand of deceleration, turning, and reacceleration, requiring both outside leg turns (60°) and inside leg turns (180°). To enable the effective coaching of these, coaches must understand movement mechanics and thus the fundamental principles that underpin good technique. Within agility training, a detailed appreciation of how the centre of mass and base of support interact to affect the direction of force, is fundamental to this. This understanding and the ensuing technical models ensure athletes have the best chance of executing the task optimally and ensures coaches can effectively instruct athletes and adapt drills accordingly.

Introduction

For many athletes, being agile is the end goal of physical performance training (6). It represents their capacity to change velocity and direction in response to the actions of their opponent and the opportunities and constraints of their environment. The cognitive element of agility is developed over many years, in which athletes refine their ability to scan the environment and identify potential patterns of play based on for example, where the ball is, where their opponents and teammates are, and what has happened previously in similar scenarios. Once they have considered the relevant stimuli, they make a decision and execute their response. The success of that response is determined by the accuracy of their prediction and the execution of the subsequent physical action to accelerate, decelerate, or change direction. In turn, these physical actions are underpinned by the athlete's strength, power, and reactive strength capacity, and the integration of these within effective and efficient movement mechanics. An athlete that can consistently undertake this process of scanning, forecasting, and successful execution, would be classed as agile.

For many coaches therefore, the end goal of strength and conditioning, aside from resilience to injury and availability for training and competition, should equally be the development of an agile athlete. As such, physical performance coaches must have the skills to train this capacity, which typically involves developing gym-derived capacities such as strength, power, and reactive strength, and integrating them within pitch-based movement patterns underlying effective change of direction mechanics. These movement mechanics, including acceleration, deceleration, and turning, must be challenged under progressively constrained, open drills, in which athletes must make and execute a time-sensitive decision. The decision they execute and the manner in which they do so, ultimately governs their success or failure, and if appraised appropriately, provides rich information and thus an opportunity for reflection and learning.

The aim of this paper, therefore, is to describe the pitch-based development of agility – this is perhaps given less consideration and attention than its gym-derived prerequisites. In achieving this aim, we will first describe the underlying mechanics of agility, namely acceleration, deceleration, and turning mechanics, before describing how they may be developed across a series of drills, that progress from closed and discrete, to open and continuous. We will focus on 60 to 180° turns. This ensures all turns have the demand of deceleration, turning, and reacceleration. Equally, this ensures we focus on drills requiring outside leg turns (60° turns) and inside leg turns (180° turns), thereby more holistically preparing the athlete. Similarly, these turns include some of the most challenging changes in velocity (given the high deceleration and reacceleration demand) and direction (given the large angles), and thus an appreciation of these in terms of biomechanics and coaching progressions (closed and discrete, to open and continuous) will render others more intuitive to train and develop (4).

Underpinning Mechanics of the 180° turn: the synergy of base of support, centre of mass, and direction of force.

Starting with the 180° turn, the athlete will have to decelerate to a complete stop, before turning and reaccelerating. This process is outlined in Figure 1, for which we will initially focus our attention on turning mechanics. The sequence is as follows: the athlete accelerates towards the target (a), initiates the deceleration phase (b-c), and then performs the final deceleration step (which is the penultimate step in relation to the current direction of travel) using the inside leg (left leg in the image) (d). This deceleration phase occurs concurrent to rotating and realigning the body through 90° (b-d). To then go back the other way, the outside leg (right leg in the images) “bounces” off the ground, while the inside leg pushes into the ground to reaccelerate (e). Finally, the outside leg completes the crossover step (f), therefore putting the athlete back into an optimal position to accelerate (g-h); we will explore acceleration in the subsequent section.

Given this sequence, we would define the final step taken in the athlete’s initial direction of travel (Figure 1e), as the first step in the acceleration phase of the intended direction of travel. That is to say, the outside leg “bounce” signifies the initiation of the reacceleration phase, which is driven by the inside leg. As such, the penultimate foot contact (inside leg) both decelerates (d) and accelerates (e) the body within the same ground contact phase. This change in mindset will help the athlete appreciate optimal movement mechanics and the execution of the 180° turn.

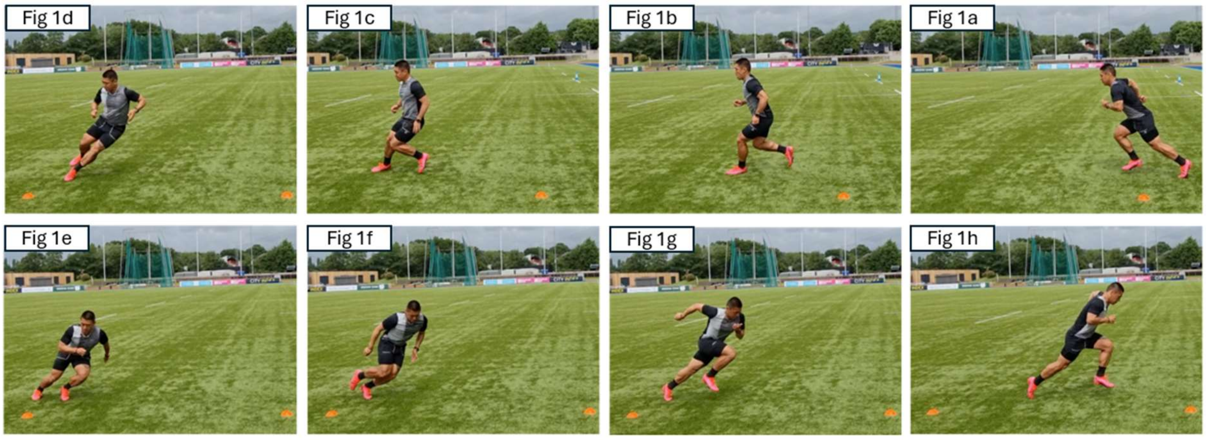

Figure 1 a-h. Movement sequence to complete the 180° turn

The key position in the 180° turn, given our initial focus on turning mechanics, is captured in Figure 1e. This position is ultimately indicative of how successful the athlete was at making the turn and preparing for reacceleration. A successful turn requires the athlete to “fall” into the intended direction of travel, which can only be achieved by us focusing on the inside leg (penultimate foot contact) performing the final phase of the deceleration sequence (see Figure 1d); this is as opposed to the outside leg, which is the more intuitive option. This inside leg strategy ensures our centre of mass (CoM), which can be approximated as the athlete's bellybutton, falls outside their narrow base of support (BoS), thus allowing the direction of force (DoF) to be applied more horizontally than vertically. This position, with the relevant performance indicators (i.e., BoS, CoM, and DoF) is highlighted in Figure 2, better enables the athlete to overcome their own inertia (defined as an athlete's resistance to change in motion), thus reducing the number of footsteps and time taken to realign their body to reaccelerate (fall forward). This success is further underpinned by the percentage of force which is directed horizontally toward the target, i.e., creating a more acute angle from which to apply force. The magnitude of horizontally directed force is in turn governed by the magnitude of separation between the BoS and the CoM.

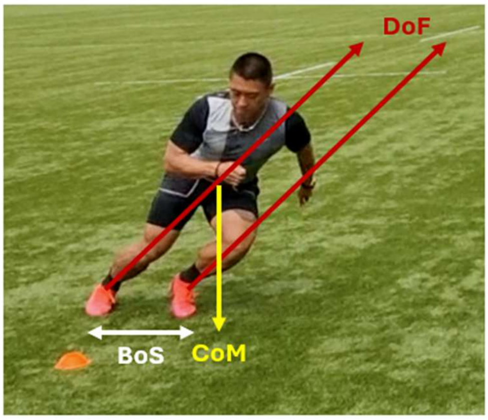

Figure 2. The key position in the 180° turn. The athlete requires a narrow base of support (BoS), with their centre of mass (CoM) outside of it. This way the direction of force (DoF) will be aimed in the intended direction of travel, with the magnitude of horizontally directed force governed by the distance between the BoS and the CoM.

One reason athletes may instinctively use the outside leg to drive the turn, is because they are reaching for the line – presumably under the assumption that touching it sooner means executing the task quicker. However, this is false economy and generally results in a stable position at the turn, whereby the CoM falls between an excessively wide BoS. Consequently, this leads to a more vertically oriented DoF or even the crossing of resultant force vectors from each leg. Similarly, given the outside leg strategy can make it difficult to overcome their momentum and thus inertia, the upper body may lean away from the target direction; this will require additional steps and thus time to resolve (Figure 3).

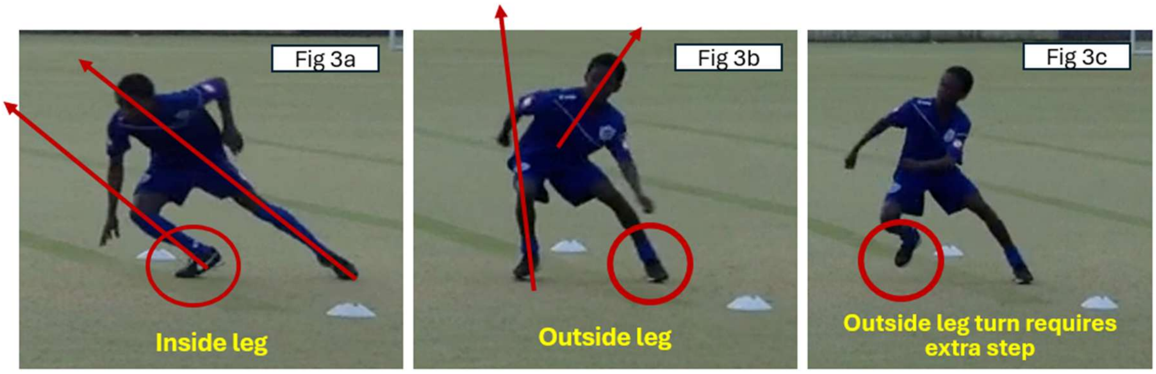

Figure 3. Outside vs. inside leg turn. When touching the line with the inside leg, the body is primed to decelerate and reaccelerate (Figure 3a). However, when reaching for the line using the outside leg, it can be difficult for the athlete to overcome their inertia, thus the upper body may lean away from the target direction (Figure 3b). Collectively, this will require additional steps and thus time to resolve the sub-optimal body alignment with respect to force production and acceleration mechanics (Figure 3c).

Of course, during a 180° turn, there will be many situations in which the constraints of the environment will place the athlete in a situation whereby their outside leg is forced to provide the final deceleration step and biggest contribution to initial acceleration – this is fine and likely an effective adaptation and task execution. But in a closed environment, whereby the athlete can make a choice between strategies (outside leg vs. inside leg), we should coach an inside leg driven turn, and gradually “re-wire” their motor programme such that this becomes the default setting in an uncontested environment.

Acceleration mechanics

The acceleration sequence initiates at Figure 1e. It is both the conclusion to the deceleration phase, as well as the beginning of the acceleration phase. With the attainment of this position, the athlete is maximally primed for acceleration in the opposite direction. Given the acute angle from which the DoF acts, consequent to the CoM being in advance of the BoS, the athlete will "explode" from the line at a ~ 45° angle, with the knee of the outside leg (right leg in the image) being driven horizontally forward (Figure 1f). This position, coupled with achieving a "low recovery" in the next two steps, will keep the athlete leaning (falling) forward and thus accelerating. A low recovery is defined as the trailing foot staying close to the ground, travelling below the knee line of the opposite leg. A low recovery ensures the foot lands quicker creating a positive shin angle at ground contact, and thus maintains the athlete in a position of acceleration. This position, and acceleration mechanics in general, can be better identified via Figure 4. In Figure 4, following a 3 or 2-point stance, the athlete will achieve a ~ 45° body lean, with ~ 90° achieved at the hip, knee, and ankle (i.e., the foot is in plantar flexion). Equally, the arm is "whipped" back and fully extended given the rhythm and timing of footsteps. At initial ground contact, landing ~ below the hips with a positive shin angle (Figure 4b), the trail leg begins its low recovery (Figure 4b-c) before landing in a similar position (Figure 4d); the opposite and incorrect strategy would be an overstride and thus a vertical or even negative shin angle at touch-down, thus incurring deceleration.

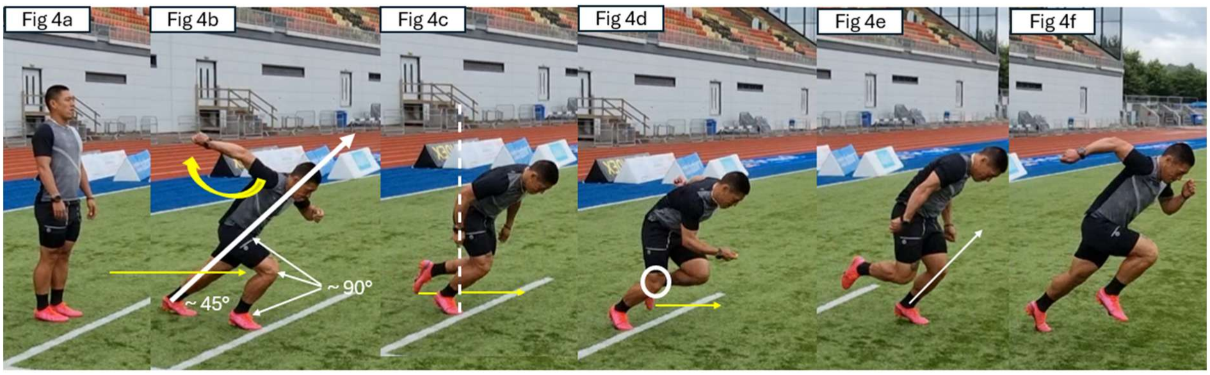

Fig 4a-b: Create ~ 45° lean, ~ 90° @ ankle, knee, and hips, with a horizontally project knee and arm "whip"

Fig 4c-d: ~ land under hip with a positive shin angle, while trail leg initiates low recovery traveling below the knee

Fig 4e-f: Foot lands maintaining positive shin angle and acceleration mechanics

Figure 4. Acceleration mechanics.

Deceleration capacity

If an athlete running forwards wishes to change their direction by less than 60°, they can maintain their speed, that is, there is no need to decelerate; only turns greater than ~ 60° require significant deceleration (1). Deceleration is the opposite of acceleration in terms of mechanics and changes in velocity. As we saw in Figure 4, in acceleration you are fully extending and leaning forward (off-balance, falling forward), over a narrow BoS (the ball of your foot). But in deceleration, you are sitting low and leaning back, over a wide BoS (Figure 1c and Figure 5). Similarly, the further your CoM from your BoS, the greater the deceleration capacity you have (7) on account of the DoF being more horizontally orientated. Furthermore, both feet, which are around shoulder width apart, end up making full contact with the floor – that is, both the balls of the feet and the heels push back against the ground, progressing you towards a stable and balanced position. Unlike turning mechanics, for which we see a variety of strategies (albeit not all are optimal), decelerating is rather more intuitive, with athletes quickly arriving at the same conclusion, that in the main, this can only be achieved if they sit back and widen their base of support to create a position of stability. As such, we seemingly have a more readily available motor programme for this, for which we do not need to refine as much. Our goal, however, should be to ensure we adequately expose our athletes to the mechanical and metabolic demands of deceleration (2). This position, and deceleration mechanics in general, can be better identified via Figure 5.

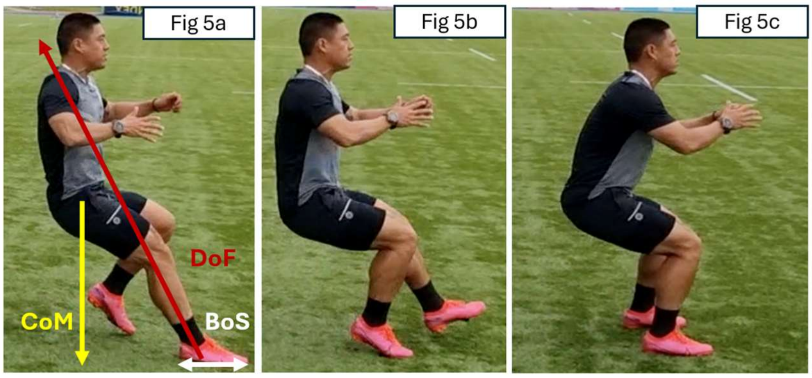

Figure 5. Deceleration mechanics. In deceleration, the athlete sits low and leans back over a wide base of support (BoS). The further the centre of mass (CoM) from the base of support (BoS), the greater the deceleration capacity on account of the direction of force (DoF) being more horizontally orientated.

The deceleration paradox. The faster you run, the slower you stop

From a mechanical perspective, deceleration performance is influenced by body mass and approach velocity, i.e., approach momentum ($\boldsymbol{p} = m \times \boldsymbol{v}$). Moreover, based on the impulse-momentum relationship ($\boldsymbol{J} = \boldsymbol{F} \times \Delta t = \Delta \boldsymbol{p}$, *where* $\boldsymbol{J}$ *refers to impulse*) and Newton's second law of motion ($\boldsymbol{F} = m \times \boldsymbol{a}$), improvements in deceleration are determined by the amount of braking force applied over time, with more force (or the same force but applied over more time) required for greater approach velocities or increases in body mass. Therefore, theoretically, an athlete attempting to decelerate from a greater approach momentum, whether a consequence of greater mass or velocity, will require a greater distance and total time over which to stop, compared to a lower approach momentum. This is likely on account of a greater number of foot contacts required to collectively generate a sufficient braking impulse to progressively reduce the horizontal momentum, with each athlete only able to tolerate so much load per step. This inevitable paradox must be acknowledged by the coach when assessing any skill that involves deceleration. As athletes get faster, they will take longer to stop; this is not a failing in coaching or programming or in the athlete's technique, but rather, a consequence of the laws of motion.

To illustrate this paradox, a worked example using calculations of momentum has been provided. Consider athlete A with an approach velocity of 7 m/s and a body mass of 78 kg (thus a momentum of 546 kg·m/s), compared to athlete B with the same body mass but a slower approach velocity of 5 m/s (390 kg·m/s). Athlete B is more likely to decelerate over a shorter distance and time interval as they have less impulse to generate to overcome their inertia. Similarly, if athlete A and B have the same approach velocity of 7 m/s but differing body masses of 90 and 70 kg respectively, then the greater impulse of A (630 kg· m/s) compared to B (490 kg· m/s) will again mean that athlete B will outperform athlete A when considering deceleration in isolation. While it is tempting to suggest athlete A could compensate for their increased approach velocity and/or body mass via training to increase force application during the braking phase, one would speculate that any training (eccentric or otherwise) that leads to a greater capacity to generate negative acceleration (i.e., deceleration), would also serve to increase positive acceleration and in effect, they may almost cancel each other out (e.g., eccentric training would likely improve stretch-shortening cycle mechanics while sprinting and thus reduce ground contact time and improve vertical force production). Beyond improvements in technique, which is likely limited as the capacity to sit back is logically based on force capacity and tissue tolerance, perhaps a reduction in non-functional body mass may be the best way for athlete A to contend with the performance of athlete B in time and distance to stop. Of course, in some sports, such as rugby, body mass clearly defines positional demands, so an athlete's power to weight ratio will always be a determining factor. As strength and conditioning coaches, we need to be cognisant of the rule: the faster the run up, the slower the turn. The quality of our reflective practice and athlete feedback is contingent on this understanding.

60° turns – performing the Dummy-Jab Step

We now move on to the mechanics of 60° turns, which are the same as those of 90° turns. Anecdotally, these outside leg turns and subsequent positions are more intuitive for athletes (similar to deceleration) as there are seemingly less strategies to effectively complete them than those requiring 180° turns. In Figure 6 the athlete must accelerate to the line, initiating the deceleration phase as late as possible, which again, will be governed by their entry momentum. The final foot contact is a "jab" to the ground, whereby, as the name implies, the ground contact time is minimised as the foot again bounces from the ground. The jab is made lateral to the CoM – the more lateral the jab, the greater the distance between the CoM and BoS (foot) and thus the more horizontal the DoF. In contrast to the 180° turn, it is the outside leg that drives the movement and provides the final footstep, acting as both the end of the deceleration phase and start of the propulsive phase.

The athlete optimally loads the outside leg by transferring all their weight over to it, which is facilitated by performing a "dummy" step, that is, moving as if they intend to travel in the opposite direction. This dummy step and subsequent weight transfer will likely see the upper body rotate and lean away from the intended direction of travel, which is acceptable in this turn. Given this demand for loading the outside leg, athletes should be coached to "sell" the dummy as they go into the turn – the better the dummy, the better the upper body weight transfer to the outside leg, the greater the capacity to generate accelerative force. Furthermore, the greater the lateral excursion of the final foot contact from the CoM, the more the resulting forces can be directed horizontally and thus the better the athlete can position themselves (lean and fall) to deliver effective acceleration mechanics. Acceleration mechanics are as previously described; however, the athlete should be careful to not place the inside leg down to the ground such that it impedes the outside leg driving directly at the target. This is a skill that requires attention and is more pronounced during 90° turns.

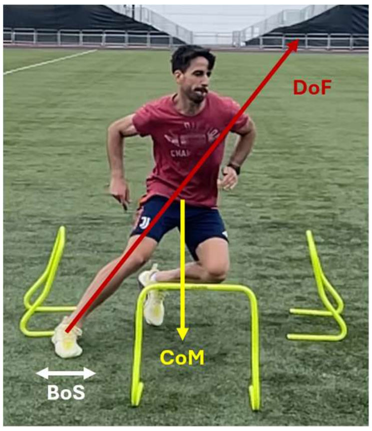

Figure 6. Dummy-Jab Step. The final foot contact is a lateral "jab" to the ground – the more lateral the jab, the greater the distance between the centre of mass (CoM) and base of support (BoS) and thus the more horizontal the direction of force (DoF). The athlete optimally loads the outside leg by transferring their weight over it, which is facilitated by performing a "dummy", that is, moving as if they intend to travel in the opposite direction. The two hurdles facing each other are positioned close to the final hurdle, thereby ensuring the athlete does not break too soon, and thus controlling the angle of the cut.

Practical Application: Training the turns

Again, we will start with the 180° turn and our focus will be on pitch-based drills. We do acknowledge that plyometrics could be trained in the field and would be an excellent addition to prime turning mechanics, however, for the sake of brevity, these will not be discussed. Equally, we will identify several key drills, but this is not an exhaustive list, and all drills should extend to provide a sport-specific context, e.g., involving a football or rugby ball, and combined within relevant patterns of play. An appropriate starting place to commence the coaching of the 180° turn is the Shuffle and Cut (Figure 7). As the athlete works between the cones, maintaining the "set" position (Figure 7a, which is similar to the power position in weightlifting), their principal goal for every turn is to follow the coach's instruction of "*head never goes between toes*". This can be facilitated by ensuring the athlete does not reach for the line with the outside leg, thus maintaining a narrow BoS (Figure 7b), and also, if needed, by allowing the inside hand to touch the floor, thus further promoting the forward lean and fall feel. With this movement skill rehearsed, it can be extended to include resistance bands or bungees, thus challenging the athlete to move away under resistance, and toward with assistance, with the latter challenging their deceleration capacity and mechanics (Figure 8). Following this, the drill can be progressed from a closed environment to an open environment, in which one athlete must mirror the other to ensure they cannot step through the gate at either end (Figure 9). For the athlete aiming to evade and step forward through the gate, it is essentially a closed skill (given they dictate intensity and direction, albeit must be aware of their opponent), thus technique should still be "textbook". However, the athlete aiming to capture will have to respond to the actions of their partner and thus is challenged under time-constraints to decipher the kinematics of their opponent; the challenge for them is far greater.

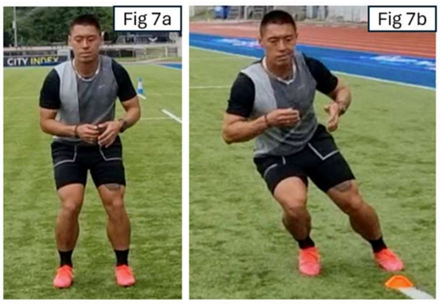

Figure 7. Shuffle and Cut. When moving between the cones, the athletes remain in the set position, which is one of stability (i.e., the centre of mass remains between the base of support) – this way they are ready to respond to any cue. At the cones however, where the athlete makes the turn, they switch to a position of instability, so they can fall (and accelerate) in the opposite direction. This is facilitated by the cue that "*the head never goes between toes"* i.e., the centre of mass falls outside the base of support.

Figure 8. Resisted-Assisted Shuffle and Cut. Resisted on the way out and assisted (challenging braking capacity) on the way back.

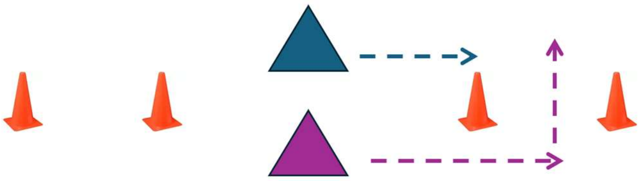

Figure 9. Mirroring. Using only shuffles (side steps) and cuts, the purple athlete must evade the blue athlete to step through either gate without being tagged.

Next, we can integrate the crossover step. Anecdotally, this may not need to be coached beyond allowing athletes to appreciate the significance of a "sharp cut" at the line, such that the CoM is well in advance of the BoS. To demonstrate this, ask the athlete to lean and fall to the side. Instinctively they will perform a crossover step to stop them from falling and face planting (Figure 10). With this appreciation, athletes can progress from lean, fall, and cross-over, to lean, fall, cross-over, and accelerate. Athletes can now incorporate this into the 5-2-180 drill (Figure 11), where again they can rehearse this within a closed environment and thus refine their technique with the help of video analysis and qualitative feedback (5). From this drill, we gradually transition to evermore time-constrained drills requiring decision-making and determination of opponent kinematics. These drills include Tag and Go (Figure 12), and the "Gate Escape" (Figure 13).

Figure 10. Side lean and fall. Instinctively the athlete will perform a crossover step to stop themselves from falling. We can use this inbuilt motor programme to our advantage by focusing our attention on getting the athlete to perform a "sharp cut" at the turn, given this will innately invoke it. This can be encouraged through cues such as "*head never goes between toes*" or initially allowing the athlete to put their inside hand on the ground as they turn.

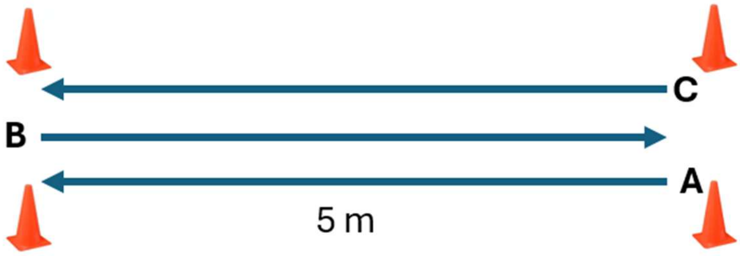

Figure 11. 5-2-180 drill. The athlete, starting at point A, accelerates to the turn-line 5 meters away (point B), performs a 180° turn, reaccelerates back to the start line (point C), then performs a final 180°turn and sprints to conclude the drill. Hence 5-2-180, 5-meter accelerations with two 180° turns. The athlete should always face the same way when they turn, to ensure both legs are trained.

Figure 12. Tag and Go. The tagger must tag the other player's hand and then escape to the line without being tagged themselves. This drill forces the tagger to adopt 180° turn mechanics to optimally prime their position to avoid being caught. Note how they instinctively adopt a side-on position, leaning into the turn before they tag (Fig 12 a), and thus ensuring a cross-step into acceleration as they escape (Fig 12 b to d).

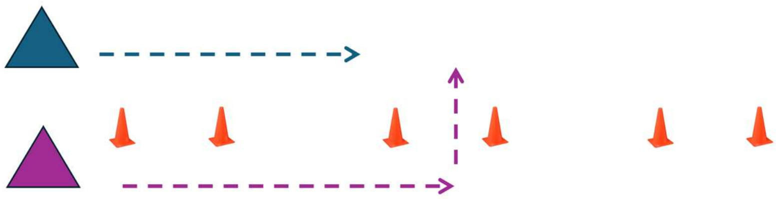

Figure 13. The "Gate Escape". The evading purple athlete aims to escape through any gate, while the blue athlete aims to block them and tag them as they step through. This drill encourages rapid changes in direction to deceive and track each other.

Training Acceleration

These drills feed into all turns and therefore some coaches may prefer to prioritise these first. In professional sports however, these may be paired with top speed running days, which are separated from change of direction days. Anecdotally, acceleration is best taught starting from a wall drill, in which the athlete can rehearse key movement patterns (principally ensuring the maintenance of ~ 90° at the ankle, knee, and hip), progressing from single switches to double and triple switches (Figure 14). This movement is then progressed to performing these switches against the resistance provided by a coach or sled, thus allowing the athlete to lean and fall forward, yet focus on technique (Figure 15). From here, the athletes progress to incorporating acceleration starts, which lead into and incorporate the practiced switches. We advise starting from a kneeling 2-point stance (Figure 16), as this constrains the task such that the lead leg initiates the acceleration with a forceful push against the ground. From here, progress to a 3-point start (Figure 17), lying start, and then a standing 2-point start. Bar the lying start, get the athlete to set up their position by first ensuring their foot and knee are roughly in alignment, and for the 3-point start, the hand is placed roughly one foot length in front of these. As they rise up from the 3-point start (into 2 and 3-point stances), this position will ensure they can optimally lean forward, load the front leg, and create a positive shin angle. With these techniques rehearsed, various partner races and games can ensue, thus driving the intensity of practice.

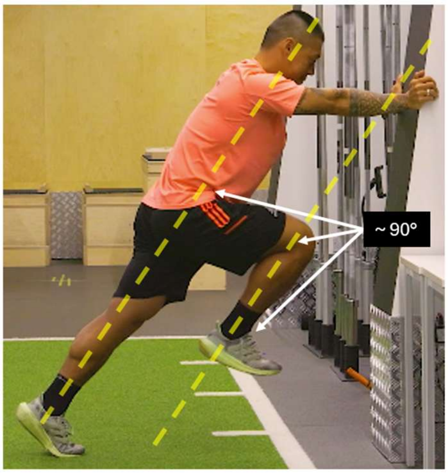

Figure 14. Acceleration wall drill. Single, double, and triple switches. At the conclusion of each switch, the athlete must achieve ~ 90° at the ankle, knee and hip, with parallel lines running between the trunk and shin.

Figure 15. Band resisted acceleration. This allows the athlete to lean forward yet focus on technique.

Figure 16. 2-point acceleration starts. This constrains the task such that the lead leg initiates the acceleration with a forceful push against the ground, with a positive shin angle facilitating horizontally directed force.

Figure 17. 3-point acceleration starts. Athlete sets up by first taking a kneeling position such that the knee and foot are roughly aligned (see figure 16a). They then place their hand one foot's distance forward, before rising into the 3-point start.

Training Deceleration

Deceleration mechanics are trained as part of any change of direction or agility drill requiring turns > 60°. That said, it can also be trained in isolation through decelerating to the line drills (Figure 5), which can progress to making lunge stops at the line. An additional progression includes the "Clothesline" drill, which is a partner race whereby only the athlete whose lane is impeded by a foam noodle should decelerate (prior to hitting it), while the other should continue to accelerate past (Figure 18).

Figure 18. Clothesline deceleration drill. This is a partner race whereby only the athlete whose lane is impeded by a noodle should decelerate (prior to hitting it), while the other should continue to accelerate past (without slowing down).

Training 60° turns

The set-up we will use for the 60° turns is illustrated in Figure 19. Of course, this can be manipulated and arguably outside of testing (if choosing to do so) this precision is largely unnecessary. However, using these dimensions, ensuring the athlete makes the turn somewhere between the mannequin and the cones situated 0.5 m away, the athlete is likely to make a ~ 60° turn. The first drill involves the athlete getting as close to the mannequin as possible before selling a dummy, whereby based on Figure 19, the left leg steps (jabs) to the left of the mannequin. The drill is then progressed to a 1v1 Dummy-Jab Step drill, in which the evading athlete must run between one of two gates positioned either side of the defending athlete (Figure 20).

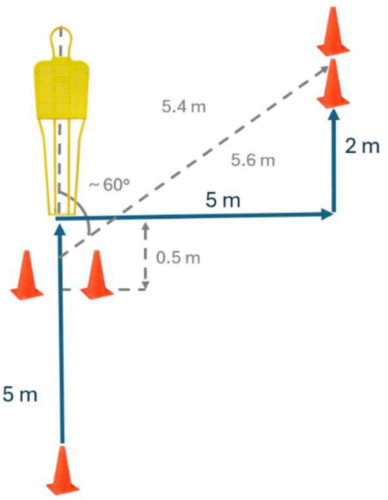

Figure 19. 60° turn set-up. Using these dimensions and ensuring the athlete makes the turn as close to the mannequin as possible, but at least after the cones situated 0.5 m away, the athlete will make a ~ 60° turn.

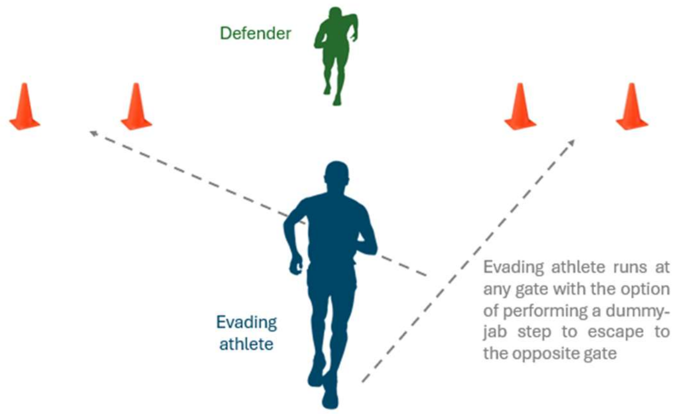

Figure 20. 1v1 Dummy-Jab Step drill. The evading athlete must run between one of two gates positioned either side of the defending athlete, with both athletes setting off at the same time. The defender attempts to tag the evading athlete before they can pass through a gate.

Conclusion

As coaches we must coach. To enable this within agility training, we must understand movement mechanics and thus the fundamental principles that underpin good technique. Within speed and agility training, a detailed appreciation of how the CoM and BoS interact to affect the DoF, better enables coaches to cue and correct movement patterns. This understanding and the ensuing technical models ensure athletes have the best chance of executing the task effectively and efficiently. Our coaching drills must therefore progressively challenge an athlete's ability to maintain the fundamental mechanical principles during a variety of different scenarios and challenges, progressing to game-based contexts, which drive competition and thus intensity, and ensure chaos and unpredictability akin to the demands of sport.

Agility, or in the case of this article, the teaching of 60 - 180° turns, can be taught as part of a block phased agility curriculum, whereby learning one skill primes the development of the next (Figure 21). The blocks identify the training emphasis, not the sole focus. Equally, our focus here is on teaching 60 - 180° turns, but a more holistic curriculum would also include for example, arced or circular runs, and conclude with top speed sprinting. Within each block, movement competency and autonomy are taught progressively, such that the underpinning principles are first established within closed skills, with movement demands progressing in complexity. The drills then progress to games and sports specific scenarios (open skills), where the challenge switches to attempting to apply the principles under time constraints and high cognitive load. In summary, the athlete learns the principles and how to apply them to various movement problems, before applying them to open-skill-based games and sport specific scenarios. The principles never change, only the way in which we must adapt to apply them.

Figure 21. Block phased agility curriculum. The blocks identify the training emphasis, not the sole focus. A more holistic programme would also include top speed and arced runs as the final blocks, but a discussion of these is outside the scope of this text.

References

1. Dos' Santos, T., Thomas, C., Comfort, P., & Jones, P. (2018). The effect of angle and velocity on change of direction biomechanics: An angle-velocity trade-off. *Sports medicine*, 2235-2253.
2. Harper, D., Carling, C., & Kiely, J. (2019). High-intensity acceleration and deceleration demands in elite team sports competitive match play: a systematic review and meta-analysis of observational studies. *Sports medicine*, 1923-1947.
3. Lin, J., Dos'Santos, T., Xu, X., Li, W., & Turner, AN. (2025). The Deceleration Paradox: The Faster You Run The Slower You Stop. *Journal of Strength and Conditioning Research*.
4. Stewart, P., Turner, A., & Miller, S. (2014). Reliability, factorial validity, and interrelationships of five commonly used change of direction speed tests. *Scandinavian journal of medicine & science in sports*, 500-506.
5. Turner, A. (2025). *Sportsmith*. Retrieved from https://www.sportsmith.co/articles/building-the-5-2-180-change-of-direction-speed-test/
6. Turner, A., Read, P., Maestroni, L., Chavda, S., Yao, X., Papadopoulos, K., & Bishop, C. (2022). Reverse engineering in strength and conditioning: applications to agility training. *Strength & Conditioning Journal*, 85-94.
7. Wei, L., Lin, J., Dos'Santos, T., & Turner, A. (2025). Mechanical determinants of superior horizontal deceleration performance in multidirectional spotrspersons. . *Journal of Strength and Conditioning Research.*