Agility Training for Experienced Athletes: A Dynamical Systems Approach

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SUMMARY

RECENT EVIDENCE SUGGESTS THAT AGILITY IS A TRAINABLE MOTOR SKILL THAT CAN BE ACQUIRED THROUGH PROPER PROGRESSIVE PRACTICE. THIS PAPER IDENTIFIES AND DISCUSSES PERTINENT CONCEPTS IN MOTOR LEARNING TO ASSIST ATHLETIC PERFORMANCE COACHES WITH THE DESIGN AND IMPLEMENTATION OF AN EFFECTIVE AGILITY PROGRAM FOR EXPERIENCED OR TRAINED INDIVIDUALS.

INTRODUCTION

Successful performances in many sports, such as football, tennis, basketball, and soccer, often require recognition and appropriate reaction to various sport situations. Individuals select and refine movements based on task-relevant cues, including an opponent and/or external object (18,21). Such movements, important to enhanced athletic performance, are conceptualized as agility. Generally, athletic performance coaches are responsible for the improvement of agility. However, a level of ambiguity surrounds the definition of agility. Optimal technical instruction is elusive because research does not support an inclusive teaching model (22). Furthermore, the absence of effective training programs appears to be a product of such uncertainty. Hence, coaches often encounter difficulty employing methodologies that seek to improve this key component of athletic performance.

Agility frequently includes sprinting in a straight line and/or rapid deliberate changes of direction. Research (23), however, supports the theory of specificity. Consequently, straight line sprinting is not expected to translate and, therefore, enhance agility. Moreover, sport activities that require planned changes of direction, such as rounding the bases in softball, are rare (22). Therefore, training that employs structured and intended movement patterns may not be advantageous to most sports. Besier et al. (3) also note that the likelihood ofinjury is increased with unplanned movements. Thus, agility training that uses only such predetermined actions may not only reduce athletic performance but also increase the risk of injury.

For the purpose of this paper, agility is defined as a physical skill that enables individuals to rapidly and efficiently decelerate, change direction, and accelerate in an effort to react appropriately to task-relevant cues (18). Literature has recognized agility as a trainable motor skill that can be improved through proper progressivepractice (9,11,12,16). The purpose of this paper was to identify and discuss pertinent concepts in motor learning to assist athletic performance coaches with the design and implementation of an effective agility program for experienced or trained individuals.

AGILITY TRAINING PROGRESSIONS

As skillful movement is established and refined, it is advantageous for a performance coach to organize agility training sessions according to the level of performer (1,7,8,14). Contextual interference (CI) refers to the relative amount of interference created when integrating 2 or more tasks into a particular aspect of a training session (10). In a low CI schedule, skills are practiced individually, whereas a high CI arrangement involves

KEY WORDS:
motor skill; agility; variance; contextual interference; information-movement couplings

Table 1
Agility training progressions

Technical training	Technical skill development	Acceleration, deceleration, COD drills, lateral shuffle, backpedal, release step
Pattern running	Closed skill drills in various directions over prearranged distances	COD drills using sprint, lateral shuffling, and backpedaling movements
RAT	Open skill drills according to perceived task-relevant cues	Competitive drills (i.e., mirror, tag, shadow, and dodging activities)

COD = change of direction; RAT = reactive agility training.

the concurrent practice of multiple movement actions. An agility training session for basketball, for instance, would include straight sprinting, lateral shuffling, release/sprint steps, and backpedaling.

Low CI schedules would consist of practicing one skill at a time, whereas a high CI schedule would involve the combination ofall 4 movement actions during a single drill or repetition. High CI schedules tend to overwhelm learners in the earlier stages of skill acquisition and can depress performance (7,10). Conversely, low CI schedules permit novices to make minor adjustments in technique during successive practice trials (12). Individuals who possess an advanced level of technical proficiency, however, may not benefit from low CI schedules. Thus, combining movement actions in a drill can add a moderate amount of CI or variability that may further advance skill acquisition. Pattern running, for example, is a frequently implemented tool to accomplish such a thing.

Pattern running generally involves a series of structured movement patterns that reinforce sport-specific actions (13). Predetermined movements are assigned to each repetition, and several repetitions are performed in succession to teach or fine-tune specific movements. Closed skill movements in various directions over prearranged distances are useful to build correct movement patterns in novice athletes (9). Table 1 provides examples of training progressions, whereas Table 2 illustrates agility drills using varying CI schedules associated with the individual's experience.

Once a high level of technical proficiency is attained, closed skill movements may not be beneficial. During most sporting events, an athlete's movements are initiated in response to the dynamic and specific circumstances of the external environment. Therefore, the ability to respond appropriately to perceived task-relevant cues or exploit information-movement couplings characteristic of a particular situation is advantageous (4). Tennis players, for instance, are commonly advised to pay close attention to their opponent's racket position during a serve to calculate and then move to that point where the player expects his/her opponent to hit the ball (2).

TRAINING INFORMATION-MOVEMENT COUPLINGS

Most of the literature that is focused on agility training employs testing that involves predetermined pattern running and planned changes of direction (4,8,13). However, the effectiveness of movement is primarily associated with an appropriate use of motor abilities specific to the perceived solution of a task presented by a dynamic interaction with the external environment. People possess an extremely high adaptive capacity to refine movement to achieve such resolutions (6). Moreover, individuals have the capacity to adjust motor actions so as to successfully master perceptual degrees of freedom or movement possibilities based on perceived task-relevant cues which, in turn, facilitates more suitable, stable, and controllable movement (2,14). What follows is the development of motor abilities that enhance coordinated movement to achieve a successful outcome (6,14). Therefore, exercise selection based on

Table 2
Agility training using a low/high CI schedule

Low CI	Technical training using only one movement during a single drill	Novice/beginner
Moderate CI	Pattern running using 2-3 movements during a single drill	Moderately skilled
High CI	Pattern running using all/most movements associated with a particular sport/activity during a single drill RAT	Skilled

Novice athletes may become overwhelmed if too many movements are introduced. A broader array of movements may be presented, and higher CI schedules implemented, as the athlete attains a greater level of technical skill.

CI = contextual interference; RAT = reactive agility training.

specific task dilemmas is essential to skill acquisition. Over time, the regular execution of such skillful motor actions will allow the physical structure of the body to adapt, thus further increasing the effectiveness of the movement (18).

Research suggests that skilled athletes produce quicker and more accurate responses because of their increased abilities to pick up task-relevant cues from their environment (1,5,14,15,19–21).

These athletes have the ability to distinguish among several applicable sources of external information to initiate and control movement. Skilled athletes can further differentiate among sources of information and act on the most useful and, at the same, exclude cues that are irrelevant to increase a coordinated motor action (14).

Studies have concluded that skilled soccer players, for example, demonstrate superior visual search strategies (5,14,15,19). Williams and Davids (19) found these players employ fewer ocular fixations compensated by longer fixation durations to pertinent task-relevant cues. The same study also reported that novice soccer players had higher initiation and reaction times during a one-on-one situation. Conversely, experienced players better extracted relevant cues from the position of their opponent's hips, lower leg, and midchest area to more accurately anticipate the opponent's movements. In a related study, skilled soccer goalkeepers demonstrated greater accuracy in predicting the direction of penalty kicks than novices. These athletes also had a greater ability to recognize and attend to pertinent visual cues such as the head, kicking leg, and ball (15). Recently, Farrow et al. (5) developed an agility test that required netball players to change directions in response to a video clip of an attacking opponent. It was determined that skilled players possessed lower decision, initiation, and total movement times than novices.

Savelsbergh et al. (14) proposed that because perceptual information and movement are specifically interlinked,

Table 3
Example of a preseason agility training session for a men's college basketball team

CI schedule	Drills	Repetition(s)	Duration of repetitions	Rest interval
Low (TT)	3–5	1	:10–:20	:30–:60
Moderate (PR)	5–7	1–2	:10–:20	:30–:60
High (RAT)	10–15	1–3	:5–:30	:15–1:30

During the preseason, agility training sessions are designed to enhance conditioning once a level of technical proficiency is attained. Acute rest intervals can be modified as players increase their level of fitness. It is assumed that individuals have experience with the structure of agility training sessions and are technically proficient. Each session is preceded by a thorough dynamic warm-up.

CI = contextual interference; TT = technical training; PR = pattern running; RAT = reactive agility training.

Figure 1. Lateral mirror drill.

Figure 2. Sprint/backpedal mirror drill.

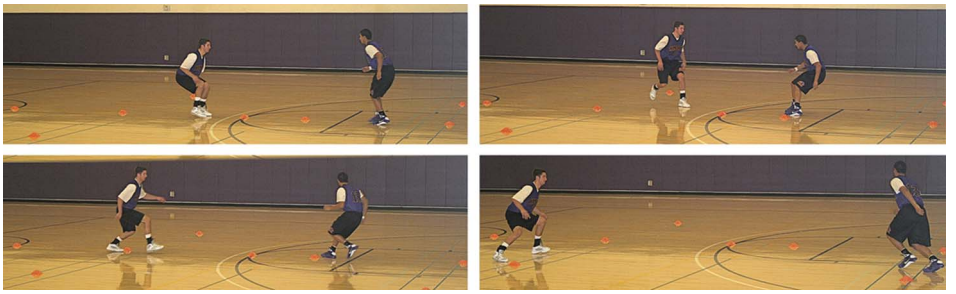

Figure 3. Shadow drill.

training should reflect specific information-movement couplings. In other words, drills in practice should replicate game situations. The obligation of a coach is to implement a set of conditions that encourage a player to adjust to specific information-movement couplings. Hence, agility sessions that reinforce game-like situations and compel athletes to respond with appropriate maneuvers are a beneficial method of training (16). Furthermore, agility sessions should be carried out at a high level of intensity to ensure that athletes refine information-movement couplings under circumstances that replicate the pace, variability, and energy demands of a particular sport. Table 3 depicts an example of a preseason agility training session for a men's college basketball team.

REACTIVE AGILITY TRAINING

To achieve a high level of proficiency, performance coaches should create a set ofconditions that impel an athlete to attune to specific information- movement couplings characteristic of his/her sport. Only under such variable conditions can an athlete expand and further exploit a repertoire of couplings (14). Based on previously documented differences in the way a skilled player exploits information-movement couplings as compared with a novice, the application of reactive agility training (RAT) sessions that replicate game situations is advised. RAT sessions that relocate an athlete's attention to the kinematics of an opponent or force the athlete to make a choice in response to the early appearance of such kinematic information will improve anticipatory abilities and subsequently produce specific appropriate movement actions (22,23). The following RAT drills, for instance, can be used to train athletes to read and react to key stimuli, which in turn, will improve agility: (a) mirror drills (Figures 1 and 2), (b) shadow activities (Figures 3 and 4), and (c) tag games.

VARIANCE WITHIN A TRAINING SESSION

Agility training sessions can be varied by implementing constraints, or limiting task-relevant cues, to certain drills. Manipulating constraints can increase and decrease the perceptual degrees of freedom to increase skill acquisition (2). Functional coordination patterns can be manipulated by altering key constraints including the structural organization of particular drills or the practice environment, characteristics of the individual, and the nature of information made available to the performer during an activity (2). Manipulating constraints can also lessen stagnation and reduce monotony to ensure motivation levels remain high, and an effective learning environment is maintained.

Distances and drills can be manipulated depending on the goals of the agility training session. Auditory and visual task-relevant cues can also be alternated. For example, although performing a lateral shuffle, vary change of direction cues with verbal and nonverbal prompts. Furthermore, RAT partners can also be changed. Stagnation can be reduced or prevented if individuals are allowed to switch partners and challenge more agile teammates.

Equipment that offers resistance, such as rubber tubing, can offer benefits to experienced participants. The addition of equipment is also helpful and can replicate game situations and increase sport-specific agility (19). Rackets, for example, can be held by racquetball, badminton, and tennis players. Basketball and soccer players should be encouraged to dribble during agility training sessions once a proficient level of skill is obtained.

The length of agility training sessions can be varied dependent on the time of the season. Performance coaches may want to employ agility training after a weight room or conditioning session, for instance, to induce fatigue similar to end-of-game situations. However, if technical proficiency is the goal, it is advisable to schedule agility training

Figure 4. Further depiction of shadow drill.

Table 4
Eight-week preseason agility program for a women's college basketball team

	Contextual interference	Drills	Repetitions	Duration of repetitions	Rest intervals
Week I					
Session 1	Low	10–12	2–3	:10–:20	:30–:60
Session 2	Low	15–20	2–3	:10–:20	:30–:60
Session 3	Low	5–10	2–3	:10–:20	:30–:60
Week 2					
Session 1	Low	12–15	2–3	:15–:25	:45–1:15
Session 2	Low	18–22	2–3	:15–:25	:45–1:15
Session 3	Low to moderate	8–10	1–3	:15–:25	:45–1:15
Week 3					
Session 1	Low to moderate	10–12	1–3	:10–:20	:30–:60
Session 2	Low to moderate	15–20	1–3	:10–:20	:30–:60
Session 3	Low to moderate	8–10	1–3	:10–:20	:30–:60
Week 4 (unloading)					
Session 1	Low to moderate	4–5	1–2	:10–:20	:30–:60
Session 2	Off				
Session 3	Low to moderate	4–5	1–2	:10–:20	:30–:60
Week 5					
Session 1	Moderate to high	10–12	1–3	:10–:20	:30–:60
Session 2	Moderate to high	15–20	1–3	:10–:20	:30–:60
Session 3	Moderate to high	8–10	1–3	:10–:20	:30–:60
Week 6					
Session 1	Moderate to high	10–12	1–3	:15–:25	:45–1:15
Session 2	Moderate to high	15–20	1–3	:15–:25	:45–1:15
Session 3	Moderate to high	8–10	1–3	:15–:25	:45–1:15
Week 7					
Session 1	Moderate to high	10–12	1–3	:15–:25	:45–1:15
Session 2	High	15–20	3–5	:15–:25	:45–1:15
Session 3	High	8–10	3–5	:15–:25	:45–1:15
Week 8 (unloading)					
Session 1	High	4–5	1–2	:10–:20	:30–:60
Session 2	High	4–5	1–2	:10–:20	:30–:60
Session 3	Off				

Agility sessions are part of a preseason program that includes resistance training. Acute recovery times can be altered as players increase their level of fitness. Each session is preceded by a thorough dynamic warm-up.

sessions before other workouts. Acute recovery times can also be altered to condition an athlete for a particular sport during the preseason training phase (Table 4). The performance coach is limited only by his/her imagination and knowledge of the sport when organizing agility training sessions.

CONCLUSIONS

The lack of an agreed on definition has hindered investigations on agility. Testing has also failed to identify those aspects most important to agility. Therefore, an inclusive teaching model is elusive. Moreover, the absence of effective training programs appears to be a product of such uncertainty. Hence, coaches often encounter difficulty employing methodologies that seek to improve this key component of athletic performance.

Despite extensive literature, there is only limited research that has focused on the development of agility (22). Agility sessions that include a low level of CI are recommended for novices. Pattern running that employs several combined predetermined movements can add a relative amount of CI. A high level of CI, however, can overwhelm learners in the earlier stages of skill acquisition and can depress performance (7,10). As skillful movement is established and refined, it is advantageous for a performance coach to organize agility training sessions according to the level of performer (1,7,8,14).

Closed skill movements may not be beneficial once a high level of technical proficiency is attained. During most sporting events, an athlete's movements are initiated in response to the dynamic and specific circumstances of the external environment. Hence, the ability to respond appropriately to perceived task-relevant cues characteristic of a particular situation is advantageous (4). Research suggests that skilled athletes produce quicker and more accurate responses because of their increased abilities to pick up task-relevant cues lrom their environment (1,5,14,15,19–21). Thus, drills that replicate game situations can be more effective to enhance agility in skilled performers. Varying constraints can also limit perceptual degrees of freedom to further increase skill acquisition in skilled athletes.

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