A Task-Based Approach to Developing Context-Specific Agility

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SUMMARY

Effective movement is a key element of elite sports performance in a range of sports, and agility training has become an important element in many sports performance enhancement programs. Traditionally, agility training has focused on the execution of closed drills that allow for the development of effective movement patterns but may not optimally transfer directly to enhanced sports performance. This article aims to examine the nature of reactive agility and provide a theoretical support for the application of reactive agility exercises and also suggests methods of delivering these exercises to maximize the transfer to enhanced sports performance.

The Nature of Agility

Before examining the optimal methods of developing agility, a necessary starting point is to establish the precise nature of agility performance in sport. Specificity of exercise and training is among the most important considerations in designing training interventions. Precise definitions of fitness components, and an understanding of their direct application to performance, are therefore important. Additionally, any definitions used can influence the way in which the development of important fitness variables is approached. Of all the elements of performance addressed within strength and conditioning, agility provides the greatest definitional challenge. Part of this is because agility is ultimately specific to the context in which it is expressed and even specific to a given situation within each context (15). For example, in tennis, the agility requirements of running wide to hit a forehand are different to those required of running to the net and having to hit a half volley.

Traditional definitions of agility have focused on the typical movement patterns associated with this concept. Definitions have involved elements, such as direction change and deceleration. Plisk (19), for example, defined agility as the skills and abilities needed to explosively change movement velocities or modes. The focus on these definitions has been the identification of key movements associated with agility, and training has duly focused on developing these movements via the application of numerous closed drills. However, these types of definitions typically do not take into account the context of the movement. Because of this, they omit the cognitive and perceptual influences that control which movement needs to be performed and, just as importantly, when it needs to be performed.

One potential consequence of these definitions is that agility is viewed as a single entity, with training simply focusing on development of the identified movements themselves. The removal of the contextual and cognitive elements can result in agility being developed almost totally via the use of closed drills, where movement patterns are preplanned, and with skill development based on a behavioral approach to learning (23,24). Although these types of exercises are extremely useful in the development of effective technique, they do not reflect the rapid and varied responses of movement typical of a game situation. In reality, sports where preplanned changes of direction are required are rare, and most sports involve decision-making requirements, with subsequent movement dependent on these cognitive processes. To maximize eventual transfer into performance, these closed-skill exercises need to be supplemented with those that involve increasing cognitive demand and which progressively reflect the precise movement requirements of the game. This open and reactive nature of sports movement also questions the relevance of closed-skill tests in distinguishing between performance levels (21).

When agility is contextualized, it becomes clear that agility is complex, involving far more than simply the performance of certain movements (30). In sport, although a number of movement patterns are clearly...
discernable, their combinations are random and occur in response to perceptual and decision-making factors (13,15). It would seem logical that an effective definition of agility should include reference to these decision-making requirements. Sheppard and Young (21) proposed a definition of agility as “a rapid whole-body movement with change of velocity or direction in response to a stimulus.” This definition moves the concept of agility forward, as it still includes key movement patterns, but also makes reference to the stimulus that, both triggers the required movement, and dictates the precise movement required.

This emphasis on the reactive elements of agility has led to new approaches being suggested for effective agility development, such as the dynamic systems approach (11), to supplement the behavioral approach. The dynamic systems approach to motor learning asserts that movement patterns arise from the organization of the neuromuscular system in response to biomechanical factors, morphological factors, environmental factors, and task constraints (5). Skill is thought to emerge when the individual is able to control the degrees of freedom of a movement (16) and hence requires the manipulation of degrees of freedom over time, with a subsequently greater emphasis on reactive-based agility exercises.

**AGILITY AS A CONTEXT-SPECIFIC ENTITY**

While identifying the need to consider the type of stimulus, the above definition still implies that agility is a single entity and thus transferrable between different sporting contexts. The question arising concerns the transferability of agility. Is agility developed in one context (e.g., tennis) directly transferable to another (e.g., basketball), or are there discernable differences between the movement requirements of these sports that limit the degree of transfer?

To maximize the transfer from training to performance, it is clearly important to understand the precise movement requirements of the sport itself, what can be viewed as Gamespeed (12). Gamespeed has been defined as “context specific movement, where an athlete maximises their sports performance via the application of sport-specific movement of optimal velocity, precision, efficiency and control; in anticipation of, and in response to, the key perceptual stimuli, and skill requirements of the game” (12). If the ultimate aim of agility training is to maximize sports performance via developing effective movement abilities and patterns, then the key elements of this definition will equally apply to the concept of agility, and this provides an effective working definition for agility.

Agility can therefore be viewed as a context-specific ability, with athletes attempting to maximize their sports performance using effective movement as and when required. This definition encourages coaches to focus on the specific game-related tasks required within each sport and identifies key movement abilities required to enhance performance in these tasks. This allows a full contextualization of movement and allows differentials between sports to be identified, as well as key task differentials between differing playing positions within the same sport.

Importance is also paid to the fact that not all movements require maximal velocity; instead, an athlete will spend a great deal of time waiting to react to a stimulus. In these instances, the key to effective performance is not necessarily their velocity of movement but, instead, the ability to constantly adjust their position to allow them to optimally react to a stimulus when it occurs—what have previously been termed “transition movements” (13). This is an important concept because skilled performers have been found to make higher-frequency and lower-amplitude movement adjustments than nonskilled performers (22). This reflects the fact that skilled performers are continually making adjustments in their movements in response to the ever-changing environment around them. These adjustments may not be discernable via traditional agility tests but will play a vital role in the ultimate effectiveness of the performers on the playing field, allowing them to maintain an effective position from where to react rapidly and effectively as required. Additionally, the definition focuses on the fact that movement is typically in response to, or in anticipation of, sport-specific stimuli and, thus, forms a variable for the development of effective agility exercises.

What is important is what the definition encourages the coach to focus on. It allows the coach to develop a much more sports-specific outlook, where the movement patterns developed are directly related to the sport-specific tasks required and linked to the specific stimuli that both trigger and control the required movement response. This change of focus allows for the development of more context-related exercises and maximizes the opportunity to transfer practice into enhanced sports performance. Additionally, the specific cognitive and decision-making processes are emphasized in addition to solely focusing on the required movement patterns, further maximizing the transfer to performance.

**LIMITS TO AGILITY**

Given the context specificity of the application of agility, it is important to determine factors that will influence and ultimately limit agility performance. Using a constraints-based approach to skill development, 3 key constraints (organismic, task, and environment) can be seen to interact to determine the optimal patterns of coordination and control for any activity (18). The model outlined in Figure 1 provides a theoretical framework with which to analyze agility and focuses on potential constraints that could limit performance. The characteristics of each constraint are outlined below.

**ORGANISMIC CONSTRAINTS**

These relate to the characteristics of the athletes themselves and how these interact to affect movement. It is important to note that physical capacities are only one of the organismic...
constraints to reactive agility. Effective reactive agility will also involve perceptual, cognitive, and motor control elements.

Physical constraints are the elements typically considered by the strength and conditioning coach. Factors, such as force capacities, muscle fiber types, and anthropometrical considerations, will contribute to effective movement capacity. Newtonian laws suggest a close relationship between force capacity and agility. However, concentric strength and power measures appear to be low predictors of change of direction speed (29). This suggests that factors other than strength alone play a major role in direction change performance. As a single physical predictor, reactive strength may be a better indicator of (or at least has a stronger relationship with) change of direction speed (30). This is likely because of the stretch-shortening cycle involvement in these activities. However, these relationships are not strong (30). Given that the relationships between strength and power within closed preplanned change of direction tests are limited, it is highly likely that these relationships will be even lower where reactive tasks are analyzed.

Perceptual constraints relate to the athlete’s ability to control his or her gaze and focus on the key factors that will trigger and control the subsequent movement requirements. Research has suggested that the ability to identify and attend to task-relevant cues is one of the reasons why elite athletes produce faster and more accurate movement responses (3,10,26). Only by integrating these reactive elements effectively into training can these perceptual constraints be developed.

Cognitive processes contribute greatly to effective sport-related movement. These involve a range of diverse elements, such as the recognition of movement patterns, the anticipation of forthcoming events, and the ability to focus and concentrate on critical elements contributing to performance. Closed drills will not effectively develop these abilities and so need to be supplemented with exercises designed to optimally develop these capabilities.

Motor control constraints refer to the athlete’s capacity to select and use appropriate motor patterns under the pressure of game situations. These are related to the quality of motor development an athlete has undertaken and the stability of these patterns under intense pressure (13,15).

ENVIRONMENTAL CONSTRAINTS
These relate to the characteristics of the environment in which the athlete is performing and how these directly affect performance. Elements, such as
the playing surface, playing dimensions, position of opponents, the ambient temperature, and wind conditions, need to be considered when analyzing the environmental constraints to performance. Where a range of playing environments are used in sport (e.g., tennis), different movement strategies may need to be developed to maximize performance in each and programs designed to develop these.

**TASK CONSTRAINTS**

These will ultimately dictate the nature of effective movement outcomes and will differ greatly between sports. The expression of agility will ultimately be context specific, and although a number of generic movement abilities are required, ultimate success will be dependent on their transferability to a given task requirement. For example, a defensive requirement for a football linebacker stopping the run will be to use an effective tackle in an attempt to stop any forward progress of the running back. Although the basketball forward may also be trying to prevent the opposing forward driving to the basket, such an action as used by the linebacker will be totally unsuccessful because the rules of the game dictate that this type of action is illegal. Therefore, the aim of the task and the rules of the game are key task-related constraints that have to be accounted for. Similarly, in sports where equipment is a major feature, such as lacrosse, hockey, and tennis, these need to be accounted for when considering the task constraints because they will ultimately affect the movement patterns deployed.

An important factor to note is that the relative importance of each constraint will change between sports and within different contexts within the same sport. In any given situation, an athlete will be faced with a range of stimuli and a range of subsequent movement choices. What is important is that the training environment is able to prepare the athlete for as many of these combinations as possible.

**A TASK-BASED APPROACH TO AGILITY DEVELOPMENT**

Clearly, agility is more than merely a physical concept, and effective agility development will ultimately need to address as many of the above constraints as possible. Effective movement in a game context involves a perception-action cycle that seeks information from the external environment and processes this to elicit the appropriate response (18). Although closed-skill drills are an effective way of developing basic technique, they do not reflect the random open nature of sports performance and do not involve this perception-action cycle. Therefore, these tools will be limited in their ability to address the perceptual and cognitive aspects of agility performance. Although closed drills are a useful tool in the development of effective technique, coaches need additional tools with which to maximize the transfer to performance. A task-based approach to agility development provides a contextual model with which to analyze and explain agility performance in any given situation and is based on constructing effective skill learning environments that address the context-specific perception-action cycle.

**EFFECTIVE SKILL LEARNING ENVIRONMENTS**

Given the role of skill development to effective agility expression, it is important to examine factors that contribute to effective skill learning. An important caveat here is that skill development and motor learning studies are limited within the agility development field. This requires that studies from other fields be examined and the conclusions extrapolated to apply to the strength and conditioning environment.

In looking at effective skill development, it is useful to analyze the characteristics of elite performance, both in training and in performance. Expert performance depends on effective decisions or the ability to make the best choice between a set of alternatives (9), and this capacity is critical in sport and draws on perceptual and cognitive skills as well as physiological capacities. Elite performance has often been presented as an autonomous process, where athlete’s movements are highly automated and require little conscious effort of explicit attention to perform and control skills (4). However, although this state of automated action may be ideal in performance, it may not promote an ideal learning environment. Ericson (8) found that experts in any field rarely let their actions become fully automated during practice. Instead, they find ways of improving the cognitive effort used in practice.

Cognitive effort is the mental work that leads to high levels of decision making, anticipation, planning, regulation, and interpretation of motor performance (17). Permanent gains in performance capacity are only achieved when cognitive and physical training occur in concert (25). This ensures that the athlete lays down the required neural networks, which underpin improvements in motor performance (25). Therefore, effective agility development programs need to encourage and foster cognitive effort in addition to physical performance. Exercise modalities and coaching interventions that encourage this combination are therefore a key tool for any coach, and a task-based approach provides these conditions.

**TRAINING THE BRAIN**

Given the role of cognitive and perceptual processes in reactive agility, components of training that are often overlooked are the processes happening in the brain. To perform well in sport, the brain has to develop optimal synaptic linkages that directly link the areas responsible for the decision-making processes with those involved in optimizing the physical responses (25). If the practice environment does not provide the opportunities for the development of these networks, then the athlete will not develop the capacity to perform maximally in the wide range of challenges he or she will face during performance (25). These effective neural networks are stimulated in enriched environments...
and are not developed in restricted environments (6). Therefore, exercises where high levels of cognitive processing are required provide an ideal environment in which to develop these crucial linkages (6).

Brain imaging has demonstrated that when associations are developed, the higher centers of the frontal area of the brain experience increased neural activity (20). However, once a degree of automation is developed, these higher centers are not stimulated, and instead, the brain’s centers for automaticity (the basal ganglia and the cerebellum) take over (20). Although these are able to perform well in predictable environments, a problem with the lower centers controlling movement is that they are unable to detect new cues (7). This makes movement patterns develop in closed conditions, especially subject to break down when unusual, difficult, or stressful conditions are encountered (27). Therefore, the brain needs to be trained to be able to detect key cues, using the higher centers, and to choose appropriate responses. This requires the development of synaptic linkages between these centers and requires a high degree of cognitive effort in training. Task-based exercises can provide the cognitive efforts required to optimize skill development.

"IT AIN'T WHAT YOU DO ITS THE WAY THAT YOU DO IT"

The advantages of using task-based exercises are that they naturally increase the cognitive requirements of the athlete and provide appropriate stimuli with which to maximize skill learning. However, a major mistake in the application of reactive exercises is the mistaken belief that the exercise itself will naturally produce the desired learning effect (14). Although the effective development of the exercise (outlined later) is important, what is crucial is how the exercise is performed and the extent to which the athlete is able to make appropriate improvements over time. In this way, task-based exercises are best implemented once a good level of technical competence in the fundamental movement patterns has been achieved (13).

A crucial part of the successful implementation of these exercises will be effective coaching and the provision of appropriate feedback through which the athlete is able to make the required modifications to performance (14). Where the exercises can be supported with effective questioning techniques, and external focused instruction and feedback, they provide for a very powerful learning environment (28). This requires a high level of knowledge about all elements that can affect agility performance and of optimal technical models for the performance of key movements.

**REACTIVE EXERCISE FOCUS: TASK BASED OR MOVEMENT BASED?**

The development of effective reactive agility exercises is an important tool for the coach. Reactive agility exercises can be set up with 2 key aims:

1. To develop a given movement pattern. Here, a progressive series of exercises can be set up that sequentially challenge the athlete's ability in a given movement pattern.
2. To develop a key sport-related task. For example, in a soccer context, drills can be set up, which develop a defender's ability to cover space and counter the movements made by attacking players.

The former tasks are ideal in developing the key movement patterns seen in sports and provide an effective movement syllabus and development program (13,15). These can be set up to exploit increasing numbers of degrees of freedom and thus movement complexity. These provide for ideal movement development activities, where the complexity of movement is progressively increased, along with the required cognitive processes. Ideally, agility development should progressively move toward the sport-related task because this naturally addresses the specific constraints of the sport itself. For example, accelerative tasks for a tennis player could involve accelerating to the net to play a volley, accelerating to the net to play a half volley, being able to run down a ball wide to the forehand, etc. In these instances, the movements are intricately linked to the key task-related outcomes, and exercises can be set up to directly develop these abilities. These task-based exercises naturally provide the linkages between movement and sports performance. However, it is important to remember that these task-related skills will be best mastered once the basic movement skills have been mastered and appropriate sequential development programs established (12,13,15).

**MODULATING THE COMPLEXITY OF REACTIVE AGILITY EXERCISES—DEGREES OF FREEDOM**

An important ability for a coach is to be able to progress exercises to increase the challenge to the athlete or to make an exercise simpler if an athlete is having trouble coping. A key factor in this is that reactive agility is not a single entity, and the complexity of exercises can be set according to the degrees of freedom present. In essence, any reactive task will use 2 key elements of variance: temporal variability and spatial variability. Temporal variability refers to the timing variance of a signal. In its simplest form, this can be thought of as similar to a sprint start, where the signal is known in advance, the only variability being when the gun is going to be fired. Spatial variability refers to the various directions from which the signal can come and the directions in which the athlete can react. Spatial variability provides a large number of potential variants to any exercise, thus providing a number of degrees of freedom that a coach can exploit.

The more degrees of freedom provided within an exercise, the more complex the exercise becomes. Therefore, coaches can progress the complexity of any exercise by increasing the number of degrees of freedom present. The required complexity can be viewed as a continuum, with totally preplanned movements at one end and with highly complex movement using total spatial...
and temporal variability at the other end. Using this continuum, the coach can provide the athlete with the appropriate exercise complexity.

MAXIMIZING THE EFFECTIVENESS OF REACTIVE AGILITY EXERCISES

In developing effective reactive agility exercises, a key element will be attempting to maximize the transfer from practice to performance. As the focus on reactive agility increases, a number of training devices and exercises have been proposed to provide a degree of reactivity to exercises. These have involved reacting to flashing lights, reacting to colored cones, reacting to whistles, and so forth, but how effective are these in developing context-specific reactive agility? Introducing an element of reactivity does increase the complexity of an exercise and can provide an increased level of challenge to an athlete by increasing the degrees of freedom the athlete has to contend with and control (15).

However, assessing whether these methods provide the most effective application is important. Although basic reactive agility exercises can be useful in increasing the complexity of movement, and adding an additional cognitive requirement, unless the stimulus and subsequent movement patterns are identical to those required in the sport, maximal transfer to performance will not occur (2). Cognitive research suggests that the anticipatory cues of high-performance athletes are linked directly to specific cues displayed by opponents within their sport (1), and unless a stimulus is sport specific, skilled athletes are unable to use their perceptual skill to their advantage (2). Therefore, the principle of specificity is paramount for optimal transfer, and the following guidelines provide an effective method by which to maximize the effectiveness of reactive exercises:

1. They should replicate sport-specific tasks.
2. They should, wherever possible, use sport-specific stimuli.
3. They should obey the appropriate rules of the sport.
4. They should be conducted in the same environment as the sport.
5. Where appropriate, they should be executed with the same equipment as used in sport.

SETTING UP EFFECTIVE REACTIVE AGILITY EXERCISES

Given the value of reactive agility drills and the benefits afforded by a task-based approach, the next key factor to address is how to set up effective reactive agility exercises. Figure 2 provides a model with which to set up effective task-based reactive exercises. This model can be applied across all sports. This process starts with the task to be trained and then proceeds to look at the indicators of success for the task, the specific task constraints, and then the perceptual triggers that will control the required movements. This then leads to the development of an appropriate exercise that trains the athlete’s ability to successfully complete the given task.

Figure 3 provides an example of how this approach could be applied to a fullback in soccer in a defensive position. Here, the task is to move appropriately in reaction to an oncoming attacker who is trying to create space to receive the ball. The defensive aim of the task will be to respond effectively to the opponent’s movements so as to maintain an effective defensive position throughout and either to prevent an effective pass or to intercept a pass. The aim for the attacker is to use appropriate movements to create space, from where they are able to receive a pass. The defender will be required to respond to the opponent’s movement, and the movement of the ball, whereas the attacker will be required to manipulate the defender and space to get to a position to receive the ball. Figure 4 demonstrates how an exercise can be set up to develop this task ability.

The task constraints in this exercise will be the specific rules of soccer, such as rules regarding tackles, obstructions, contact, and offside. The environmental constraints will involve the playing surface along with the spatial set up of the exercise in terms of playing area, the location of the ball, the initial location of the attacker, and the initial location of the defender. Many of these environmental constraints provide means by which variations can be provided.

WHY NOT JUST PRACTICE THE SPORT

Undoubtedly, the optimal application of reactive exercise would be the game itself, and it could be argued that simply playing the game will develop the necessary perceptual and cognitive skills. However, this is to ignore some key aspects of skill development:

1. Skill development requires a degree of repetition. Designing reactive drills via the methods outlined above provides for the repetition required for effective skill learning while providing for the variety within these movements to maintain an effective learning environment. Simply relying on the game cannot guarantee this level of repetition.
2. The athlete needs to be able to assess and adapt his or her movements appropriately. This requires that appropriate attention is paid to key cues and to subsequent performance. This process may not occur naturally and in these cases needs recourse to the key feedback requirements of effective coaching. These are more easily applied in training contexts than during game situations.

This second aspect brings up an important point in that reactive agility exercises can be effectively integrated into sport-specific sessions and do not necessarily require separate sessions in themselves. This does, however, require close cooperation with the coach and a clear rationale behind what is the aim of the exercises. Where strength and conditioning coaches and sports coaches can work closely in the setting up and evaluation of reactive agility exercises, a very powerful combination can be achieved, with movement directly into highly specific game contexts.

**SUMMARY**

By viewing agility as a context-specific entity, a coach can take a task-based view of movement. Here, agility can be developed in a game-specific context, maximizing transfer to on-field performance. Additionally, the inclusion of sport-specific reactive-based tasks...
maximizes cognitive and perceptual involvement and fosters a learning environment where long-term skill development is optimized. They provide a powerful tool by which strength and conditioning coaches can develop closed skills into sport-specific movement.

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REFERENCES


