

STUDIES IN PHYSICAL CULTURE AND TOURISM  
Vol. 18, No. 1, 2011

## REVIEW ARTICLE

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### IMPROVING ATTENTIONAL PROCESSES IN SPORT: SPORT SPECIFIC ISSUES DURING EFFECTIVE PLAYING TIME

**Key words:** attention, tennis, playing time.

#### ABSTRACT

Development of training programs aimed at improvement of attention requires a deeper understanding of the concept of attention and its typology. We should remember that various life and sport situations pose different challenges to participants' attentional processes. The paper aims to identify sport specific issues of attention. It focuses on tennis (singles game) as compared to other sports. We based the process of identification of sport specific issues of attention on a detailed analysis of the structure of tennis and its requirements. This enabled us to identify a number of objects attracting tennis players' attention, and compare them to objects from other sports. We were also able to reveal the complex nature of decision making in tennis by pointing out potential courses of action as well as multiple selection criteria available during a tennis game. Eventually, we tried to identify how a tennis game specifically challenges such attentional skills as attention scope (capacity), direction and selectivity, intensity and durability as well as flexibility. The present study deals with attentional processes during the playing time as it quite undoubtedly constitutes the most important part of tennis player's attention management and is the period during which the outcome of the match is decided.

#### STRUCTURAL DEMANDS FOR TENNIS PLAYERS' ATTENTION

During a tennis match a player is supposed to hit the ball with a racket in such a way that it crosses over the net and lands on the opponent's side of the court, making it difficult or impossible for the opponent to return it in order to score points [1]. The above definition is quite helpful in identifying the most important objects tennis players should attend to: the court, the racket, the player (himself), the net, the opponent, the ball and the score.

Under this definition we can also posit that the ultimate task in playing tennis consists in sending an object (i.e. a tennis ball) into a target (i.e. the opponent's part of the court). Therefore, we will consider the tennis court as a target for players to aim at and pay attention to. Although hitting a target is a common task in many sports, each discipline sets different conditions for the participants' attention, depending on the target dimensions, location, presence of physical obstacles on the way to it and whether it is moving or stationary.

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The target dimensions in a tennis singles game include a rectangular court almost 12 m long and 8 m wide<sup>1</sup>. In comparison, table tennis players are supposed to send the ball into a table surface 1.5 x 1.5 m, volleyball players on a court 9 x 9 m, handball players into a goal 2 m high and 3 m wide, soccer players into a 2.5 m high and over 7 m wide goal, basketball players into a hoop a 45 cm in diameter and golfers into a hole 10 cm in diameter.

Precision and attentional requirements in performance sports are often much higher than the overall target dimensions would suggest. Shooters are usually fully satisfied only when hitting the very center of the target, which is a small black spot 1 cm in diameter. To be successful in soccer it is not enough to simply kick the ball in the direction of the goal but one has to often put the ball into the very corner of the goal. Tennis, badminton and volleyball players try to send the ball into carefully chosen parts of the court in order to put it out of the opponent's reach or at least to make it difficult for him to receive, return or block it.

This means that tennis players' attention should also be directed towards the opponent, his or her features, skills, capabilities, position, moves, actions etc., which is, in fact, a common practice in many sports. For instance, a handball player passing the ball to his teammate tries to avoid the opponent's blocks, a soccer player taking a direct free kick tries to curl the ball around the wall of defenders and the goalkeeper, a volleyball setter tries to mislead the opponents with well disguised sets while volleyball hitters try to omit the opponents' blocks of the opponents much the same as basketball players when executing their shots. In racket games (including tennis) a player controls only one opponent (singles game) or two opponents (doubles), so the attentional demands are not so high as in team games.

Courts, goals, holes, baskets, archery targets, bowling pins are all stationary targets. However, there are also many sport situations, when one has to send an object into a moving target. For example, in team sport games one has to accurately pass (send) the ball or puck to a teammate, who is running, jumping or skating. Shooters sometimes need to fire at a running target. The moving target

for fencers, boxers, kickboxers or karate and kendo fighters is the opponent. By the way, hitting the ball into the opponent's body can be also an effective tactic in tennis, but is regarded as ungentlemanly.

Although a tennis court is basically a standardized and stationary target, we argue that owing to the opponents' positioning, skills, etc. it constantly "changes" its location and dimensions. One can say that it is, functionally, a "moving" target, e.g. when the opponent is in the right corner, then the left side of the court seems to be a better target area and vice versa; or when the opponent is far behind the baseline, then the area right behind the net should be aimed at. While playing a superior opponent it is often necessary to aim further away from him (i.e. closer to the lines of the court) to put the ball out of his reach or make it difficult for him to return it, than when playing against a less skilled opponent.

The target location (distance between the player and the target) also determines the attentional demands of hitting a target. Table tennis players hit the ball at an average distance of 2-3 m, but in most sport games, including tennis, the distance between the player and the target ranges from a few up to 20-30 meters or even more. For example, soccer players can sometimes impressively execute accurate shots over the distance of 40-50 m. Probably one of the most demanding sport games in this regard is golf, which requires the players to send the ball over a distance of 100 meters or longer. It is also worth noting that the distance between the player from the target can be either standardized (11 m for penalty kicks in soccer or 5.80 m for free throws in basketball), or variable, which is the case in most game situations.

The next element challenging sport players' attention is the presence of physical obstacles on the way to the target, e.g. nets, hurdles, bars, poles, gates, etc. that need to be omitted, passed by or jumped over. Sport events with physical obstacles include the 3000 m steeplechase run, 110 m hurdles run, high jump, pole vault, show jumping and cross-country equestrian jumping or such alpine skiing events as slalom, giant slalom, super-G or downhill. In tennis as well as in badminton, volleyball or table tennis, players must remember that they have to send the ball (or the shuttlecock) over the net in order to reach the desired target.

The tennis net is a transparent, stationary and standardized barrier. Players should be conscious of its location (i.e. their position in relation to the net)

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<sup>1</sup> The precise dimensions of a tennis singles court are 11.885 m (length) and 8.23 (width). The valid area while serving is the service box 6.40 m long and 4.115 m wide [4].

as well as its dimensions. The most important is the net height, which should be 91.5 cm at the center strap, and 106.5 cm at the net posts. This is a medium height when compared to the low table tennis net (slightly over 15 cm) and relatively high badminton net (over 150 cm) as well as volleyball net (over 240 cm).

Attentional requirements also differ from sport to sport, depending on the body parts and/or objects used by players to send the ball (or a similar object) into the target, type and complexity of movements, as well as the hitter's position and possibility of physical contact with the opponent while hitting.

While in volleyball, basketball, handball, rugby and soccer players can only use their body parts (arms, legs, trunk, head) to send the ball into the target, in many other sports, attentional requirements related to the body parts are much more complex. For example, ice hockey, field hockey, tennis, table tennis, badminton, squash, golf, billiard, polo, baseball, lacrosse are all sport games that require the players to use an extra object like a stick, racket, bat or even a bicycle (in cycle ball) to send the ball into the target.

Among the many important parameters of these objects, e.g. shape, weight, length, grip size or grip cover, the size of the hitting surface area also seems to possess special importance. The hitting area of a tennis racket (its head size) is much bigger than that of a table tennis racket, cricket bat, ice hockey stick or field hockey stick. In volleyball, the players expand the hitting area by using both hands to hit the ball rather than one. Quite similarly a soccer player can expand the hitting area by using his chest or thigh, which are larger in comparison to the relatively small area of the foot. It seems that the smaller the hitting area of the object used to control the ball, the greater the attentional requirements for the player.

In order to send an object accurately into the target, players need high precision of their own body movements and control over the used objects (racket, stick, bat, bow, gun, etc.). Handball, basketball and lacrosse players *throw* the ball into the target. Bowlers release and *roll* the ball along the surface, shooters *pull* the trigger to release the bullet, and archers stretch and then *release* the arrow together with the string. In tennis, table tennis, squash, volleyball or golf the players send the ball into the target by *hitting* it, with the contact time between the racket (arm or stick) and the ball

amounting to about 0.004-0.006 sec. [5]. This short time increases the attentional demands for athletes.

Another important consideration is that the stroke mechanics of a tennis serve, forehand or backhand are quite complex when compared to the archers' movement (raising the bow, stretching and then releasing the string together with the arrow) or shooters' movements (raising the gun and pulling the trigger). Tennis actions involve all body parts moving in numerous joints in all possible planes and directions. It seems that the more complex the movements, the more challenging the attentional demands of the sport.

Throwing, hitting or similar sports actions can be generally executed either from a stationary or a moving position. It is worth noticing that complex tennis strokes are very often executed while moving (walking, running, sliding, jumping, falling). This makes the tennis player's movements similar to the soccer player's shots taken after a run-up, volleyball digs, basketball jump shots, ice hockey players' shots made while skating or polo players' shots made when riding a horse. This mobility makes the attentional requirements of these sport situations totally different from sport actions carried out from a stationary position (i.e. standing, kneeling, lying), e.g. darts throws, basketball free throws, archers' and shooters' actions as well as golf and billiard shots.

Tennis, volleyball, table tennis and badminton players as well as golfers, archers and shooters are privileged in the sense that nobody hinders them physically (i.e. with direct body contact) when hitting the ball or shooting. On the contrary, soccer, handball, ice hockey and rugby players have to pay attention to such potential opponents' actions as blocking, pulling, pushing or holding many times during the game (except for free kicks, penalty kicks or corner kicks).

In sports games like soccer, basketball, handball, volleyball, cricket, baseball, ice hockey, field hockey, rugby, tennis, table tennis, golf, squash or badminton it is crucial to watch the object (ball, puck or shuttlecock) carefully, before it is sent into the target. And it turns out to be quite a challenging task for the players' attention. Even world class players happen to miss the ball (very seldom) or hit it imprecisely, which in the case of tennis players means that they sometimes hit the ball with the racket frame instead of the strings.

Different sports set various conditions for players' ball tracking skills and their attentional

abilities, depending on the ball size, movement type, speed, distance of the ball flight and any “unpredictable” changes of the ball trajectory.

Ball sizes differ significantly between sports and may range from small table tennis balls (4 cm in diameter) or tennis balls (6.5-6.8 cm) to large waterpolo balls (22 cm) and basketballs (29.5 cm). It seems that the smaller the ball, the greater the attentional requirements of a game.

In sport games a player has often to send a motionless ball into the target. This is the case with all golf shots and billiard shots, but also with soccer penalty kicks, corner kicks and free kicks. It is a completely different task from sending a moving object into the target, i.e. a soccer ball rolling on the grass or a hockey puck sliding on the ice. Even more challenging is hitting a flying or a bouncing ball. The former includes soccer volley kicks, all hits in volleyball, baseball and badminton as well as volley shots in tennis and squash. Hitting a ball that bounces off the table takes place in table tennis, a ball off the ground in tennis or off the wall(s) and the ground in squash. Shots made on the bounce are common in soccer as well.

Another important factor determining players’ attentional requirements is the initial speed of the oncoming ball, which sometimes can be quite high. The shuttlecock is poised to enter the Guinness Book of Records at 162 miles per hour (261 kph), i.e. the speed it travels on the smash – as compared with a squash ball at 151 mph (243 kph) and a mere 138 mph (222 kph) for a tennis ball<sup>2</sup>. The fastest hockey shot ever recorded belongs to the All Star Player Bobby Hull, whose slapshot was measured at 120 mph<sup>3</sup>. Polish National Handball Team player Karol Bielecki fires shots on goal with the speed of over 120 kph, which is also common for serves executed by Polish National Volleyball Team player Mariusz Wlazły<sup>4</sup>.

A high initial speed of the oncoming ball sets a big challenge for players’ attentional processes, especially when combined with a short distance of the ball flight (i.e. the distance between the place of the shot execution and the place where it is caught, blocked or hit back). Soccer, handball or hockey

goalkeepers need to save shots from various distances ranging from a few up to several dozen meters. Volleyball players need to receive serves which travel over a dozen meters but also spikes, when the distance between the attacker and the defenders’ block is sometimes as close as 0.5 - 1 m. Short distances between attacking (serving, passing) players and defending (returning, blocking) players balls are characteristic of table tennis matches, badminton matches or squash matches, because of relatively small court (table) dimensions. But they are also common practice in tennis, especially when one or all the players on the court are close to the net. This sets extraordinary demands on players’ perception skills, and exceeds by far the human reaction time capabilities requiring great anticipation skills coupled with attentional skills.

Another special challenge to players’ attention seems to be “unpredictable” changes of the ball trajectory. They may occur due to the so-called “bad bounces” off uneven parts of the surface, e.g. table edges in table tennis, holes or plastic lines on the tennis clay court, grass clusters or puddles on a soccer field, etc. Other examples of “unexpected” changes in the ball flight direction are ball ricochets, e.g. a ball touching the net cord in volleyball, table tennis or tennis; a hockey puck deflected by a player’s stick or skate; a soccer ball deflected by defenders forming the wall during a free kick; a ball deflected by a defensive block in volleyball, or a sudden blow of wind in outdoor racket sports.

The attentional demands of tennis described above are combined with decision making processes which are regarded as cognitive processes leading to the selection of a course of action among several alternatives based on certain criteria (Tab. 1). In a tennis doubles game, when the partner shouts “out”, it means that he prefers his teammate not to hit the ball, which he thinks will be too long or too wide. But in most cases the player has to return the oncoming ball, which makes him decide whether to take the ball before it bounces on the ground (i.e. with a volley) or after the bounce (with a groundstroke). In the latter case he also has to decide whether to hit the ball on the rise or on the fall. If the ball is coming directly at the player’s body, then he has to decide whether to use a forehand or a backhand stroke. Every tennis stroke means more or less conscious decisions concerning the optimal ball direction, length, height, spin and

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<sup>2</sup> [http://www.shuttlecock.com/Resources/Shuttlecock/speed\\_info.php](http://www.shuttlecock.com/Resources/Shuttlecock/speed_info.php).

<sup>3</sup> [http://wiki.answers.com/Q/What\\_is\\_the\\_fastest\\_speed\\_ever\\_clocked\\_on\\_a\\_hockey\\_puck](http://wiki.answers.com/Q/What_is_the_fastest_speed_ever_clocked_on_a_hockey_puck).

<sup>4</sup> <http://www.siatka.org/index.php?id=blue/section=korp/files/metodyka/foto/1/2007/lp/11/files/metodyka/koordynacja.pdf?kibic.aktualnosci.wszystkie.21683>.

speed. Then the tennis player has to choose the best stroke mechanics to achieve the desired ball flight characteristics. For example, one might choose between the eastern and the western grip, big or small backswing, racket motion upwards or downwards, open stance or closed stance, active leg drive or no leg drive, etc. Both before and after executing his shots the player should also take the best position on court to perform his actions most effectively, i.e. he must decide whether to remain on the spot or move to another place, e.g. to the front or behind the baseline, to the left or to the right side of the court.

Generally, tennis players' decisions are made upon their perceptions of the characteristics of the oncoming ball, opponent's features, skills, capabilities and actions; player's own features, skills, capabilities and psycho-physical state as well as net and court dimensions or other criteria (see the right column of Table 1).

Tennis coaches often give such tactical advice to their players as "a shorter, slower and higher ball should be attacked!" This implies that a tennis player should make the decision to attack upon the characteristics of the oncoming ball – its length, speed and height. Sending the ball to the

**Table 1.** Decision making in tennis – main courses of action and selection criteria

Main decision (action) alternatives	Selection criteria
1. To hit or not to hit the ball?	1. Oncoming ball features:
2. When to hit the ball?	<ul style="list-style-type: none"> <li>• direction</li> <li>• height</li> <li>• length</li> <li>• spin</li> <li>• velocity</li> </ul>
<ul style="list-style-type: none"> <li>• before it bounces off the court (volley) or after the bounce?</li> <li>• on the rise or when it is already falling down?</li> </ul>	2. Opponent's features, skills, capabilities, position and actions:
3. To hit the ball with a forehand or a backhand?	<ul style="list-style-type: none"> <li>• physical features (height, weight)</li> <li>• court position</li> <li>• movement direction and speed</li> <li>• stroke technique (backswing, grip, hitting point, racket head position)</li> <li>• strengths and weaknesses,</li> <li>• preferred game patterns</li> <li>• unconscious movements and gestures giving hints of tactical intentions</li> <li>• psychophysical state (signs of tension or tiredness)</li> <li>• unusual circumstances (opponent slipped, injured, suffers from cramps, broken string, etc.)</li> </ul>
4. To hit the ball to the right or to the left?	3. Player's own features, skills, capabilities and position:
5. To hit a low ball or a high one?	<ul style="list-style-type: none"> <li>• court position</li> <li>• strengths and weaknesses</li> <li>• psycho-physical state</li> </ul>
6. To hit a long ball or a short one?	4. Net height
7. To hit the ball with a backspin or a topspin?	5. Court surface and dimensions
8. To hit the ball with a high or low velocity?	6. Score
9. What stroke technique to use?	7. Other factors (wind, light, rain, temperature, humidity)
10. What court position to take?	

right corner of the court precisely at the moment when the opponent is positioned in the left corner, or placing a short ball right behind the net, when the opponent is far behind the baseline, are just two examples of decisions based upon the opponent's actions. Good decision making in tennis should also consider physical features of the opponent, e.g. sending low balls against very tall players and high balls against short players, as well as forcing opponents who display signs of tiredness to long, exhausting ball exchanges.

Tennis players also take into account their own features, abilities and skills. For example, they use their better shots as often as possible trying to avoid their less skillful strokes. Perhaps the most commonly used pattern in tennis is hitting powerful forehand strokes over and over again and running around the weaker backhand side.

For many players the rationale behind choosing crosscourt shots so often (as compared to relatively rare shots hit down the line) is the lower height of the net in the middle of the tennis court (net height as a selection criterion) and the fact that the diagonal of a tennis court is longer than a sideline perpendicular to the net (court dimensions as a selection criterion).

It is also common that tennis players "play to the score". For example, leading 40:0 in a game they go for much more risky patterns of play (like hitting the ball very close to the lines or with a very high speed), than they would do when the score is tied. In other words, they use the score as a criterion for the selection of a course of action.

The above analysis reveals many potential courses of action available during a tennis game, selection criteria to be used and, consequently, a very complex nature of decision making in tennis. It should be remembered that most decisions in tennis are made in a split second, intuitively, and only few of them occur on operational or strategic levels [3].

All players' actions in competitive sports games should be driven towards scoring points, which means that the players must pay attention to the score. We already mentioned "playing to the score" (i.e. making tactical decisions according to the score), but there are at least two more reasons for increased awareness of the score in tennis. Firstly, it is because the players are very often supposed to keep the score by themselves, i.e. there is no officiating. Secondly, because the score in tennis changes very frequently. Contrary to soccer

games, where the score may not change at all during an entire 90-minute match, and the final score may be a 0:0 draw, in tennis the score changes more or less every 30 seconds.

This also means that apart from the objects inherent to playing tennis (ball, racket, court) and its spatial aspects (i.e. distance between players, court dimensions) or kinematic aspects (ball velocities) one should also consider the temporal aspects of the tennis game setting specific attentional challenges. One of them is the match duration time, which is not fixed and can range from 30 minutes to even 5-6 hours. According to Królak [5] the mean match duration time varies between women's and men's competitions: a match can last from 1 to 2-3 hours in a women's game and from 1½ to 3-4 hours in a men's game. It is worth noticing that tennis players do not have to pay so much attention to the overall match time like soccer, basketball or handball players, whose tactics partially depend upon the remaining time of the competition.

In order to win a typical (best of three sets) tennis match the player has to win at least 48 points, which means that the ball is put in and out of play 48 times at the very least (usually many more times). If we consider the mean duration time of a tennis point, which is less than 10 sec., and the duration time of the breaks between two successive points, which according to the rules cannot exceed 20 seconds<sup>5</sup>, then it becomes obvious, that the so-called dead playing time is twice as long as the effective playing time. In a three-hour tennis match, breaks will take up over two hours.

Undoubtedly, the most important part of tennis player's attention management refers to the effective playing time, as it is when the match is decided.

#### SPECIFIC ATTENTIONAL DEMANDS IN TENNIS PLAYING TIME

Attention capacity demands in tennis can be described by listing the multiple objects attracting players' attention: the court, the net, the ball, the racket, the player himself, the opponent, distributed on a medium size area (tennis court is bigger than a

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<sup>5</sup> After 3rd and each successive odd game of the set, there is a longer 90 sec. break, during which players change the sides of the court.

tennis table and smaller than a soccer field). Another point is that there are many details associated with most of these objects that need to be attended to, e.g. speed, spin, direction, height and length of the flight of the oncoming ball. One should also point out the many actions that need to be performed by tennis players more or less simultaneously, such as watching the ball, watching the opponent, making decisions, running to the ball, hitting the ball.

Out of the traditional five senses: sight, hearing, touch, smell and taste, the last two seem to have no special significance for player's perception in tennis. The predominant importance should be attributed to the ability of seeing clearly the target (the chosen part of the court), the oncoming ball characteristics and the opponent's actions, as well as the visual control of one's own positioning in relation to the court and the net (*visual attention*).

Hearing (*auditory attention*) does have a supporting function for tennis players. They receive sounds of the ball coming off the opponents racket or bouncing off the court, sounds of a breaking string in the opponent's racket, sounds of opponent's steps providing information about his positioning, sounds of his breath can reveal increasing tiredness, etc. Some tennis players complain about being disturbed by airplanes, trains, crowd noise or their opponents groaning every time they hit, with Monica Seles and Maria Sharapova being the two most famous examples of that.

There is anecdotal evidence indicating great sensibility of the touch receptors in the playing hand (palm) of tennis players, who can recognize with ease their own rackets just by feeling the grip even with closed eyes, and are reluctant to changing a racket during the course of a match to another (almost identical) own one, but having a different "feel" of the handle grip (*tactile attention*).

Two more senses that seem to be important for tennis players are equilibrioception and proprioception. Balance, also called equilibrioception or vestibular sense, allows tennis players to sense their body movements, direction, and acceleration, and to attain and maintain postural equilibrium and balance (*vestibular attention*). Proprioception or the kinesthetic sense provides the player's brain with information on the relative positions of the parts of the body without visual control (*kinesthetic attention*).

Apart from precise perceptions, playing the game requires also other cognitive processes:

recalling past experiences gathered in similar situations, decision making, memorizing current experiences or using mental imagery. The latter skill allows the player hitting the ball into target without even watching the target (when turned back to the court) just by following the mental image of the court in mind.

Because of the aforementioned global match time, tennis players need a long attention span. Differently from marathon runners, cyclists, swimmers or rowers, who must be fully alert from the very start to the end of a race, tennis players do not need continuous attention. They need short time (usually around ten seconds) intervals of increased alertness, interrupted by breaks lasting twice as long. This process is repeated at least 48 times, which is the least number of points played during the best of three sets of a tennis match, but it quite often exceeds 100 repetitions.

Tennis players also require attentional flexibility as they shift their attention multiple times during play. Playing tennis requires flexible changing of the intensity of attention, moving the visual focus in space and adopting the scope of attention. The interval character of the tennis game allows attention intensity changes in a sine wave, raising during point play and falling during breaks. This process seems to be quite similar in all interrupted sports, as observed in the attentional strategy of cricketer Ian Botham reported by Weinberg & Gould [7]: "I switch off the moment the ball is dead – then I relax completely ... But as soon as the bowler reaches his mark, I switch back on to the game. I think, that anybody, who can concentrate all the time is inhuman".

During point play tennis players must *follow fast moving balls* with the eyes constantly shifting their attention from one side of the court to the other. It also means that for some time during a rally they will be interchangeably concentrating more on sending the ball to the target and on receiving the ball sent by the opponent. These two phases of play are more distinct in the actions of a handball goalie, who first of all, is committed to saving shots, but after a successful save switches his attention from defending to attacking, takes the ball and usually tries to send it to a running wingman initiating a fast counterattack. The receiving phase does not exist in most shooting and archery events, where the competitors can concentrate solely on sending a bullet or an arrow into the target.

One should also think of shifting attention in tennis in terms of *narrowing and broadening* the scope of attention. Narrow focus of attention on the ball is usually adopted just prior to hitting it (“targeting”), whereas broader scope of attention is needed to assess the situation (“scanning”) and anticipate the opponent’s actions as well as the ball direction, speed, etc. [2].

Although tennis players direct their attention very often at external objects, e.g. the court, the ball, the opponent, they cannot completely ignore the information about themselves, i.e. their balance, muscle tension or muscle tiredness (internal objects), so they also have to switch between external and internal attention.

During point play tennis players should direct their attention preferably to present events (watching the ball and opponent, feeling the grip of the racket, deciding the course of action, executing shots), but also do need to make use of their past experiences in similar situations as well as try to anticipate possible future actions.

#### SUMMARY

Below are the most important structural characteristics and specific attentional demands in tennis that need to be integrated in training programs aimed at improving attentional processes of tennis players:

- Tennis court is a target to aim at and hit. Basically, it is a stationary target, which has standardized and relatively large overall dimensions.
- The opponent in tennis has no direct physical contact with the hitting player but due to his features, movements, abilities, etc. makes the tennis court functionally a moving target with variable and much smaller (than its overall) dimensions.
- A tennis player predominantly adopts a moving position (which constantly changes his or her distance to target and causes instability during hitting), uses relatively complex movements (involving mainly the arms but also the trunk and the legs moving in many joints, in different planes and directions) and has only split-second contact with the object sent at the target, due to the hitting character of the motion.
- Tennis racket is an object of limited hitting surface area, used to send another object (the

ball) into the target (the chosen part of the court).

- Tennis net is a transparent, stationary, physical barrier of medium height set on the way to the target.
- Tennis ball is an object sent into the target, which has a relatively small size, moving character, flying and/or bouncing type of motion, variable and often very high speed flight, medium to low flight distance and sometimes “unexpected” changes of flight direction.
- There are high demands for both perceptive and executive attention.
- There are special requirements for visual attention, but also other senses are highly involved.
- A very complex nature of decision making in tennis results from numerous potential courses of action as well as many selection criteria.
- There are great attention capacity demands due to the many objects involved and many actions executed more or less simultaneously.
- Extreme attentional flexibility demands in tennis result from the many changes of attention intensity, the need to follow fast moving balls from one side of the court to the other, changing the scope of attention from broad to narrow and from internal to external objects, as well as changing between past, present and future events.
- There are many (often over 100) short time intervals of increased alertness in tennis, usually lasting not more than 10 seconds, interrupted by breaks lasting twice as long.

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