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CHAPTER 10

THE RECIPE FOR EXPERT DECISION MAKING

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The technical and tactical proficiency and physical prowess of an athlete is often used as a means of distinguishing the elite from their lesser skilled counterparts in fast-paced interceptive and team sports. Not surprisingly, then, a large proportion of training time is spent refining these qualities. However, there is also a less-obvious quality that is of equal importance to performance that can distinguish between differing skill levels. Decision-making skill¹ is the ability of a player to quickly and accurately select the correct option from a variety of alternatives that may appear before the ball is hit or kicked or an opponent moves. Colloquially, decision making is often referred to as *reading the play*. Some team sport coaches operationally describe a skilled decision maker as the player who is ‘a good driver in heavy traffic’ - the player who seemingly knows what is about to occur, two passes before it happens. While such players may not be the fastest around the court, their ability to accurately

forecast a game's future means they always seem to have all the time in the world. While reading the play is a cinch for players like Australian footballer James Hird, ice-hockey star Wayne Gretzky or basketball legend Michael Jordan, for us mere mortals it's more like reading Latin.

This chapter is concerned with first highlighting the key facets of decision making skill and then, importantly, reviewing how this skill can be improved through training. In order to outline the key underlying components of the decision making process we discuss those components that separate the best from the rest. Second, we detail the common developmental pathways followed by expert decision makers as a means of identifying potential practice activities that may develop the key components of decision making skill. Two aspects of decision making training are then discussed. First, whether decision making can be enhanced through video-based simulation methods completed outside of the usual training context. Second, we review methods that can be used in a physical practice setting to increase the skill of players to make both *what* (what movement is to be carried out) and *how* (how a movement is to be carried out) decisions (refer to Chapter 11 by McPherson for additional discussion of these ideas)

The Recipe to Becoming an Expert Decision Maker

What are the key ingredients to becoming an expert decision maker? From a scientific perspective there is a seemingly never-ending debate about the different

perceptual-cognitive competencies an expert athlete should possess. The reason for the absence of a straight-forward answer lies in the problem itself. An expert in sport needs to possess excellent perception, attention, memory, skill execution and many more competencies. Before we discuss some of these concepts in more detail however, it is necessary to outline the phases of the decision making process. One model that is commonly used to describe the decision making process is illustrated in Figure 10.1.

FIGURE 10.1 NEAR HERE

In order to describe this model we offer a brief example from soccer to illustrate each of the seven stages. Imagine a striker in soccer who is dribbling towards the goal and is approached by a defender. At this point, the decision problem has *presented* itself: what action should the ball player take in response to the approaching defender? The striker *identifies* the constraints on his behavior (e.g., he cannot pass offside) and prioritizes his goals (e.g., retain possession, but score if possible). In light of these, he *generates* possible options that he may undertake, such as shooting at the goal, passing to a wing player, or dribbling away from the defender. He *considers* these courses of action, perhaps by ranking them according to their likelihood of achieving his primary goal (retaining possession). Then, he *selects* an action; this is likely to be the one with the highest rank. He *initiates* the action by physically performing so as to bring about the action he selected (e.g., physically dribbling the ball to the right). In doing so, he buys time

for the wing player to streak towards the goal, where he passes the ball and assists in a shot on goal that results in him positively *evaluating* his decision.

Expert decision makers have learned to progress through these stages very quickly and efficiently, resulting in intuitive performance in the most complex of situations under high pressure. How do they do this? To answer this question, we now describe some of the components that are acquired on the road to decision making excellence.

Components of Expert Decision Making

Expert decision makers differ from their less capable peers in a number of capacities as detailed throughout this book. Of particular interest to the current discussion is the expert player's ability to *read the play* technically referred to as pattern recognition and anticipation. Interestingly, pattern recognition skill was first investigated in the game of chess. Research demonstrated that chess grandmasters were able to sum up a board in one quick glance. Provided with 5 or 10 seconds to look over a specific chess situation, the best players could accurately recall the exact location of 90 per cent of the pieces. Lesser skilled players could only remember 50 per cent. The researchers concluded that the grandmasters could *chunk* the pieces on the board into fewer, larger chunks of information that were more easily remembered and subsequently recalled to produce the required pattern. This is similar to the way we all remember

frequently-used telephone numbers as one block of numbers rather than eight individual numbers.

Sports science has subsequently demonstrated that elite team-sport players also possess the analytical mind of a chess master. Watching a team sport like netball is a classic example of watching a continuously changing pattern. Interestingly, while the pattern may look meaningless to the untrained eye, that is, 14 players sprinting and dodging in all directions, to an expert player (or coach) it can all look completely logical and can inform them in advance as to where the ball is about to be passed. This is quite a handy skill to have if your job requires you to intercept as many opposition passes as possible. It is thought that elite players have developed the ability to rapidly recognize and then memorize patterns of play executed by their opponents. Importantly, this capability to recognize an opposition team's attacking or defensive patterns is not because the elite players have a bigger memory capacity than the rest of us. Rather their memory of sport-specific attack and defense strategies is simply more detailed than ours and can be recalled and used in a split second.

More recent research has also revealed that the ability to recognize patterns of play may transfer across team sports that possess a similar structure of play. Bruce Abernethy (see Chapter 1) and his colleagues examined expert decision makers from the Australian basketball, netball and hockey teams and compared their performances on a pattern recognition task with lesser skilled athletes from the

three sports. Consistent with previous work, the experts recalled patterns from their sport better than their lesser skilled counterparts. However, of interest was that when the experts from one sport (e.g., netball) were tested on other patterns (e.g., basketball patterns), their recall was still better than the lesser skilled athletes from that sport (i.e., the non-expert basketball players). Such findings imply that elements of pattern recognition are general in nature and can transfer between sports. This has important implications for the development of decision making as discussed in the next section on the developmental pathways of expert decision makers.

It has been reasoned that superior pattern recognition skill provides a player with an awareness of what a teammate or opponent is likely to do next. The outcome of effective pattern recognition is anticipation or the capability to prepare a response in advance based on the information provided early in an event sequence. The capacity to anticipate is particularly valuable in time-stressed sports for a number of reasons. First, in a situation like the tennis return of serve, it may be necessary to begin moving before an opponent has even struck the ball in order to successfully intercept it. Second, it provides a player with more time to prepare a response, which may increase the likelihood of executing a successful response. Finally, anticipation may also effectively reduce the expert's information-processing load. In sum, the net result of being an expert decision maker is to create the appearance of *having all the time in the world* with which to prepare

and execute a response in time-stressed situations by efficiently traveling through some or all of the stages of the decision making process previously described.

Developmental Histories of Expert Decision Makers

A recent research strategy to understanding decision making skill has involved interviewing elite decision makers and asking them to detail retrospectively the types of activities they completed in their childhood and adolescent years. It is thought that such information may shed some light on the types of activities that should be practiced if one wishes to become an expert decision maker.

The same athletes Abernethy and colleagues tested on pattern recognition skills also completed developmental history profiles. While there are too many findings to detail here (see also Chapters 2 and 3), there are a few that are pertinent to the current chapter. Of particular interest was that the athletes accumulated far less sport-specific practice (less than 4,000 hours on average) prior to reaching expert levels than the 10,000 hours that would be deemed necessary by the theory of deliberate practice (see Chapter 3 for more information on this theory). In explaining this finding, it is critical to note that the number of different sports these athletes participated in as a junior was inversely related to the number of practice hours required to become an expert player. For example, one netball player only detailed 600 hours of netball specific practice before being selected for the Australian team. However, she participated in 14 other sports as a junior.

Based on such findings it has been reasoned that participation in a variety of sports before specializing can be advantageous to one's development of expert decision making skills. Importantly, as highlighted in some research on Australian football, it's not just any sport. Rather, participation in sports that are conceptually similar to the one in which a child wants to excel is more likely to generate the transfer of pattern recognition skill previously described (as well as other capacities like physical fitness). For example, expert decision makers in Australian football were found to participate in a significantly greater number of secondary invasion sports relative to non-expert decision makers. Invasion sports are those much like Australian football that involve players running freely on a field or court and being able, in some way, to directly challenge their opponents for possession of a ball. This includes sports like soccer, hockey and basketball.

Decision Making Training Approaches

Off Court Training

The time available to train players in team sports like basketball and soccer is limited due to their physical demands. Inevitably these time constraints mean important skills such as decision making are not practiced enough. As a result, researchers have been interested in devising methods to both test and then, importantly, improve the decision making skill of athletes outside the normal

training environment. In order to be considered a credible training approach, specific conditions must be adhered to.

- The decision making skill to be developed must be a limiting factor to sports performance, that is, if it isn't a quality that separates experts from the rest then there is little reason to focus on it in training (for example generalized visual training as described in Chapter 1).
- Suitable training regimes are those that supplement physical practice and selectively enhance the specific perceptual capacity.
- Most importantly, any improvements in decision making arising from training must translate to improved sports performance.

The following section will review some of the training initiatives examined to date with the above criteria in mind.

General visual vs sport specific training.

A key issue when selecting off-court training programs is the notion of whether you are actually training the specific limiting factor to decision making performance. A variety of training methods have been employed that have been broadly termed *visual-perceptual training*. The research literature investigating visual-perceptual training programs in sport can be separated into generalized

visual training programs and sports-specific perceptual/decision making training programs. Generalized visual training programs have typically originated from within a clinical optometry setting, where behavioral optometrists in particular have prescribed visual training exercises designed to improve the vision of children with reading difficulties. The key tenet behind these training programs prescribed by behavioral optometrists is that improved visual capacity will translate into improved sporting performance. Alternatively, sports-specific perceptual/decision making training programs have emerged from sport scientists seeking to train the visual-perceptual capacities known to distinguish the performance of experts and novices in the specific sport of interest. These programs have typically involved video-based approaches focusing on early postural cue identification or the reading of patterns of play. Both general and sports-specific approaches aim to increase the speed and accuracy of a performer's perceptual response to an opponent, albeit via very different training stimuli and activities (see Abernethy, Chapter 1 for more discussion). This chapter will focus on sports-specific perceptual/decision making training as it is likely to provide a more fruitful avenue for the development of decision making skill. Unlike generalized visual training methods, sports-specific training attempts to closely replicate or simulate the decision making conditions of the natural sports skill.

Sports-specific decision making training.

Postural cue training. The solid empirical evidence demonstrating that expert performers use postural information sources such as an opponent's movement pattern to anticipate likely ball flight (e.g., direction of a tennis stroke or soccer kick) provided researchers with a logical starting point for the design of sports-specific decision making training approaches. Currently, one of the most promising methods for training anticipation is via the use of video-based temporal occlusion training. These approaches generally involve the video presentation of a performer executing a particular action from the player's perspective, with this vision then edited at a point just before the occurrence of a particular cue (Figure 10.2). Participants are asked to respond by predicting the outcome of the full play sequence. For example, players watch a tennis server from the receiver's perspective and as the server reaches the top of the ball toss, the vision is occluded or paused so that no more cues are provided. The participants then report their estimate of the direction and spin of the serve. The participant is then given feedback on his or her prediction either verbally or, more typically, by being permitted to view the post-occlusion action. This procedure has been used in an experimental setting and has in some instances successfully improved the perceptual speed, and/or accuracy, of sports performers.

FIGURE 10.2 NEAR HERE

In relation to racquet sports, a number of studies have been conducted where typically beginner to intermediate level participants have been perceptually

trained. The training activities have involved a combination of temporally occluded video footage of particular strokes (i.e., tennis serve and passing shots) and specific instruction (guidance) concerning the relationship between the various perceptual information sources and subsequent ball flight direction (e.g., an instruction such as “a ball toss placed over the server’s head indicates a topspin service is likely”). Improvements in perceptual skill have subsequently been examined via film or video based tests that utilize movement initiation time or non-sport-specific perceptual accuracy measures (e.g., pen and paper response grids, vocal reaction time or a button press task) as an indication of decision making speed and accuracy. Results commonly reveal that the perceptual training groups make faster, and/or more accurate responses, relative to a control group and a placebo group, when such groups are included in the experimental design.

In more recent times, the above perceptual training approach has been used to compare the relative effectiveness of various instructional approaches. For example, traditional, explicit instructional approaches that directly inform the player what cues are most informative have been compared with more indirect approaches such as implicit (subconscious) learning where the player doesn’t necessarily realize they have made such connections (see Masters, Chapter 7). A number of innovative approaches of this nature have been studied, such as providing task-related, goal irrelevant instruction. For example, a player is told to predict the speed of a tennis serve rather than its direction. The logic behind such instructions is that attention to this information might indirectly facilitate the

players' service prediction performance, as they would *implicitly* establish relationships between the service kinematics and resultant service outcome, without necessarily consciously processing such information. Interestingly, results of such studies have generally found that perceptual learning can occur in the absence of direct instruction about the relationship between a specific cue and its resultant action. Although, it should be noted that the complexity of the decision making task is a key mediating factor in the use of implicit techniques and will be discussed in a later section. Nonetheless, coaches are encouraged to strongly consider such indirect approaches over direct instruction (Masters, Chapter 7 has a more detailed discussion of this topic).

Pattern recognition training. While postural cue training is more localized toward understanding the movement mechanics of the opponent, pattern recognition training is concerned with teaching players how to recognize and subsequently anticipate the outcome of familiar patterns of play as they evolve, as seen in a wide variety of team sports such as basketball. While there has been less experimental work directed toward examining this issue relative to postural cue training, again, the available evidence is generally positive. Improved decision-making performance has been reported in pattern-based situations such as defending or initiating offensive football (gridiron) plays, initiating offensive basketball plays and selecting the best option in soccer situations.

A typical example of pattern recognition training can be highlighted using the sport of basketball. Players' decision making skill was examined by having them physically respond to near life-size video-based simulations of typical offensive basketball situations presented from the player's perspective. Their task was to decide what to do next by choosing one of four available response options (e.g., pass to the top of the key, pass to the base of the key, shoot, or dribble). Training consisted of short sequences of play taken from professional matches that were *frozen* on screen at a critical decision point. Players were asked to imagine that they were the player in possession of the ball and make a decision of whether to pass, shoot, or dribble as quickly and accurately as possible. They were then shown an un-occluded replay to provide knowledge of the result. Both implicit and explicit instructional groups improved their decision-making accuracy from pre-to post-test by around 15 percent. In comparison, a general visual training group and a control group did not significantly improve. No meaningful differences in decision time were observed. In addition to highlighting the value of training players' recognition of common patterns of play, these data again confirm and extend previous research findings indicating that participants do not always require explicit instruction to promote the learning of perceptual regularities in the environment.

Future directions of off-court training.

A key issue that remains unresolved with video-based decision making training is the degree to which the learning transfers to the on-field setting. Only recently has research focused on this issue and, pleasingly, available evidence suggests transfer does occur, although the exact conditions guaranteeing its success are not entirely clear.

One of the factors that requires further consideration is what specific features of the natural task need to be replicated in a simulation for any of the perceptual improvements commonly demonstrated in the laboratory to transfer to performance in the natural setting. One framework for examining this issue is through the concept of fidelity. Fidelity refers to how closely a simulation accurately reproduces the real-world setting. In examining the research on simulation and subsequent transfer, the issue of what degree of fidelity is necessary for learning to occur obviously needs to be considered. Traditionally, simulators have been designed to reflect the real-world task as closely as possible. Fidelity has been manipulated in a number of ways, including physically, functionally and psychologically. Physical fidelity relates to the *look* of the simulation relative to the performance context. Functional equivalence/ functional fidelity relates to the similarity in *feel* between the simulation and real task. Psychological fidelity refers to how real a participant *perceives* the simulation to be. When video-based decision making training is considered, there are two areas that are of interest to scientists and coaches alike. First, whether video-based perceptual training is enhanced when linked in some way to the sport-specific

physical responses. Second, whether a three-dimensional (3D) simulation method is superior to a standard two-dimensional (2D) simulation due to the addition of depth information.

A small number of studies have been conducted to examine the importance of linking decision making training with on-court training. For instance, a longitudinal examination of the serve reception skill of elite volleyball players found that a variety of video and on-court gaze behavior skills such as ball detection and visual tracking improved the player's serve reception performance. More recent research evidence has demonstrated that for beginning tennis players learning how to anticipate a tennis serve, it did not matter whether the perceptual information was presented in a perception-only (no physical response required) or perception-action coupled manner (player required to return the serve). Both learning modes were superior to a group provided technical instruction about serve mechanics. What remains unresolved from such work, and certainly requires greater investigation, is whether this effect is consistent across all skill levels and types of skills.

The logic behind research examining differences in 2D and 3D simulation approaches is that if the players feel 3D is more realistic than 2D, they will perform more naturally and any video simulation training they complete will better transfer to actual on-court performance. Recent experimental evidence from a basketball simulation task was equivocal. Players interacted with life-size video

of offensive game situations filmed from their perspective, in both a 2D and 3D format. The basketball players were required to watch an offensive pattern of play unfold, just as they would in an actual game, and then make a decision by actually executing a pass, shot, or dribble (Figure 10.3). The players' response to each situation was filmed so that the accuracy and speed of their decisions could be analyzed later through video analysis. Despite most players reporting that they felt the 3D display was more realistic than the 2D display, their decision making performance did not differ greatly whether it was projected in 2D or 3D. One notable exception was in situations where the players needed to use depth information to make their decision, such as when executing a long pass across the court. In these situations the 3D condition produced superior decision making speed. Given the amount of team-sport situations that require this perception of depth, this is a potentially important result and warrants further examination of this concept.

FIGURE 10.3 NEAR HERE

Summary.

While there are many unanswered questions concerning the application of video-based simulations to develop decision making skill, there is also enough evidence to support continued investigation and usage of such approaches. Unanswered questions include:

- what is the appropriate intervention length?
- what skill level of player benefits most from such training?
- what type of instructional approach is most effective, and how tight should coupling be to the physical response?
- will a virtual reality approach provide further training benefits to those already gained through video-based approaches?

However, there is equally much evidence to offer encouragement to coaches in the field. In particular, video-based training simulations offer advantages that don't typically exist in the normal training environment. For instance, players who need to do extra decision-making training can do so without needing the remainder of their teammates to be there to execute the team's patterns. Regular visual simulation sessions could be added to the usual practice week as a low-impact workout for injured athletes or simply to add a new and enjoyable method of training to enhance performance without increasing the physical demands on the player. Finally, the general opinion of athletes exposed to such training approaches is that they are a valuable addition to more traditional training methods.

On field decision training

On field decision training plays a key role in daily training. In this section we will demonstrate how decision training can be improved based on the current state of

research. While the importance of decision-making skill in ball games is recognized by many coaches, what still needs to be resolved is how to optimally develop the quality of training to refine these skills.

We distinguish decisions about what movement is to be carried out (*What decisions*) from decisions about how this movement should be carried out (*How decisions*). For instance a table tennis player needs to decide between a forehand or backhand drive (*what*) and if this stroke is played cross-court or baseline, short or long, with spin or without spin (*how*). *What* decisions are often trained in isolation in tactical training and, similarly, *how* decisions are trained in isolation in technical training sessions. In the following sections we will provide evidence for, and examples of, practical interventions for *what* and *how* decisions in isolation as well as when integrated. The main conclusion being that *what* and *how* decisions should be combined quite early in the learning process or early in a season for higher skilled athletes (also see Chapter 11 by McPherson for related discussion).


What decisions.

Four factors that are important for the selection of movements will be discussed, namely: *situation complexity, if-then rule use, creative decisions and option generation.*

Situation complexity. Some tactical training approaches follow the logic of the traditional technical training model of a simple to complex progression of skill development. For example, basketball players are first presented with a 2vs2 situation containing two choices for the ball player, such as pass or shoot. The situation is initially conducted with quite inactive defense and always from the same distance to the basket and then complexity is progressively added such as a more active defense, more variable situations, and the addition of more choices by increasing the number of players involved. Alternatively, some approaches propose to start quite complex so that players need to adapt quickly to the ever-changing situations such as those present in pick-up games 2vs2 or 3vs3. This hard-first strategy seems of some advantage and is therefore recommended for higher skilled players.

If-then rule use. Another important factor of *what* decisions is the use of if-then rules. For instance, in a 2vs2 situation in basketball coaches may present two if-then rules through verbal instruction or a whiteboard. Rules such as: IF the defensive player opposed to you is too far from you and your partner is closely defended THEN shoot. The second rule may be formulated as such: IF your partner is in a good position and the defensive player is too close to shoot THEN pass to your partner. Of course labels such as; *good position* or *defensive player is far enough away to shoot* depend on the skill level of the players in that situation. As an alternative, a coach could also implicitly develop more shooting opportunities by setting up a slower defensive player in one set of plays and more

passing opportunities by setting up a good and fast defensive player for the ball player deciding between these options. Based on research conducted to date, it appears that in quite simple situations which involve two to four options each defined by one If-Then rule, better and faster choices can result from adaptive behavior that can be picked up directly by the player and may only be interfered or slowed down if the If-Then rules are coached explicitly beforehand. However, if the situation is more complex such as a full 5vs5 situation with a number of rules and cues that may require a player's attention to make a good decision, then coach instruction may be required to focus the player's attention on the key aspects of the situation.

Creative choices. A third and less researched aspect of training *what* decisions is that of creative choices. Whereas training of If-Then rules results in one good choice for a given situation or set of situations, it does not allow adapted choices to be made during the course of a game. Therefore, there are some methods that consider not only each choice in isolation but train choices in sequences and how people should react based on previous choices. One famous example is the “hot-hand” phenomenon that suggests that a player has a higher chance to succeed if she has previously been able to successfully shoot two or three hits compared to a situation in which she previously missed the last two or three ts. The empirical evidence is not clear-cut, however, that playmakers use such information for ball allocations. Using the belief that someone is hot can lead in some situations to better performance (e.g., if individual performance is

variable) and in others to worse performance (e.g., if an opponent can gain an advantage of the more allocations to one player). Therefore, structuring training to require playmakers to remember previous hits/misses of their team-mates becomes a possible training activity. In sum, it is important to train the selection of different choices that can be conducted in the same situation so an opponent is left uncertain about potential changes in the play.

Option generation. Another mode of training refers to the cognitive development of different choices within the same situation, called option generation. For instance, one strategy used by coaches is to require players to play the same option over and over again, but using a different choice each time. For example, in basketball, a specific routine for the playmaker may result in a pass to the left wing player, then a pass to the center player or to the right wing player. Research indicates that training such option-generation results in better choices if players use a spatial strategy. That is, generate all options on the left side first and then options on the right side rather than using a functional strategy that first searches for all passes over the court and then for shooting and dribble options. The advantage of a spatial strategy lies in the reduced number of options generated, which leads to a faster choice. Additionally, expert players are well guided if they rely on their intuitive first choice, because these choices often generate the highest success given a specific situation.

How decisions.

The *how* decision, for instance in tennis, is to choose the exact parameters of a backhand down the line return. The process of such a *how* decision follows the *what* (e.g., forehand or backhand drive) decision by only a matter of milliseconds and as a result, can be changed later than changing from a backhand to a forehand stroke for example. There are at least three factors that are important for the production of movements: game-like situations; use of pre-cues; and the type of instruction.

Game-like situations. Practice sessions should replicate actual game events and phases of play with the coach ensuring players are educated concerning how the training activity used reflects the decisions and processing speed required in the competition environment. A well-known skill acquisition expert Judith Rink summed it up best when she said

“Transfer of practice to the game environment depends on the extent to which practice or training resembles the game. If the athletes do not practice in game-like scenarios, they will not play the game well, yet, if practice is too game-like, it may be too difficult to integrate and perform the emphasized skills. The resolution of this implication is that practice needs to occur at a level that incorporates as much of the game as the players can successfully manage”.

The adoption of this philosophy is evident in well-publicized coaching approaches such as *Teaching Games for Understanding*, *Gamesense*, or *Play Practice*. A central tenet of all these approaches is that the decision making elements of the task are given priority, at least initially, over the instruction of technique.

Use of pre-cues. Coaches use pre-cues to enable faster *how* decisions. For instance, they provide probabilistic information such as *80 per cent of the opponent's topspin balls will be played to the backhand*. As a result of such a pre-cue, the player can focus more on their backhand and then choose either cross-court or down the line based on the relative positioning of himself and his opponent. Another technique is for the coach to direct their player to use perceptual information that changes very late in an event before conducting the *how* decision. For example, an opponent's movement to the left should result in an attack to the right. The time needed to react on such information in *how* decisions depends on the movement planned. For instance, in an attacking phase of play in soccer, information presented by the approaching attacker at the very end of his run will determine whether the goalkeeper should jump to the left or right corner.

Type of instruction. Additional aid is often given by instruction. For instance instructions about *how* decisions can be given verbally in quite different formats. Based on recent research it seems that indirect information preceded by analogies (e.g., *move your racket as you would pull it from a backpack* when

serving in tennis) has advantages over direct information about the movement itself if players need to use such movements in competitive situations. In addition, instructions that focus a performer's attention on the effects of a movement can have additional benefits for subsequent performance (see Chapters 7 and 8).

Current Limitations

We see systematic on-court decision-making training as still in its infancy and therefore we want to draw attention to some limitations that can be overcome by further research and best practice. In regard to coaching *what* decisions, further work is required to develop a method that allows coaches to know how to select between different tactical training methods to generate an optimal outcome given a specific team, situation and task. The application of if-then rules as tactics seems a limited approach for teaching creative decision making and situation-based decisions. Furthermore, how to teach players about what kind of information to attend to when making their choice is not yet commonplace in real world training environments. For instance, in penalty situations such as in soccer, the information that helps a goalkeeper distinguish between a left or right corner kick may be quite different at the start of the approaching kicker relative to just before foot to ball contact.

In regard to *how* decisions, even in laboratory research where significant amounts of data are accumulated about instructions, feedback and other parameters that

influence performance, we still do not know exactly when to combine the *how* decisions with the *what* decisions in early learning or across seasonal training plans. For instance, coaches need to decide when in pre-season training an adjusted skill is ready to be tested in more complex tactical situations. Similarly, it remains unclear how to combine instructions and feedback of *how* and *what* decisions in complex training schemes. The individual limits of athlete information processing, emotional and cognitive abilities are not yet integrated into guidelines for coaches.

Conclusion

What does the research tell us about how to train decision making in the field of play? The best answer we are able to provide to coaches is that decision making is very situation (sport) specific and depends on both athlete abilities and the task at hand. Far from providing a comprehensive set of decision making aids, we have presented some principles for the development of *what* and *how* decisions that are general enough to be applied across different sports and situations, yet specific enough to provide guidelines to choose between different training alternatives.

Coach Recommendations

Expert decision makers are not born, but made through a combination of their developmental experiences as children and then through quality coaching that

provides on- and off-court decision-making training opportunities. The on- and off-court training methods discussed here can be coupled with other learning approaches as detailed in the other chapters. A common question is how much each of these training types should be used. Naturally this question is difficult to answer in a general sense, however our observations of current practice is that off-court training should be used far more frequently than is currently the case. Too often any off-court training completed is simply a coach led preview and review of a competitive match which, while of some educational value, certainly does not proactively train the players' decision making capacities. It is our belief that off-court decision-making training should be conducted in a similar manner to a weight training program. That is, the training principles of volume, frequency, intensity and overload are manipulated so that a progressive training effect is generated over time. The recipe of becoming an expert decision maker, in our opinion, is to systematically combine on-court training focusing on the execution of *what* and *how* decisions with off-court training. That is, all steps of the decision-making process, particularly the components of *generate*, *consider* and *select*, should be part of both types of training though not necessarily presented in an explicit manner.

Key Readings

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Footnote

¹A variety of terms are used to describe decision-making skill. These include perception, cognition and perceptual-cognitive skill. These terms are used interchangeably throughout the chapter.