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CONTENTS ISSUE 76

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COACHING & SPORT SCIENCE REVIEW

The Official Coaching and Sport Science Publication of the International Tennis Federation

EDITORIAL

Welcome to issue 76 of the ITF Coaching and Sport Science Review. This issue covers a range of aspects in the game including: technology; the inside-out forehand; the effects of mini tennis; serve and return of top players; intelligent tennis devices; the USTA's new campaign, Net Generation; motivation between boys and girls; wheelchair tennis players' movement; and variability in tennis practice. This issue also features a study on the costs of tennis in selected countries.

The 2018 series of ITF Regional Coaches Conferences by BNP Paribas came to an end on the 3rd November after almost a month of back-to-back conferences. There were just under 1200 delegates in total from all of the seven ITF Regional Coaches Conferences and Tennis Europe Coaches Conference. A series of Junior Tennis Initiative (JTI) Workshops and JTI Tutor Workshops were run after the conferences which will contribute to the continuous development of tennis in those regions. The ITF would like to thank all the delegates, guests, speakers, regional associations, national associations and other organisations involved for making this set of conferences one of the best yet. The programmes and proceedings can be downloaded from the ITF eBooks app, which is available on the Apple app store and the Google store. The programmes and proceedings are also available on the ITF website under the relevant region's page, and to be redirected please click here.

The next series of Regional Coaches Conferences will be in 2020 but for now the ITF looks forward to its Worldwide Coaches Conference by BNP Paribas, which will be held in Bangkok, Thailand in 2019 from the 25th to the 27th October. Also, 2019 will see the return of the ITF Worldwide Participation Conference after its success in 2018. The conference will be held on the 7th and 8th July 2019. More information about both conferences will be released in due course.

The ITF eBooks app now has 118 publications, of which over 60 are free, and there are publications available in English, Spanish, French, Russian, Mandarin, and now just recently, Portuguese, with 5 new publications. Also, Tennis iCoach now features 12 presentations from the 2018 ITF Worldwide Participation Conference, and the first presentations from the LTA's National Coaches' Conference are now available. You can sign up for just $30USD per year, and by going to www.tennisicoach.com. The ITF Academy, which will be launched soon, will provide information, education and certification support through a blended learning approach. The ITF Academy will become the home for the Tennis iCoach library of videos, presentations and articles, and two initial online courses on ethics in coaching and an introduction on tennis will be released for users to try out.

Finally, we would like to thank all the authors for their contributions, as well as all of those who sent in proposals. We hope that you enjoy reading the 76th edition of the ITF Coaching and Sport Science Review just as much as we enjoyed putting it together.

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Using technology to improve practice and performance: A practical summary

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ABSTRACT

The purpose of this article is to outline the evolution of science and technology within the sport of tennis, while simultaneously providing players and coaches with some specific practical applications that can be utilized by players of all ages and abilities.

Key words: technology, practice, court efficiency, evolution of technology, practical application

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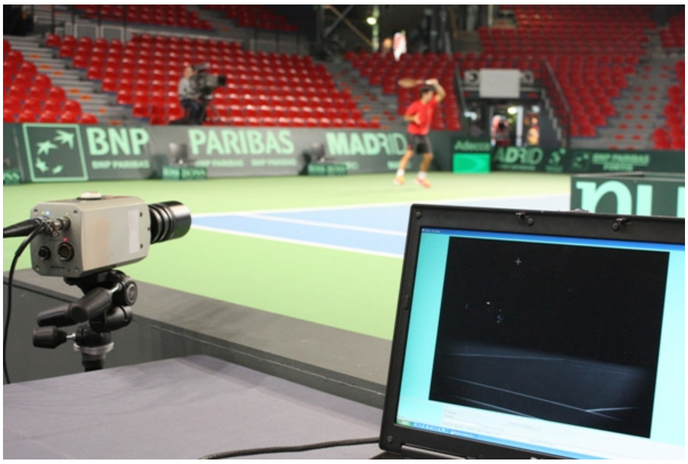
INTRODUCTION

In 2006, tennis witnessed its biggest technological revolution since graphite rackets forever changed the game in 1980 (Lammer & Kotze, 2003) when Hawk-eye technology was officially introduced at the Miami-Nasdaq 100 ATP event. This revolutionary technology not only set a technological precedent within the sport but also served as an invaluable tool for referees, players and coaches, allowing objective observations to be made regarding performance (Boadong, 2014), and essentially opening the floodgates to a barrage of technological innovation.

Technological applicability has unquestionably widened its frontiers to include sports in the 21st century as we can now see technology reigning supreme over institutions such as the World Anti-Doping Agency (WADA), Fédération Internationale de Football Association (FIFA), International Tennis Federation (ITF), Women's Tennis Association (WTA) and the Association of Tennis Professionals (ATP), etc., not only to uphold the regulations and policies of their respective sports (Loland, 2009) but also assist in making enhanced observations and improved data collection (Giblin, Tor, & Parrington, 2016).

Qualitative analysis is the most commonly employed strategy by most tennis coaches to identify and diagnose deficiencies in strategy and technique but this can be problematic due to the rapid speeds at which the game is played (Elliott et al., 2003). Furthermore, strength and conditioning specialists are far too often dependent on a subjective opinion regarding a player's physical status, health and performance, rather than an objective analysis, which can often lead to overtraining, fatigue and injury. The obvious disadvantages with the aforementioned 'subjective analysis' techniques have been widely documented (Hughes and Franks, 2004) and so the urgency within the sport to integrate modern technology has become imperative. According to Omoregie (2016), to better understand how technology assists a sport, it is possible to categorize them into six sub-categories; self-technologies, rehabilitative technologies, landscape technologies, movement technologies, implement technologies and database technologies.

The purpose of this paper is to illustrate how both database and movement technologies can vastly improve the effectiveness of coaching and player performance on-court, improve physical performance and injury prevention off court, and simultaneously provide some specific training devices while cautioning users to the potential pitfalls associated with the abundance of current information and at our disposal.



TECHNOLOGY 'ON-COURT'

From an on court perspective, coaches primarily focus on two key components of development; maximizing technical efficiency (Schönborn, 2000) so as strokes can be repeatedly performed, and implementing a correct strategical foundation that maximizes the physical and mental capacities of the individual. As much as 75% of all information processed by the brain is in visual format (Williams, 2009) and so the advent of so slow-motion video analysis applications that are readily available on mobile devices, are actively assisting players and coaches alike. Moreover, multiple studies (Jones & Stuth, 1997) have demonstrated that the use of mental imagery (pictures, video, etc.) combined with physical practice can significantly increase the efficiency of the motor action being acquired.

Practical, cost effective, and easy to use, applications such as 'Coaches' Eye', 'HUDL Technique' and 'CoachMyVideo' are fast becoming ubiquitous amongst the tennis population offering a myriad of popular functions including 'split-screen comparison', 'transparency/side by side viewing' as well as some more esoteric features such as 'timers and chronometers', 'measurement tools', 'joint angles', 'zoom capabilities', 'mirror imaging', 'screen captures' and 'composite picture sequence display' (photo sequencing). More robust options such as Dartfish and Siliconcoach have long been considered the 'gold-standard' of video-analysis as they provide users with a host of additional features such as HD 'video' and match 'tagging' which allows users to view entire matches while simultaneously grouping points in to specific categories such as 'forehand winners', 'backhand errors' or 'aces out wide' so that occurrences can be enumerated and patterns of play from both the subject player and opponent can be ascertained. However, such programs are considerably more expensive and time consuming to use than the aforementioned mobile applications making them somewhat less relevant in today's market.

When attempting to improve a players understanding of the game, implement specific patterns of play or increase general strategic awareness, coaches are relying more and more on statistical analysis and data collection. A staggering 90% of the world's data has been generated in just the last 2 years (ScienceDaily, 2013) and tennis recently demonstrated its commitment to technological modernization as the WTA tour recently partner with SAP analytics to provide 'real-time' statistics and data measurement during matches to assist coaches with game plans and strategy. Additionally, the ITF has implemented detailed match statistics for all main draw matches at its pro-circuit events, which are available (in real time) through its 'ITF Pro-Circuit' application (iOS and Android) allowing many 'transitional' players the unique opportunity to gain insights into their own performance.

With an increased desire for statistics and data, numerous applications have become available for match 'tracking' including Tennis Stats HD, Pro Tennis Tracker, Tennis Trakker, Tennis Math, TennisStats and SmashPoint, all of which provide a vast array of information such as unforced errors, winners, serve %, and break points saved, as well as a multitude of other pertinent information that has become highly regarded and prevalent in professional sports (Haigh, 2009). These applications are typically available for a nominal fee and assist coaches in objectively evaluating performance which is imperative as studies suggest (Franks & Miller, 1991) that a coach's ability to accurately recall events post-match is relatively poor (less than 40%) and so the need for data accumulation has increased. Craig O'Shannessy (2014) has become a modern pioneer of tennis analytics, data collection and strategy implementation as he has emphasized, in particular, the importance of first exchange, and for example how the most commonly occurring rally length (the mode) in professional tennis is just 1 shot.

Qualitative feedback is rapidly becoming more redundant as quantitative analysis is now more accessible than ever providing unbiased objective fact as opposed to subjective opinion. Play Sight has rapidly become synonymous with modern tennis technology as its camera-and-kiosk system transforms a traditional tennis court in to a technological marvel through its interactive touch-screen kiosks, HD cameras, advanced image processing and unique analytical algorithms that provide players with a complete practice/match evaluation that objectively details key areas such as stroke type, ball trajectory, speed ,spin, and player movement and can even offer line calling, real-time video streaming and multi-angle video replays.

Furthermore, a host of companies such as Babolat, Head, Zepp, Yonex, Sony and Wilson are now exploiting modern technology by affording players the opportunity to convert their tennis racket in to an 'analytical machine' through the use of 'clip-on' racket sensors. According to Daniel Becker who is senior marketing manager of Babolat, the built in sensor uses an "accelerometer that analyzes the direction of the racket and a gyroscope that analyzes the rotation of the racket" in addition to "a piezoelectric sensor that analyzes the vibration of the racket to inform the location of the ball on the racquet" (marketwatch.com, 2015).

TECHNOLOGY 'OFF-COURT'

As trainers attempt to increase their athletes overall athletic ability while simultaneously eliminating injury, the quest for a competitive advantage has crossed in to the strength and conditioning domain. From an athlete assessment standpoint, a useful tool for trainers to utilize is Omegawave; a small portable device which asseses a range of short and long-term adaptational changes that occur in the human body. The device calculates a range of pertinent information including heart activity (ECG), ultraslow brain wave activity (DC potential), neuromuscular fatigue, and reaction rate measurements, all of which can be viewed and instantly analyzed. By monitoring specific changes, trainers are able to modify training protocols as Omegawave's system provides applicable information that can help the athlete improve his/her stress resistance and work capacity, avoid overtraining, and reduce the risk of injury (Fomin, Nasedkin, 2013). All measurements are stored in a cloud-based system that provide results and recommendations that are relevant to the athlete's cardiac, metabolic, Central Nervous System (CNS) and hormonal readiness, which are all primary markers when determining if an athlete is ready to perform successfully at any given time in a season.

From an athlete monitoring perspective the use of Velocity Based Training (VBT) has become the industries primary method for determining strength training load. The 'Push Band' is a wireless wearable device that measures movement velocity via the use of a 3D accelerometer and Gyroscope allowing trainers to instantly monitor fatigue and readiness by identifying reductions in movement velocity and power output. Power is often overlooked by strength trainers and athletes, but strength is only one factor of the equation (F=ma), (Zatsiorsky, 1995), and different strengths have different velocities (Verkhoshansky, 1982) so this portable device ensures that proper development is exhibited throughout the entire force-velocity continuum. A variety of factors such as current training status, chosen periodization model, power, velocity, and average/maximal repetitions are automatically accounted for by said device, and the information generated helps trainers determine optimal loading without relying on the naked eye or rates of perceived exertion (RPE).

CONCLUSIONS

Each of these technological advancements provides coaches, players, parents and trainers with useful information that can significantly alter training protocols, match evaluations, tournament scheduling, injury prevention and more. However the dangers presented are palpable, as now more than ever 'educators' must ensure that their advice is sound, the information they provide is objectively supported, and the interpretation of the collected data is candid, as in the 21st century 'everyone' can readily access detailed information and statistics assuming the role of 'expert'.

Whether using video analysis, power output processors, or any other similar apparatus, it is important to exploit technology in a way that will be beneficial to all members of the sport's industry. Improved data/measurement acquisition and processing, enhanced observations and testing, and improved equipment and training aids alone are not sufficient feedback to substantially improve performance (Giblin, Tor, & Parrington, 2016). An educated interpretation of the data provided by technology will ultimately be one of the most important aspects of the process as we strive for more efficient practice environments (Liebermann, et.al. 2002). The current technological revolution creates unfathomable opportunities associated with it, but also creates an abundance of dangers. Technology and coaching are only effective when there is an established and well defined culture, where disciplined people and disciplined thought co-exist. After all, this is only the beginning.

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RECOMMENDED ITF TENNIS ICOACH CONTENT (CLICK BELOW)

Tennis iCoach

The inside out forehand: Technique and methodology

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ITF Coaching and Sport Science Review 2018; 76 (26): 6 - 8

ABSTRACT

This article discusses the technical and methodological aspects of the inside out forehand. With regards to technique, the importance of appropriate footwork for the efficient execution of this stroke is stressed. As to the methodology, discovery strategies are suggested. Finally, some on-court exercises are presented in order to to improve the footwork technique.

Key words: groundstroke, biomechanics, forehand

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INTRODUCTION

The inside out forehand is played when the player moves towards the left half of the court, with the initial objective of protecting his backhand in order to use the forehand drive (Figure 1). In the case of left handed players, the movement happens on the right hand side

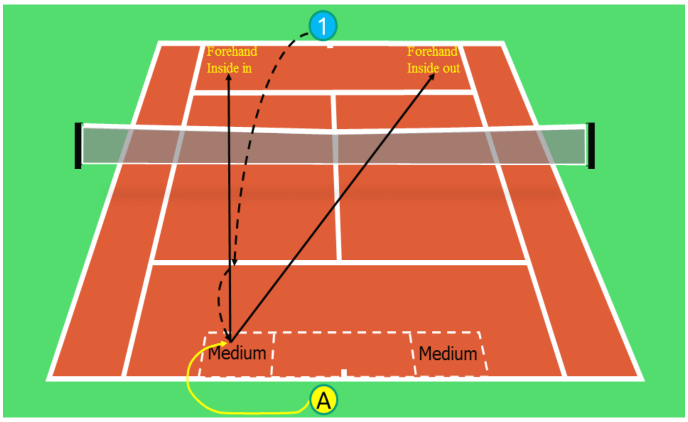

Figure 1. Inside out forehand from inside in and from inside out.

It is the direction of the ball after being hit that provides the name to the technical movement. Thus, in the case of the shot going towards the outside of the player or the diagonal, it is called the “inside out forehand”. On the contrary, if it is used down-the-line, it is called “inside in forehand”.

The cross-court inside out forehand is the most commonly used ‘inside’ shot, as it clears the net over its lowest part, making it safer. The flight of the ball is also longer since it is a diagonal shot, which forces the opponent to move, thus creating space, providing, a priori, a good attacking position. This stroke generally aims at “locking” the opponent on the backhand side, to look for a winner in the same place, or to aim to the other side of the court.

The down-the-line inside out forehand is a higher risk stroke, which normally finds the opponents forehand drive and needs more speed and accuracy (except when the space has been created before). This stroke is performed with some more spin than the cross-court; the net is higher and the ball trajectory is shorter.

INSIDE OUT FOREHAND FOOTWORK AND TECHNIQUE

IIn general, the movement is a hitting technical movement on the forehand side, the body position is conditioned by the position of the feet which are open and laterally placed, so, the ball can be hit with a more open angle, on the left side of the court, or right side of the court in the case of a left-hander such as Nadal (Figure 2).

Figure 2. Rafael Nadal.

As Reid, Crespo, Santilli & Miley (2005) state, short movements are those in which the player has to move approximately 3 m. max. in order to make a stroke. Therefore, we agree that the forehand footwork in the inside out forehand is of this type, and furthermore, that it is crucial.

In evaluating the movement patterns of professional players on clay, Ferrauti & Weber (2001) observed that approximately 80% of all shots are played at less than a 3 m distance from the ready position on the baseline. In order to play optimal defensive and offensive strokes in short distances, coordination and agility, as well as appropriate and versatile balance are necessary (Bourquin, 2003). The basic short movements are multi-directional shuffles, and side step, as well as small adjustment steps.

In the stroke, it is important to emphasise: the lateral movement; getting around the ball in order to get into the right position and get side-on enough; reaching the ball with short steps; preparing the stroke whilst moving around the ball; pointing with the left hand to calculate the distance to the ball; and, thrusting the body forward at the time of impact in order to generate more power to the stroke.

As to the specific footwork in the inside out forehand, Reid et al., (2005) consider that footwork exercises which work on this important aspect of the movement, and thus, the stroke execution, have played a key role for on-court training of many professionals, over the last 15 years. Pato Álvarez, one of the most outstanding coaches in Spain, used many of these exercises with his players during the 80´s and 90´s, so much so, that they have become a characteristic element of many coaches´ toolkits.

In this sense, many authors believe that with the proliferation of very strong baseline players over the last years, the capacity to reach angled balls near the sidelines, in a speedy and efficient way, and to recover, is getting more and more important. The skill of covering the court with efficient movements at short distances is part of the footwork toolkit for most professional players.

The comparison between beginners and advanced players, when preparing a baseline stroke when running, is an example of an important element of the movement that must be trained on-court (Saviano, 2000). Advanced players start the movement towards a baseline stroke in the lower limbs, and the initial rotation of the shoulder happens without excessively moving the racket (Ellenbecker & Roetert, 2003). This allows the player to start the upper body rotation, without this rotation interfering in the movement towards the ball. On the contrary, in these strokes, beginners usually get ready and sprint to the ball with a totally extended arm and with the racket behind their back.

Regardless of the playing level, it is key for players to adopt a balanced position during movement so as to transfer the force as efficiently as possible, and to provide a stable base (for the head) from where to process visual information correctly. It is important to train to keep the correct body position during on-court movement and stroke execution (Ellenbecker & Roetert, 2003; Verstegen, 2003) (Figures 3 & 4).

Figures 3 and 4. Inside out forehands.

TEACHING THE INSIDE OUT FOREHAND: METHODOLOGICAL CRITERIA

Brabenec (1996) states that in modern tennis, the forehand stroke must be a "weapon" (65% to 70% of the court should be covered with this stroke) with the backhand being a solid support complement. Furthermore, when the opponent plays a slow ball to our backhand, we must run around the backhand, as much as possible, to play an attacking forehand. The forehand that is played from the backhand corner, allows the player to camouflage his/her intentions. It can be played inside out or down-the-line to the side line. It also provides the probability of hitting another forehand, should the opponent return the ball.

Dent (1996) considers that returning serve (2nd serve) with an inside out forehand is an excellent opportunity to be aggressive with this stroke. The coach or player aim a second service to the opponent´s backhand. The receiver runs around their backhand to return with an attacking forehand.

Thus, the receiver must start to move around the backhand as soon as the serving player has thrown the ball up. The highest "percentage" return is an inside out cross-court forehand drive, which forces the serving player to change direction. It is the greater distance on the lower part of the net and allows the receiver to move easily, and to return to the central geometrical position, limiting the opponent's attack angles.

When talking about the footwork needed against a short ball, Farrell (1998) suggests that many players would rather avoid their backhand and play an inside out shot; and, therefore, the coach must teach and train this movement.

On the other hand, the player must be encouraged to "hit his deepest" to the baseline, so that the shoulder and the racket go forward at the same height as the contact point (if the contact point is at shoulder height, as it always should be).

CONCLUSIONS AND PRACTICAL APPLICATIONS

When teaching and training the inside out forehand technique, we recommend using the didactic strategy of guided discovery or problem solving in which the coach creates playing situations that challenge the player to discover the solution.

In this case, this occurs by means of teaching with the constraints approach, and using variability in practice (Martín-Lorente, Campos, & Crespo, 2017).

Open, global, holistic facilitators of adapted solution approaches, that involve a player´s implicit knowledge and reasoning, and an understanding of the demands of the game are, obviously the most appropriate.

Exercise 1

Purpose: Develop specific footwork for the inside out forehand

Place and equipment: Tennis court, racket, target.

Methodology: Shadowing the movement without the ball.

Description: The player is approximately 1 m. behind the centre service line in zone A. The cone is placed as in the figure. The player holding the racket will make the movement to hit an inside out forehand and will make the gesture of the stroke (Figure 5).

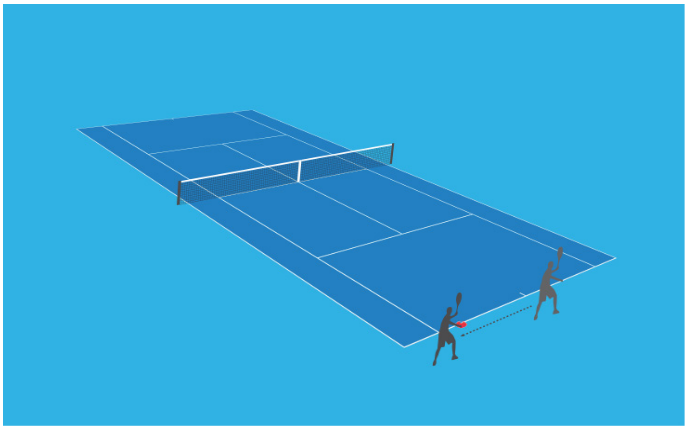

Figure 5. Exercise 1.

Exercise 2

Purpose: To develop the specific footwork and hitting for the inside out forehand.

Place and equipment: A tennis court, a basket with balls, rackets, targets.

Methodology: The coach feeds from the basket.

Description: The player is approximately 1 m. behind the centre service line, on the left zone of the court. The cone is placed as in the figure. The coach is approximately half way along the alley on the left side and hand feeds the balls to the area shown in the figure so that the player must move round the ball with the appropriate footwork, just as shown by the black arrow. The player will hit the inside out forehand towards the targets placed on the other half of the court (Figure 6).

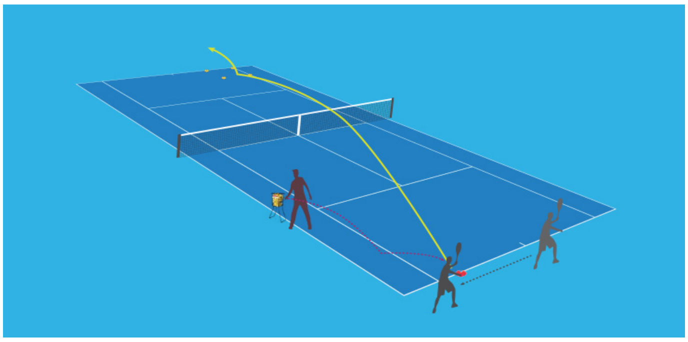

Figure 6. Exercise 2.

Exercise 3

Purpose: To develop the specific footwork, hitting and aiming for the inside out forehand in a closed situation.

Place and equipment: A tennis court, a basket with balls, rackets, targets.

Methodology: The coach feeds from the basket.

Description: Similar to the previous exercise but the coach is on the other half of the court, and feeds balls from the basket for the player to move to the ball with the right footwork, just as is shown by the arrow. The player will hit the inside out forehand towards the targets on the other half court, alternating the direction of the strokes (Figure 7).

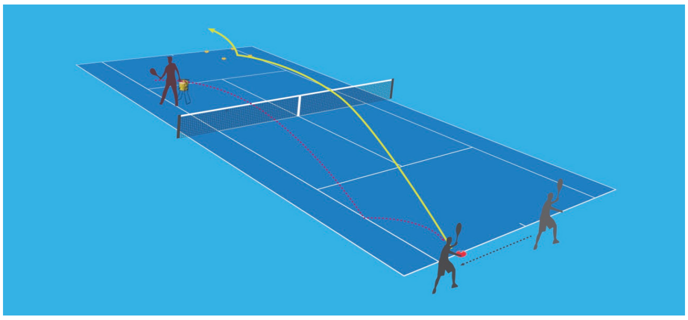

Figure 7. Exercise 3.

Exercise 4

Purpose: Develop the specific footwork, hitting and aiming for the inside out forehand in a semi-open situation.

Place and material: A tennis court, a basket with balls, rackets, targets.

Methodology: The coach feeds from the basket.

Description: Similar to the previous exercise, but the coach is on the other half of the court in the alley, feeding balls from the basket for the player to make the player move to the ball with the right footwork, just as is shown by the black arrows. The coach feeds three balls per series. One ball to the left, one to the centre, and another ball to the right of the player. No need to place a cone on the side of the player, so that they do not trip over it. The player will hit all inside out forehands towards the targets on the other half of the court, alternating the direction of the strokes (Figure 8).

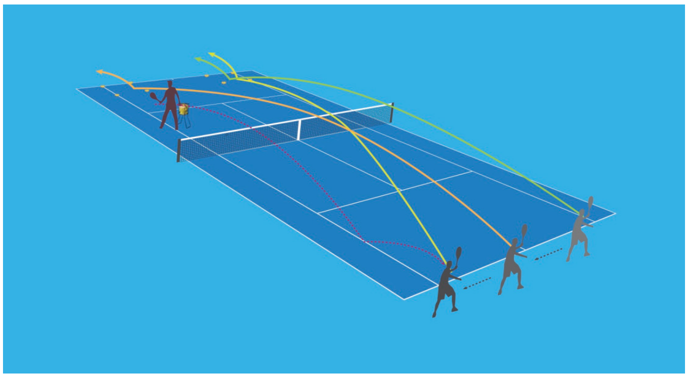

Figure 8. Exercise 4.

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Effects of an 8-week mini tennis coaching intervention on children's groundstroke performance

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ITF Coaching and Sport Science Review 2018; 76 (26): 9 - 11

ABSTRACT

Evidence suggests that modified versions of tennis (e.g. LTA mini tennis) positively influence children's technical and tactical development. However, Fitzpatrick, Davids and Stone (2017) highlighted that mini tennis may not afford children as many opportunities to develop the backhand, as it does the forehand, potentially leading to a skill imbalance. Here, we investigated effects of an 8-week coaching intervention, designed to alleviate the asymmetry between forehand and backhand performance, on children's match-play and skills test performance (Fitzpatrick, Davids & Stone 2018). After the intervention, the experimental group performed a higher percentage of backhands than the control group during match-play. The experimental group also demonstrated superior improvements in forehand and backhand technical proficiency compared to the control group and in their ability to maintain a rally with a coach. Findings suggested the modifications applied during our intervention may enhance children's skill development and afford more opportunities to develop the backhand.

Key words: Constraints-based coaching, mini tennis; intervention, task constraints, backhand

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INTRODUCTION

Modified versions of tennis, such as mini tennis and tennis play and stay, have been designed to enhance children's skill development and to reduce the speed of the game, such that children's behaviours closely reflect those needed in standard (i.e. adult) tennis (Buszard et al., 2016). Despite considerable evidence to suggest that these modified versions of tennis do indeed facilitate children's technical and tactical development (e.g. Larson & Guggenheimer, 2013; Timmerman et al., 2015), claims that they enable children's performance behaviours to closely resemble those of standard tennis have been largely speculative. Fitzpatrick et al. (2017) investigated this concept within mini tennis (MT); although MT elicited longer rallies and fewer errors than standard tennis, analysis revealed that MT players performed considerably more forehands than backhands during match-play (i.e. 2:1 ratio). In contrast, the ratio of forehands to backhands performed in standard tennis is closer to 1:1 (Reid, Morgan & Whiteside, 2016). Crucially, the asymmetry between groundstrokes observed in MT match-play may be even greater within children's coaching sessions, where Farrow and Reid (2010) reported a ratio of approximately 6:1 in favour of the forehand. It has been highlighted that such asymmetry between forehand and backhand performance may lead to a skill imbalance over time, possibly to the detriment of children's performance development (Fitzpatrick et al., 2017). For example, if MT players are not afforded sufficient opportunity to perform backhands, the stroke may not adequately develop, potentially allowing weaknesses to emerge; weaknesses that can be exploited by opponents. Here, we implemented an 8-week MT Red coaching intervention, designed to enhance children's skill development, while simultaneously alleviating the asymmetry between forehand and backhand performance.

METHOD

Participants

Sixteen children were randomly assigned to one of two groups; control (n = 8, age 7.2 ± 0.6 years, tennis playing experience 1.9 ± 0.6 years) and experimental (n = 8, age 7.4 ± 0.4 years, tennis playing experience 2.1 ± 0.6 years). All children were right-handed, with two-handed backhands.

Procedure

Pre- and post-testing comprised two elements: match-play and tennis-specific skills testing (TSST).

Pre-test: match-play

Each player was filmed completing three standard MT Red matches of 'first to 10 points' (LTA, 2017), against three randomly assigned opponents.

Pre-test: TSST

Players attempted to maintain three rallies for as long as possible with the coach. The mean rally length of the three attempts produced a 'rally performance score'. Additionally, two LTA Level 3 coaches qualitatively assessed four aspects of players' stroke production for forehands and backhands, respectively: movement to the ball, backswing, ball impact/follow-through, and recovery, using a 7-point scale (Farrow & Reid, 2010). The four scores were summed for players' forehand and backhand, respectively, producing a maximum achievable 'technical proficiency score' of 28 points per stroke.

Intervention

Both groups attended an 8-week MT coaching programme (1-hour per week). Both groups were taught by the same coach and performed the same activities throughout, but the experimental group's learning environment was modified (see Figure 1).

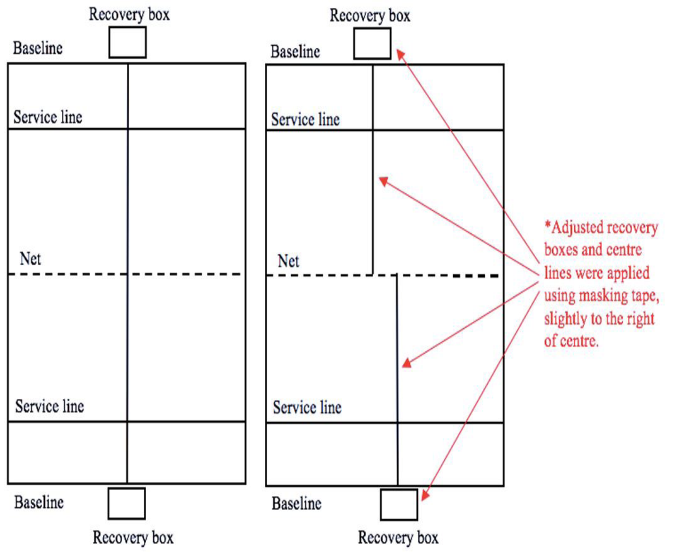

Figure 1. Recovery box and centre line locations for the control (left) and experimental group (right).

Experimental group players were asked to attempt to play a backhand if the ball landed to the left of the adjusted centre line (Hopper, 2011), and to return to the recovery box after each shot (Bryant, 2012). Additionally, during the experimental group's points-based activities, the coach awarded bonus points (i.e. added incentive) if a player put their opponent under pressure using their backhand (Hopper, 2011).

Post-test

Each player was filmed completing three MT Red matches, against the same three opponents as pre-testing, and repeated the TSST.

Data Analysis

Match-play video data were coded using a custom-notational analysis system (inter-rater reliability k = 0.95). The match-play variables in Table 1 were subsequently calculated (for full list see Fitzpatrick et al., 2018); TSST technical proficiency scores and rally performance scores were reduced to mean values.

Dependent variable	Equation
Forehand %	(number of forehands/total shots played after the serve) x 100
Backhand %	(number of backhands/total shots played after the serve) x 100

Table 1. Match-play variables.

Two-way, mixed design analyses of variance (ANOVAs) (practice condition x time) were performed, to investigate intervention effects. No statistical difference was detected between the total number of shots performed by each group during the intervention, so intervention effects were not attributable to differences in frequency of actions practised.

RESULTS

Key findings are presented here (for all reported results, see Fitzpatrick et al., 2018).

Match-play shot type

Figure 2 shows that the percentage of backhands played by the experimental group increased by 17.0% after the intervention; the percentage played by the control group decreased by 1.8%. The percentage of forehands played by the experimental group decreased by 17.3% after the intervention; the percentage played by the control group did not change.

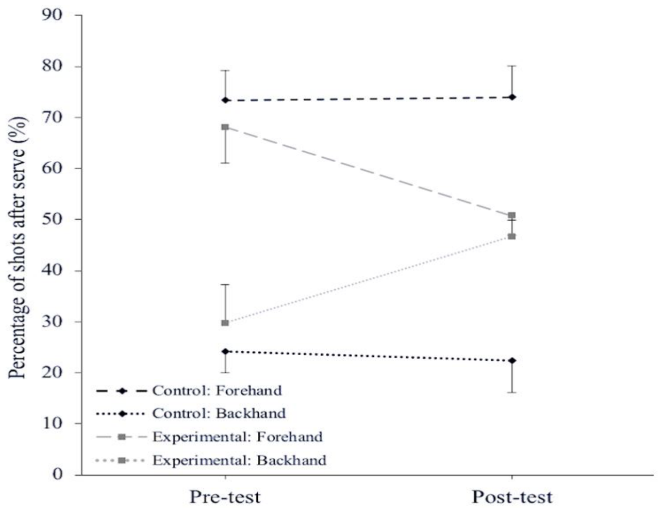

Figure 2. Percentage of forehands and backhands performed by each group.

TSST technical proficiency and rally performance score

Figure 3 shows that the experimental group's forehand and backhand technical proficiency scores improved by 3.3 points and 4.0 points, respectively, after the intervention; the control group's improved less, by 1.5 points (forehand) and 0.8 points (backhand). Additionally, the experimental group's rally performance score increased by 7.6 shots after the intervention (from 16.2 to 23.8 shots); the control group's increased by 2.9 shots (from 14.3 to 17.2 shots).

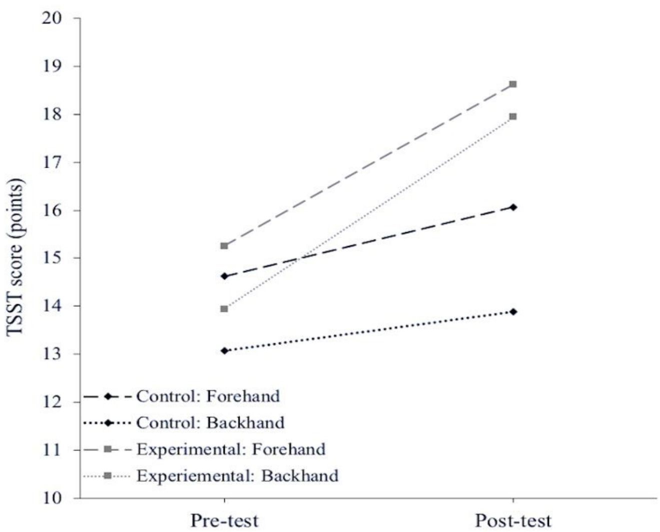

Figure 3. TSST technical proficiency scores.

DISCUSSION

Pre-test match-play data replicated the asymmetry found by Fitzpatrick et al. (2017), with both groups performing a disproportionately high number of forehands compared to backhands. During post-testing, the experimental group demonstrated greater symmetry (46.7% backhands, 50.8% forehands), compared to the control group's continued asymmetry (74.0% forehands, 22.4% backhands). The experimental group's post-test values corresponded closely to the forehand-to-backhand ratios observed in standard tennis (close to 1:1). The ratios observed in standard tennis demonstrate that it is crucial for learners to develop both groundstrokes if they are to successfully transition through the stages of tennis.

The standard MT Red environment affords players sufficient time to move around the ball to perform a forehand, when a backhand may be more appropriate (Fitzpatrick et al., 2017). However, this is an inefficient movement (using more time and energy), unlikely to elicit optimal technique (Hodgkinson, 2015), and detrimental to players' recovery movements (Hughes & Moore, 1998). Positioning the experimental group's recovery box slightly towards the forehand side of the court increased the distance players were required to move, to position themselves to the left of the ball and play a forehand, making this behaviour less likely to emerge. Instead, our modifications encouraged players to adapt and explore different solutions (i.e. playing a backhand), which may facilitate more functional technique.

Accordingly, the experimental group's backhand technical proficiency improved more than the control group's. Interestingly however, the experimental group's forehand technical proficiency also improved more than the control group's, despite hitting fewer forehands during match-play. This suggests that after the intervention, the experimental group elected to play each respective shot only when it was appropriate, and therefore exhibited more functional technique. In contrast, the control group continued to attempt to move around the ball and perform a forehand, when a backhand may have been more appropriate; so, although the control group performed more forehands, the technique elicited was often poor. Notably, the scoring system incorporated movement to the ball and recovery movement, so it is possible that the intervention improved the experimental group's movement around the court as well as their swing technique.

The experimental group's rally performance score (i.e. rallying with a coach) also improved more than the control group's, however both groups demonstrated similar improvements in match-play rally length (i.e. rallying with fellow players) (see Fitzpatrick et al., 2018). Rallying with a coach, who can control the direction and pace of each shot, is easier for children. Accordingly, it appears the intervention enhanced the experimental group's rally ability enough to elicit longer rallies with a coach, but not enough to replicate this during match-play with fellow players.

CONCLUSION

Results suggested that our intervention effectively alleviated the asymmetry found between forehand and backhand performance during children's match-play. Simultaneously, the experimental group demonstrated improved rally ability when rallying with a coach, and enhanced technical proficiency, offering strong support for the modifications applied here. Coaches may wish to implement similar modifications during coaching sessions, to enhance children's skill development and reduce the disparity between the percentages of forehands and backhands typically played.

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Differences in service and return in top 8 men and women ranking

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ABSTRACT

Our objective in this paper is to analyse the performance parameters in the serve and return of the top 8 men and women in their respective rankings in 2017. ATP and WTA service and return performance statistics were gathered from the top 8 men and women ranking in 2017. Findings have shown that the top 8 men and women win a higher percentage of points and games with the service than with the return, and they win more points with the first than with the second service. Men´s ranking registered higher values in service parameters, while women ranking showed a better performance in the return. Finally, male players with a higher position in the ranking have a higher percentage of break points saved and points won at service, something which was not so in the women's ranking. The results of this study help in understanding the differences in service and return parameters between male and female tennis.

Key words: performance analysis, professional tennis, service, return, ranking.

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INTRODUCTION

The analysis of competition aims to record and analyse the behaviours and actions of athletes in real match situations (O'Donoghue, Girard, & Reid, 2013). Tennis is the racket sport that has most frequently applied performance or competition analysis (O´Donoghue, & Ingram, 2001), defining a number of variables or performance indicators that contribute to success in competition (Hughes, & Franks, 2004). Among these indicators, service is usually considered as the most critical aspect, and different studies have stated that this is the key stroke to determine the result of a tennis match (Giampolo & Levey, 2013). Along this line, Barnett, Meyer & Pollard (2008) have found that the top 100 players of the male ranking won almost 80% of the games when serving and 22% of the games when returning, regardless of their ranking. Furthermore, points won at the second service and points won at return in the second service are significant predictors of the upper part of the ranking in the professional top 100. However, there are no studies comparing the differences in these variables between male and female tennis, nor their impact on world ranking. Therefore, the aim of this study is to analyze serve and return performance parameters in top 8 male and female ranking during 2017.

METHOD

Sample

The research sample consisted of a total of 16 players of which 8 were the top ranked male tennis players, (Age: 27,3 ± 4,2 years; Height: 189,6 ± 7,8 cm) and 8 were the top ranked female players (Age: 25,9 ± 4,2 years; Height: 174,4 ± 6,5 cm) of their respective professional tennis tours.

Procedure

ATP and WTA competition statistics were gathered from the top 8 ranked men and women players at the end of 2017. The data were taken from the information published in the ATP official website (www.atpworldtour.com/en/stats) and WTA (www.wtatennis.com/stats). The variables selected for service performance were: % first service, % points won with 1st service, % points won with 2nd service, % service break points saved, % games won at service and % points won at service. The variables selected for return performance were: % points won at return of 1st service, % points won at return in 2nd service, % break points won, % games won at return and % points won at return.

Data analysis

A comparison was made between the mean in both sexes (male vs. female) using the T-Student test. Then an analysis of the linear regression was made in steps so as to identify the parameters with greater influence on the position in the ranking, both male and female. The significance level was set at p<.05. All data were analyzed with the IBM SPSS 20.0 statistic packet for Windows (Armonk, NY: IBM Corp.).

RESULTS

Table 1 shows the results of the comparisons of the mean of the performance parameters in serve and return between the male and female top 8 players. The men registered higher values in service parameters, while the women showed a better performance in return. The percentage of good first services was similar for both sexes.

Variable	Men	Women	Diff.	p
Service performence				
First serve (%)	61.5 ± 3.5	62.1 ± 5.3	0.6	0,790
1nd serve points won (%)	75.9± 2.9*	66.9 ± 2.7	9.0	<0.001
2nd serve points won (%)	54.5 ± 3.5*	47.1 ± 2.1	7.5	<0.001
Saved break points (%)	65.4 ± 3.9*	58.1 ± 2.6	7.3	<0.001
Serve games won(%)	85.3 ± 3.7*	71.6 ± 5.0	13.7	<0.001
Serve points won (%)	67.5 ± 2.7*	59.3 ± 2.2	8.3	<0.001
Return performance				
Returns won in 1st serve (%)	30.7 ± 2.3	39.2 ± 2.2*	8.5	<0.001
Returns won in 2nd serve (%)	51.9 ± 2.2	57.4 ± 2.4*	5.5	<0.001
Break points won (%)	39.9 ± 2.7	46.9 ± 3.4*	7.0	<0.001
Games won at return(%)	25.4 ± 3.9	40.7 ± 4.7*	15.3	<0.001
Points won at return(%)	38.9 ± 2.2	46.0 ± 2.1*	7.1	<0.001

*Table 1 Comparison of the mean performance parameters for serve and return of the top 8 men and women players in the professional rankings in 2017. * Significant differences in favour, p<0.01. Values expressed in eana and standard deviation ±.*

The results of the linear regression show the saved break point variables and games won at service as the most influential on the final position in the male ranking. Figure 1 shows the greater percentage in these variables determines a higher position in male ranking (blue dots) noting the differences of ~10% between the 8th and the 1st positions. Therefore, a significant influence is noted in male ranking (the higher percentage, the higher the position in the ranking). No differences were identified in female ranking (red dots).

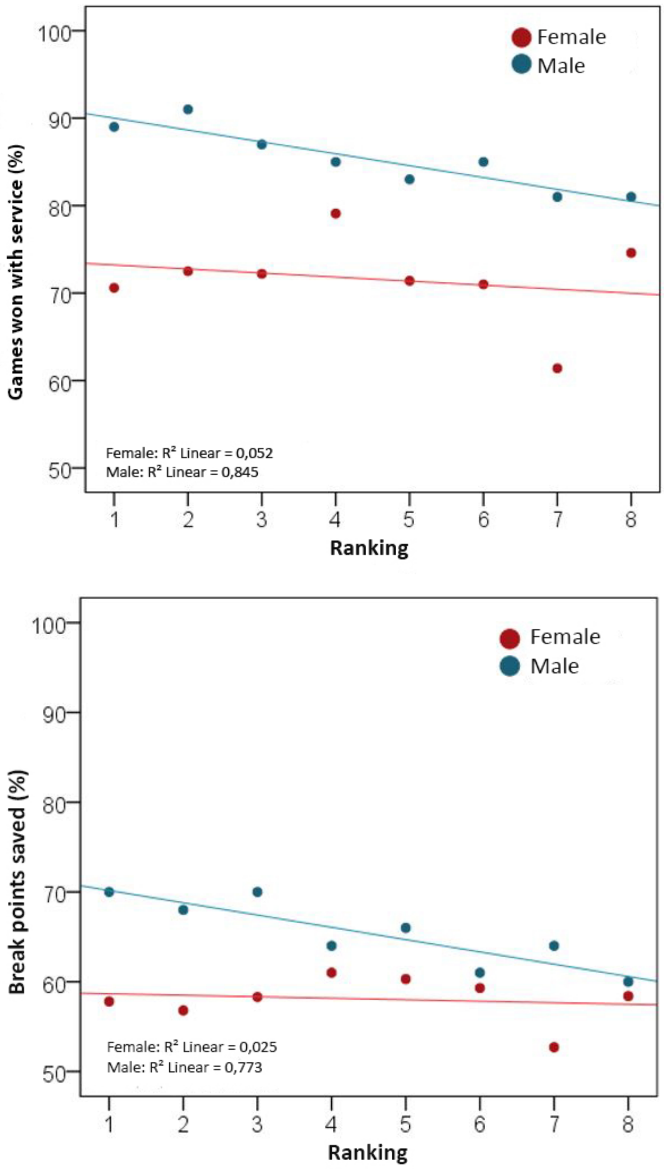
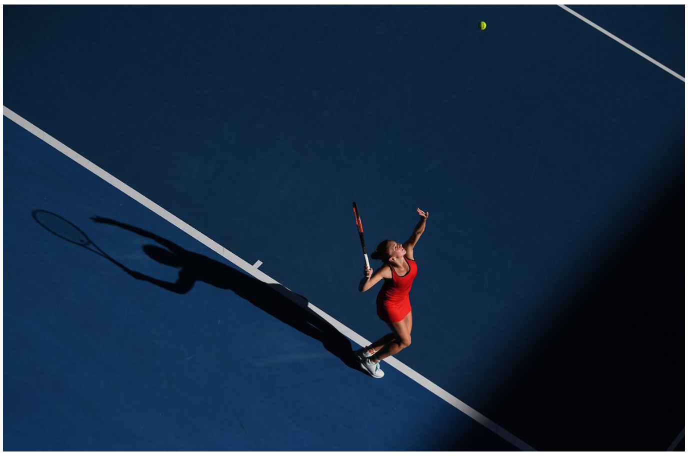


Figure 1. Graph showing the dispersion of the influence of the percentage of points won at service (top) and the saved break points (bottom) on the position in the ranking.

COMMENTS AND CONCLUSIONS

The results of this study indicate that both men and women win a greater percentage of points and games at service than when returning, with the exception of winning more points at return on the second serve than the first serve, in line with Mecheri, Rioult, Mantel, Kauffmann and Benguigui (2016). Therefore, a good percentage of the first serve seems to be key for determining the result of the point in tennis. However, male players get a significantly higher percentage in service parameters than women, while the latter get significantly higher percentages in return parameters. This result could be due to the higher speed of men´s service (Verlinden et al., 2004)..

Notwithstanding, the result of this study shows how better ranked players get better service parameters, following the line of study



of Barnett et al. (2008). This way, differences of approximately 10% have been found in the percentage of saved break points and games won at service between # 1 and # 8 of the male tennis ranking. However, the service and return variables do not seem to determine the female ranking, perhaps due to a greater equality among players, or a lesser degree of dependence on these variables in the final result of the match.

Therefore, the results of this study show performance parameters in serve and return for the top 8 male and female players, which can act as a reference to coaches and players when planning and designing training sessions. Furthermore, these data seem to demonstrate how the serve is a very influential stroke in men´s tennis, and can determine the need of adopting a service dependant game pattern, while in women´s tennis, players can adapt to different game styles. Finally, some studies have shown how the serve and the return are more determinant on some surfaces than on others (Brown & O'Donoghue, 2008), so, future research could consider the possible differences of these parameters on different playing surfaces.

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Selection criteria for intelligent devices for tennis

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ABSTRACT

Today coaches can resort to a great number of devices that contribute to the tennis training process. Still, more often than not, the selection of one device over another creates uncertainty due to the great variety in the market, and to the lack of knowledge about the performance of the different models. Therefore, the target of this study is to provide some detailed technical information about the performance of those devices that provide technical and kinetic data, and to present some criteria for coaches and players to rely on, in order to get the tool that best suits their needs.

Key words: tennis, new technologies, training

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INTRODUCTION

During the development process of a tennis player, a key element when programming the teaching-learning process consists of the analysis and evaluation of the different areas (Sanz, 2012). Due to scientific advances, the information that coaches have available is much more powerful, with more complete and accurate data, which are presented in an immediate and easily represented fashion.

Thus, the evaluation and analysis of technique and kinetics have been one of the most systematized areas in tennis, more than others such as tactics and psychology. The first reference to the use of technology for tennis player development goes back to the early 20th. century (Beldam & Vaile, 1905; Vaile, 1906; Paret, 1926; Lacoste, 1928). However, it was not until recently that technology started growing exponentially in the market, offering an affordable and economic way of getting data, a process that has taken the place of the "coach´s eye", a system which presents deficiencies regarding the accuracy of data based on excessive subjectivity (Sanz, 2012).

Another benefit of the use of the new tools is the greater motivation that its application brings about in the teaching-learning process for players and coaches, given that it can give evidence of the technical level in real time, and allow checking of progress by comparing the different training sessions or matches. Furtthermore, these data can be shared by means of the different social platforms (Quinlan, 2013).

This paper aims to analyse the performance of the tools that provide technical and kinetic information of the action of the racket on the ball, and show a criteria for coaches and players to base their decisions on.

METHODS AND PROCEDURES

These are the devices analyzed: Sony Smart Tennis Sensor, Babolat Pop, Babolat Play (Pure Drive), Zepp Tennis, Zepp Tennis 2 and Artengo Personal Coach. A detailed analysis of the official websites of the devices selected was carried out in order to understand their performances.

FUNCTIONALITY OF THE DEVICES

A classification of the different devices and their recording capacities for the different items is presented below. In fact, Table 1 shows the capacity to record aspects related to the training volume in the different devices.

	Artengo Personal Coach	Babolat Pop	Babolat Play	Sony Smart Tennis Sensor	Zepp Tennis	Zepp Tennis 2
Capacity to record the total volume of strokes	✓	✓	✓	✓	✓	✓
Capacity to record the total volume of each type of stroke	✓	✓	✓	✓	✓	✓
Capacity to record the training/ match time	×	✓	✓	✓	✓	✓
Frequency of strokes per minute	×	✓	✓	×	×	×
Capacity to record the training/ match active time	×	×	✓	×	✓	✓
Capacity to record the calories burned in each training	×	✓	✓	✓	✓	✓
Capacity to record the number of impacts in each point or series	×	×	×	×	×	×
Capacity to record the average number of impacts in each point or series	×	×	×	×	×	×

NB: When "✓"appears in blue, it will mean that the device is providing the information but not in the official measuring unit.

Table 1. Capacity to record training volume related aspects.

Table 2 shows the capacity of the devices for stroke related aspects.

	Artengo Personal Coach	Babolat Pop	Babolat Play	Sony Smart Tennis Sensor	Zepp Tennis	Zepp Tennis 2
Capacity to discriminate the different types of strokes	✓	✓	✓	✓	✓	✓
Capacity to analyze the points of impact in each stroke	×	×	×	✓	×	✓
Capacity to analyze the point of impact in the same type of stroke	✓	×	✓	✓	✓	✓
Capacity to discriminate between top spin and slice	×	✓	✓	✓	✓	✓
Capacity to discriminate the flat stroke	×	×	✓	×	✓	✓
Capacity to determine the amount of spin in each stroke	×	✓	✓	✓	✓	✓
Capacity to determine the quantity of average and maximum spin in each type of stroke	×	✓	✓	✓	✓	✓

NB: When "✓"appears in blue, it will mean that the device is providing the information but not in the official measuring unit.

Table 2. Capacity to discriminate the different rackets, types of strokes, spin, and to analyze the points of impact.

Table 3 highlights the speed related aspects.

	Artengo Personal Coach	Babolat Pop	Babolat Play	Sony Smart Tennis Sensor	Zepp Tennis	Zepp Tennis 2
Capacity to determine the speed of the ball in each stroke	×	×	×	✓	✓*	✓
Capacity to determine the average and maximum speed of the ball in each type of stroke	×*	✓	✓	✓	✓	✓
Capacity to determine the speed of each swing	×	×	×	✓	✓*	×
Capacity to determine the average and maximum swing in each type of stroke	×	×	×	✓	×	×
Capacity to determine the quantity of effect in each stroke	×	×	×	✓	×	✓
Capacity to determine the quantity of average and maximum spin in each type of stroke	×	✓	✓	✓	✓	✓

*NB: When "✓"appears in blue, it will mean that the device is providing the information but not in the official measuring unit. ×*Just provides the serve max. speed. ✓*Just provides the speed of each stroke in service.*

Table 3. Capacity to analyze the speed of the ball and swing and spin.

Table 4 shows the statistics of the game related variables.

	Artengo Personal Coach	Babolat Pop	Babolat Play	Sony Smart Tennis Sensor	Zepp Tennis	Zepp Tennis 2
Capacity to record game statistics (percentage of 1st and 2nd services and points won with serves, winners, unforced errors, etc.)	×	×	×	×	×	✓
Capacity to introduce specific data of each session-match (type of surface, weather, perception of the performance of the player, etc.)	×	✓	✓	✓	×	×
Capacity to compare different training sessions or matches intra- subject.	×	✓	✓	✓	✓	✓
Capacity to compare inter-subject performance	×	✓	✓	✓	✓	✓
Capacity to differentiate between training and match play	×	✓	✓	×	×	✓
Capacity to record the results of the match	×	✓	✓	×	×	✓
Capacity to add comments to the training session or match	×	×	×	✓	×	×

Table 4. Capacity to record game statistic aspects and to make intra- and inter-subject comparisons.

Table 5 shows the possibility to create videos and to get data.

	Artengo Personal Coach	Babolat Pop	Babolat Play	Sony Smart Tennis Sensor	Zepp Tennis	Zepp Tennis 2
Capacity to record videos	×	×	×	✓	✓	✓
Capacity to visualize the videos in slow motion	×	×	×	✓	✓	✓
Capacity to visualize data of the execution in real time	×	×	×	✓	✓	✓
Capacity to reproduce execution in 3D	×	×	×	×	✓*	✓
Capacity to make videos with the most relevant executions (longest points, strokes at highest speed and strokes plus slice)	×	×	×	×	×	✓
Capacity to make videos of each stroke	×	×	×	✓	×	✓

*NB: ✓*Just provides the speed of each stroke in service.*

Table 5. Capacity to record videos of the execution and to provide instant data.

CRITERIA FOR THE SELECTION OF A DEVICE

Here are some reasons for coaches and players on which to base their decisions when selecting the most appropriate device for their needs:

From the point of view of the coach

- Number of students: in the case of school coaches who work with a great number of students, it would be ideal to look for a device that can be used with a variety of racket brands and models. Coaches working individually, or with small groups can choose a more restricted model.

- Information level required according to the level of the students, and the knowledge of the coach (competition versus amateur): coaches must value the type and quantity of information they can interpret and they need, in order to improve the level of the students they work with. The higher the level and technical knowledge of the students, the higher the information requirements will be. Possible examples could be spin related data, the training load or the performance comparison between the different training sessions or matches.
- Recordings: if the "video" option is preferred, with specific data on the execution in real time, Sony Smart Tennis Sensor and the two Zepp models, will be best options since they are the only ones that offer this possibility.
- Competition statistics data: for coaches who need game statistics as well as technical and kinetic data, the only device offering this possibility is Zepp 2 sensor.
- Type of population: one of the greatest constraints for teaching tennis at an early age is that devices cannot be adapted to smaller rackets, so junior and pre-tennis rackets are excluded.

From the point of view of the player for individual use

- Frequency with which the player breaks the strings: if a player breaks the strings on a regular basis, or alternates different rackets, it will be necessary to choose a sensor that can be changed to another racket, while an amateur player will be able to choose an internal device.
- To share data and performance in the social media: if players want to compare their results with those of others, using the same tool, they can buy any device, except the Artengo Personal Coach.
- If the player practices with a coach or not: in case a player has a coach, he/she should first ask the coach for advice, to make sure which the most convenient tool is, depending on their characteristics. Just as explained above, the higher the level and the technical knowledge of the player, the higher the information requirements will be.

CONCLUSION

The use of intelligent devices in tennis, is no doubt, a considerable help to the training process, but it is important to bear in mind that they are there to contribute and help, and never to take the place of the coach. The selection of one device over another will largely depend on the parameters you want to control, i.e. whether they are more targeted towards the knowledge of the stroke dynamics, to having immediate 'videos' or feedback, to getting competition statistics, etc. No doubt, the tables presented will help to allow for a better selection based on concrete interests.

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RECOMMENDED ITF TENNIS ICOACH CONTENT (CLICK BELOW)

Tennis iCoach

Net Generation: A generation of innovation

Craig Morris and Karl Davies (USA)

ITF Coaching and Sport Science Review 2018; 76 (26): 17 - 19

ABSTRACT

The status of youth sport in the USA has been in a gradual downturn over the past decade which has resulted in kids not getting the appropriate amount of physical activity. The USTA has recently created Net Generation, a new youth brand, to join other Sporting National Governing Bodies in attracting and retaining more youth and to get them playing sports for a lifetime. Net Generation was created with an American (Athletic) Development Model in mind that conforms to seven participatory principles.

Key words: physical activity, youth brand, Net Generation, sport sampling, early specialization

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INTRODUCTION

As a follow up to the Play and Stay Campaign special monographic article published last year that included a contribution from the United States Tennis Association (USTA) as well as a USTA presentation made at the ITF Participation Workshop in London, we would like the opportunity to share insight into our recently created youth brand Net Generation (www.netgeneration.com). In keeping with a consistent drive to USTA's mission statement of promoting and developing the game of tennis, this article will provide a background on youth sports and move into what Net Generation is as well as how it is positioned as a youth brand within an American (Athletic) Development Model (ADM).

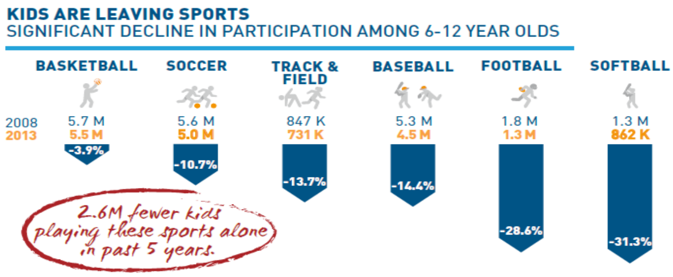

Figure 1. Number of kids leaving sport 6-12 years old (Aspen, 2015).

YOUTH SPORTS

Youth sports participation in the USA has changed from child-driven, recreational free play for enjoyment to adult-focused, highly organized, and deliberate practice dedicated to sport specific skill development (Caine, D., Maffulli & Caine, C. 2008). An importance is placed on developing and reaching appropriate skill levels to excel at many levels of athletics (Vaeyens, Gullich, Warr, & Philippaerts, 2009; Malina, 2010). This evolution in youth sports may have developed as a result of society's increasing regard for successful athletes, who demand significant recognition and financial rewards for their exploits. As a result, many children and adolescents participating in sports now have a desire to achieve elite levels (Vaeyens, Gullich, Warr, & Philippaerts 2009). A by-product of this desire to have more athletes move into a performance-oriented direction has been the transition of after school sports programs from physical activities focused on fun and run by volunteers to fully fledged businesses with objectives of producing athletes to earn rewards as a professional athlete or college sports scholarship.

The current state of sports participation in the USA is not a positive one, with participation rates dropping in all sports. Fewer than half of children ages 6 to 11 meet the U.S. Surgeon General's recommendation for engaging in at least 60 minutes of moderate physical activity most days of the week (Troiano et al., 2010). A common strategy to address this inactivity with youth is through sports activity, especially team sports, as children like playing in groups due to the social interaction. However, fewer kids these days are doing that, as the sports participation rates among preteens have been dropping. The Sports & Fitness Industry Association (SFIA) found that 37 percent of kids played team sports on a regular basis in 2018, down from 40 percent in 2013.

In research circles, the benefits of youth sports participation have never been understated and have been proven without question. Recently, there has been a push by researchers in the field of youth sport to promote sports sampling. The emphasis on sports sampling has many benefits as it relates to young age groups. Most importantly, early sports sampling and diversification do not deter success in sports where peak performance is reached after full maturity. Moreover, sports diversification at a younger age shows to be positively linked to a longer sports career, a lifetime of physical activity, and an overall state of health and wellness (Cote, Lidor, & Hackfort, 2009; LaPrade et al., 2016).

To ensure all kids have an opportunity to grow up fit and strong, sports stakeholders need to eliminate the barriers to sports participation (Aspen, 2013) which include:

- Lack of neighborhood recreation spaces
- Inadequate coaching
- Rising costs and exclusionary league and team policies
- Excessive time demands on families
- Safety concerns
- Cultural norms
- Too few sports options to accommodate the interests of all

NET GENERATION

It is with the considerations mentioned above that the USTA has taken stock of where they are as a National Governing body involved in impacting youth through a sport. Through marketing and tennis product research, the solution was to develop a youth brand that could unite all tennis programming stakeholders and kids 5-18 years old under one umbrella. That youth brand is called Net Generation.

Net Generation is a celebration of a game where no one sits on the sidelines. Tennis is easy to learn and tailored for all ages and abilities, giving kids a game that will help them build friendships and learn skills they will use for life. Net Generation aims to connect tennis providers with players in a safe environment that focuses on engaging more kids in sports in order to get them playing for a lifetime. To achieve this, all providers are required to complete a Safe Play background screening that the USTA subsidizes. The USTA's willingness to pay for each Net Generation provider's Safe Play background screening demonstrates the importance of protecting our youth in sports in this day and age.

Net Generation's mission is to spread the love of tennis to a new generation by empowering those that will teach them. Coaches, organizers, and teachers can gain access to the expertise of the USTA as they work with leading experts worldwide to develop new play formats, curricula, and digital tools. Net Generation is innovating to reach a new generation and a new era of tennis.

NET GENERATION AS AN ADM

The guiding principles of Net Generation conform to an American (Athletic) Development Model (ADM) that is positioned as the aligning tool for all of USTA's stakeholders from a skill development and competition perspective to achieve its objectives of stemming early specialization, developing multi-sport athletes, and increasing physical activity in youth. As the USTA refines their Long-Term Athlete Development plan, ADM will form a critical component in how the USTA embraces core athlete development principles. The long-term goal is to allow American youth to utilize sport as a path toward an active and healthy lifestyle and to create opportunities to maximize their full potential. These key principles, tailored to the sport of tennis, include:

- Making tennis opportunities more accessible, local, and affordable;
- Providing developmentally appropriate activities that emphasize motor and foundational skills in training and then further developing these skills through competition;
- Cross-promoting with other sports (e.g., soccer, basketball, volleyball,) to facilitate multi-sport participation and athleticism;
- Delivering a fun, engaging, and progressively challenging atmosphere, centered around player and athlete outcomes rather than wins and losses;
- Providing high-quality coaching at all age levels;
- Giving parents the information needed to guide their child's development through tennis;
- Integrating physical education programs in the schools, recreational community programs, and elite competitive programs.

Through an objective of attracting and retaining more athletes and have them play tennis for a lifetime taking into consideration all playing levels a squaring of the pyramid is supported as per the one below created by the Aspen Play Institute (Aspen, 2015).

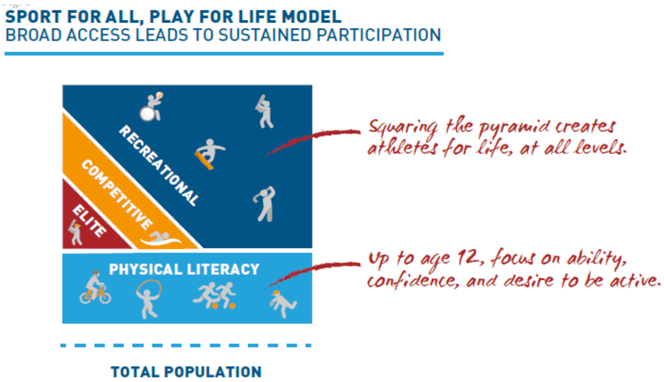

Figure 2. Squaring the pyramid (Aspen, 2015).

NET GENERATION AS A YOUTH BRAND

Four stages have been designed that follow the sport scientific growth and development stages of youth, with the first stage for 0-11 year olds, then pathways of recreational (stage 2: 12-18, stage 3: 18+, stage 4: age for life) and performance (stage 2: Girls 11-13, Boys 11-15, stage 3: Girls 12-16, Boys 15-20, stage 4: Girls 15+. Boys 18+). Under each stage, the constructs of Positive Youth Development of competence, confidence, connection, and character will be expanded upon in developing athlete centered outcomes (Vierimaa, Bruner, & Cote 2018). An additional construct, creativity, has been added in making sure programming is matching the wants and needs of the athlete.

Competence

Competence is defined as the physical, technical, and tactical development of the athlete. This is a combination of skill development (training) and competition.

Skill Development

Skill Development curricula have been developed for three providers: schools, community, and coaches.

Schools: Kindergarten-Grade 12 (8-10 lessons plans have been created for the following grades: K, 1-2, 3-4, 5-6, 7-8, 9-12). All activities are designed using the red stage equipment as play will be taking place in a school gym or any flat surface. Turnkey lesson plans were created in conjunction with SHAPE (Society of Health and Physical Educators) to give everyone the tools to teach tennis.

Community: Red (1-3), Orange (1-2), Green (1-2), Yellow (1-2). Six practice and play plans have been created for each level that support a progression format.

Coaches: (Red 1-4), Orange (1-3), Green (1-2), Yellow (1-2). The certified coach practice and play plans were developed with the coach in mind. The curricula are comprehensive, competency based, collaborative, and convenient to use.

Competition

In order to build a strong connection between skill development (curricula) and competition, the USTA competition department is doing research and analysis of the competitive formats of individual and team events to help ensure that they serve their purpose as a transition from training/practice into competition while also developing skills and success.

Through recent research conducted by the University of Central Florida on behalf of the USTA, the objectives as we move forward from a competition point of view will be:

- A competitive pathway that is easy to find and register for that supports local play, is affordable, is a blend of rankings and ratings, and supports multi-sport participation
- Competitive events that are well-run and officiated
- Better trained coaches to help with participation in the competition
- Developing a rating tool that facilitates participation
- Youth progression that is based on skill development
- A team competition pathway for all skill levels.
- Promotion of more local competition play

Confidence

In building confidence and success for players playing tennis, Net Generation curriculum has been designed with a primary focus on developmentally appropriate activities. A significant component of achieving this goal is the use of modified equipment. This strategy is in line with the findings of the research conducted by the ITF of the 10th year anniversaries of the Play and Stay Campaign (Buszard, Farrow, & Westerbeek 2017) that supports the use of modified equipment that aligns more with developmental age and not chronological age.

Coaches Workshops

In trying to build the confidence of each provider in providing success and confidence with the athletes (school teachers, community, and coaches), non-certification training opportunities are delivered to help them better understand the curricula and how to facilitate the best delivery of engagement and enjoyment. Each provider group is offered a workshop that utilizes experiential learning and showcases relevant activities for each level as well as how to coach, manage, and organize practices.

Connection

The ability to find cohesion in the sporting triangle (players, parents, and coaches) is a desire for any sporting organization. According to Vierimaa et al., (2018) connection is the most important construct of Positive Youth Development.

Under the ADM for each stage, the relevant resources for both parent and coach will be produced with the objective to make that experience for each player the best possible and to conform to athlete-centered outcomes.

A Net Generation app has also been produced to provide the opportunity for a coach to connect to their players in a digital platform. The app includes the following:

- Ability to connect consumers with providers
- Progress Portfolio
- Digital Journal
- Skill Level Assessments
- Skill Challenges
- Take Home Practice
- Check-Ins

Character

Within all curricula, a character component has been built in that includes a word of the day and, in some curricula, a pledge. A straightforward way of delivery has been presented throughout the curricula. Understanding of the word of the day are presented as questions that the coaches can use to start the conversation and create better understanding of that word of the day.

Creativity

Under Net Generation, a consistent strategy will be adhered to in identifying and replicating best practices and overall creativity in programming to achieve its guiding principles.

CONCLUSION

Although Net Generation is still in its infancy, the impact it has already provided in the US tennis community has been overwhelming.

Net Generation is an innovative youth brand that is looking to attract and retain more athletes to keep them playing for a lifetime. Net Generation is well positioned to provide the next generation of greats.

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RECOMMENDED ITF TENNIS ICOACH CONTENT (CLICK BELOW)

TennisiCoach

Motivation in competitive tennis: Is it different for girls and boys?

Natasha Bykanova-Yudanov (SWE)

ITF Coaching and Sport Science Review 2018; 76 (26): 20 - 22

ABSTRACT

In the exciting world of sport, tennis is a game that appeals equally to ladies and to gents. There's even a mixed doubles event with a tradition of over a hundred years, today carrying a prize cheque worth a hundred thousand pounds for the winning pair at Wimbledon. While Wimbledon doubles and singles draws are the same size for ladies and for gents (64 doubles and 128 singles), in the other competitive tennis events – be it pro, junior or veteran – the males competing outnumber dames competing by a sizable margin. The number of male events is higher and their qualification draws are bigger (ITF webpage). Could it be that girls don't fancy competitive tennis as much as the boys, or is there a different reason for this female underrepresentation? To answer this question, the researcher headed to the Swedish National Junior Championship and asked participants a few simple questions.

Key words: tournament, participation, cooperation, competition

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INTRODUCTION

Aussie legend Neale Fraser, three times Grand Slam winner, Davis Cup and Fed Cup captain, who led the Australian gents to four trophies and the Australian ladies to three respective finals, once reflected on the difference between his male and female charges.

I'll tell you one thing: the four girls were playing doubles, [Australian Fed Cup team members] Kerry Reid, Wendy Turnbull, Dianne Fromholtz, Evonne Goolagong, and they were playing away, playing away... After a few games I asked: "Girls what's the score?" "It's 4-1 I think" - said Wendy. I asked Kerry what was the score, "No, it's 3-2", then I asked Evonne: "No. it's 3-2 to us". They had no idea what the score was, they were just playing... I found that hard to accept. When you train, you train with a purpose -- but they were just going through the motions.

(Quote from an interview with Neale Fraser at Wimbledon 2007).

Does such a seemingly indifferent attitude towards the scoreline represent a lack of interest in competition among females? Or something else?

In their study on competitiveness in elite pro athletes, American John Houston and colleagues defined sports competitiveness as the "desire to enter, participate and win in competitive sports events" (Houston et al., 1997). Their research at the end of last century showed, somewhat unexpectedly, that "elite female tennis players scored higher on the sports specific measure of competitiveness than their male peers" (Houston et al., 1997). In all the other sports researched for competitiveness, it was the opposite.

More recent data has come from Sweden, another country rich in tennis traditions. Former Davis Cup captain Calle Hageskog and his associate Marie Hedberg studied participation in competitive tennis of boys and girls of different ages. Results showed that very few of Swedish girls who tried the game in younger age would still be playing matches by the time they reach adulthood. The number of competing tennis girls were declining faster than the number of competing boys even in this gender-equality role model state. Linneunivesitetet's study (Hageskog and Hedberg, 2015) found that the biggest drop happens in the 13-16yo age group.

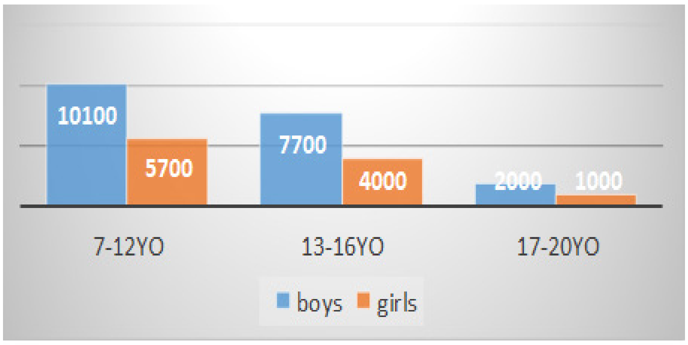

Figure 1. Tournament participation in different age groups (Hageskog and Hedberg, 2015)

As seen in the chart above (Hageskog and Hedberg, 2015), the number of competing girls is almost half that of boys, and while 4000 girls aged 13-16yo were playing tournaments, only one in four pursued competitive tennis at 16.

Knowing what draws girls to competition could probably help us keep them there longer.

The participation motives of competitive junior tennis players, boys and girls, were at the centre of this research, conducted during the Swedish Indoor Junior Championships in April 2017.

METHOD

A questionnaire was assembled to target a tennis player's preferences in training and in competition. Questions and answers were designed so as to reflect three different aspects of sports – co-operation, competition and health. Participants were invited to choose one or more alternative answers to each question.

1. What do I like most at trainings?
2. What's the best part of playing tournaments?
3. What do I wish to have in my tennis life?
4. What's my perception of my tennis, what is my tennis for me?

The questionnaire was conducted among participants of the Junior

Swedish Championship-2017 in the U14 and U16 categories. An equal amount of each gender (23 boys and 23 girls) was asked to complete the questionnaire, despite higher numbers of male participants in both age groups (207 boys to 121 girls in U14 draws, and 178 to 102 in U16 draws). Girls and boys were chosen at random.

The questionnaire took place at the tournament site, GLTK (Gothenburg Lawn Tennisklubb), and was conducted mostly after the matches.

RESULTS

Overall, competitive boys and competitive girls were similar in their preferences: the most popular choice with the girls was also most popular with the boys, on all four questions.

During training, boys and girls preferred to play singles points (12 boys and 11 girls).

At tournaments, the most fun for both genders was to play singles (20 boys and 19 girls).

The most popular wish was to have more tennis trips (13 girls and 9 boys).

On the question on motives the most popular answer was that it was “fun to play” (22 girls and 17).

Only on one occasion were the girls split equally between two alternatives. The question “what they liked most at trainings” saw 11 votes going to “playing singles points” and 11 going to “working on technique”. Among boys, “working on technique” got the least enthusiastic response – only one among 23 participants favoured it.

Differences between genders however were found on the second most popular alternatives.

The second most popular alternative on the “wish list” for girls was “playing more team tournaments” (9), at the same time only three girls chose the general alternative “playing more tournaments”. Boys gave 8 votes to the first and 7 votes to the second.

More girls than boys favoured doubles: 11 to 7.

Second best alternative for both genders was noticeably different on the question of motives: while 11 boys chose the “pro- or university- opportunity”, girls were equally split between three choices: “pro- or university- opportunity”, “best way to keep in shape” and “fun to follow and watch matches”, where each got 5 votes.

DISCUSSION AND CONCLUSIONS

Similarity in answers was somewhat expected, as the research participants were contesters of the major junior tournament in Sweden. Their choice of tournament was in itself confirmation of their competitive side.

The similarities echo Alison Booth's behavioural research on competitiveness (Booth, A., & Nolen, P. 2012). Booth doesn’t believe that an average woman avoids competitive behaviour more than an average man. Any difference which is observed there she puts down to social and historical influence.

This research is not about “average” participant – we have a selective field of competitive junior tennis player, boys and girls, raised in a similar mixed-sex environment in Sweden, a country known for its excellent records on gender equality.

As answers to the questionnaire showed, what was most popular with competitive boys was also most popular with competitive girls. Why then are girl’s participation numbers in tournaments are much lower, and why are they dropping faster than boy’s?

At the 2017 Swedish Indoor Nationals, the participation difference was more than obvious. U/14 draw had 207 boy’s and 121 girl’s participants, which translates into the difference of over 71% in the boys' favour. In the U/16 class, boys outnumbered girls by an even bigger margin: 74% (178 boys and 102 girls participating). Moreover, consistent with Linnea university findings, the number of participants in the U/16 Nationals was lower by 17% than in the U/14.

These stats show that even though the answers to the questionnaire were similar from boys and girls, there may be something in competitive tennis that doesn’t appeal to girls, or, it might be that they prioritize different things.

The father of Wimbledon champion Goran Ivanisevic, Serdjan, in an interview to the author in 2000, reflected on his own experience: “I was watching girls for over 50 years in my club in Split. Girls are more sensitive. I’m convinced and I always said that tennis is not a girl’s sport, because tennis is a fight. It’s not contact but it is fight. Mental fight as well. The nature of women is different. Girls are not meant to fight against each other. It’s in man’s nature to beat, to win, to conquer, but women are not physical aggressors by nature. For them to be a successful tennis pro they need to have strong personality, plus there have to be lots of parent help from the very beginning”.

This goes somewhat in line with Robert Deaner, who suggests that the lower competitiveness of females is not a result of lower exposure to sport, but a mere reflection of their lesser interest in competitiveness as a whole. His research showed that it’s mostly male, not female athletes, who endorse competition and winning as their motives for participating in sports (Deaner, 2016).

Booth and Deaner are two opposites on the same subject, but descending from theoretical clouds to practical reality, finding reason behind low female competing numbers might help avoid unfortunate tendencies.

Withdrawal reasons in sports were examined by Butcher et al. (2002). Their research, spanning over 10 years, showed that females felt more strongly than men that they were not good enough and experienced more pressure to perform well (Butcher et al., 2002). We can look from an opposite angle and search for what the girls do enjoy most at training and in competition.

The “Me and my tennis” questionnaire revealed that apart from playing singles points (12 votes from boys and 11 from girls), which is a quintessential competitive way of training, girls equally

favoured working on technique (11 votes). Working on technique in tennis is a pure cooperation drill, which includes lots of feedback from the coach, discussions and encouragement – and zero competition.

Among boys "working on technique" got the least enthusiastic response of all alternatives – only one among 23 participants favoured it. "Non-points" drills was no favourite either getting only 6 votes from the boys. By contrast they were very popular with the girls - 17 votes.

On the list of "tennis wishes" the most popular alternative for girls was "tennis trips": 13 have chosen it. Second favourite was a wish to play more "team tournaments" (9 votes). The general unspecified idea of playing "more tournaments" appealed only to 3 girls. Boys didn't differentiate how they compete: to them "team tournaments" were almost as important as "tournaments" (8 to 7). And they did like tennis trips too: 9 votes.

The questionnaire showed that tennis juniors have a clear need for team events, especially girls. Their aspiration is understandable knowing how challenging individual sport could: no team around to share the burden of defeat, no coach on the bench during the match.

Questions about views on their tennis, which is linked to motives, offered some variety as well. While most boys and girls are united that tennis is "fun to play", there are decidedly more boys than girls who also view their tennis as "a pro- or university- opportunity" (11 boys to 5 girls). By the way, girls in their second preference were equally split between "pro- or university- opportunity" (5), "best way to keep in shape" (5) and "fun to follow and watch matches" (5).

Interesting as well was that girls chose more alternatives for every question. While boys ticked just one answer, girls were more generous. One explanation may be that for the girls competition is not the only attraction of the game. It could be that tennis girls love competing, but they love "competing plus" – and that "plus" could be equally important as the actual on-court battle.

Buunk and Massar (2014) made a point of the fact that for men, competition was a common fact of life since the time immemorial, while women were not as exposed to it. Evolutionarily, as the weaker species, they favoured cooperation.

The idea that greater exposure makes a difference in participation figures was confirmed by American experience. Sports participation statistics from the seventies showed that only 7,4% of American high school athletes were females. Forty years later the figure grew to sizable 42% (Keilman, J., 2012). At the same time, big changes occurred in prize-money distribution: if in the seventies the Wimbledon prize cheque for a male winner was almost twice as heavy as lady's winning cheque, nowadays they get an equal share.

We can presume that modern tennis girls would have a better track of the score than their predecessors some forty years ago, as was observed by the Aussie legend Neal Frazer.

The questionnaire "Me and my tennis" showed that competitive girls are similar in their tennis preferences to competitive boys, but they do appreciate cooperative drills and team events more than boys. Adjusting training and tournament plans according to this knowledge might make competitive tennis more enjoyable for the girls and prevent the drastic decline in female tournament participation through adolescence which is witnessed today.

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Wheelchair tennis player movement speed: Differences in movement, with and without a racket

Alejandro Sánchez-Pay and David Sanz-Rivas (ESP)

ITF Coaching and Sport Science Review 2018; 76 (26): 29-30

ABSTRACT

This study attempted to measure the capacity of wheelchair tennis players to accelerate and change directions, as well as investigate the differences with regard to the level of the athlete, either using the racket or not using the racket, when moving. 9 international players participated in this study. We measured the time they took to cover 5, 10 and 20 metres and the time to make an agility test (T court test), with and without a racket. The results showed that the use of the racket negatively impacts the movement ability of the players. Higher level players seem to make specific displacement movements more efficiently with or without the racket, as compared to lower lever players. Results of our findings, apart from being reference values for trainers, inform about the use of the racket for specific mobility in the physical training of WT players.

Key words: speed, agility, racket, wheelchair

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INTRODUCTION

The duration of a wheelchair tennis match ranges between 60 and 80 minutes (Ponzano & Gollin, 2017; Roy, Menear, Schmid, Hunter, & Malone, 2006; Sánchez-Pay, Sanz-Rivas, & Torres-Luque, 2015). During this time, players cover between 2,000 and 4,000 m. on the chair, with an average speed of 1m/s and a max. of 2,9 m/s (Ponzano & Gollin, 2017; Sindall et al., 2013). The great number of accelerations and decelerations of WT players is a consequence of the specific movements of the players in their chairs: starting, sprinting, stopping and turning (pivots) (Sanz, 2003). This sequence, which must be done while holding the racket, makes mobility an important success factor in WT (Bullock & Pluim, 2003). Correct displacement lets the player prepare properly to hit a stroke (Filipcic& Filipcic, 2009). Propelling the chair while holding the racket has negative effect on the production of power and displacement speed (de Groot, Bos, Koopman, Hoekstra, & Vegter, 2017), mainly during the first three pushes of the chair (Goosey-Tolfrey & Moss, 2005). These studies show the difference when displacement takes place exclusively on a straight line, apart from not knowing if there are differences depending on the level of the group. Therefore, this study will target the analysis of the influence of using the racket in the different speed and agility tests and setting the differences depending on the level of the athletes.

METHOD

Participants

The participants in the investigation were the best 9 WT players in the national ranking. Out of these 9 players, the best 4 in the international ranking were in the National Selection (Group 1) and the remaining best 5 in the second group (Group 2). Table 1 shows the characteristics of the sample.

Participants	National ranking	International ranking	Group	Injury	Weekly training (hours)	Tennis experience (years)
1	1	Top 20	1	AF	20	12
2	2	Top 20	1	AT	15	8
3	3	Top 50	1	L2	8	5
4	7	Top 50	1	OI	3	24
5	5	Top 100	2	AF	6	9
6	6	Top 100	2	D11	10	2
7	8	Top 100	2	AF	8	17
8	9	Top 150	2	D9	6	8
9	10	Top 150	2	D4	8	7

AT: Amputation at tibia level. AF: Amputation at femoral level. L: Spinal cord injury at the lumbar level. D: Spinal cord injury at the dorsal level. OI: Imperfect osteogenesis

Table 1. Characteristics of the National Selection players (group 1) and the second team (group 2).

Measurements and instruments

Three measurements per participant were recorded by means of the field tests used in different studies to evaluate the speed and agility of wheelchair athletes. After a standard 5 minute displacement warm-up, with changes of direction, and 3 minute controlled sprints, players did the following tests:

- Displacement speed test: Displacement speed was measured through Chronojump Photecell® (Chronojump, Barcelona, Spain) and Cronojump software version 1.7.1.8 for MAC. Four gates were used, they were placed at 0, 5, 10, and 20 metres. The subjects started from a line at 0.5 m. behind the first gate (Figure 1a). Each participant took the test 3 times without a racket, and three times with the racket and a resting time between each 2 minute repetition. Average values of 5, 10 and 20 m. of the three repetitions were recorded. The time was recorded in seconds and milliseconds with an error of ± 0.001 seconds.

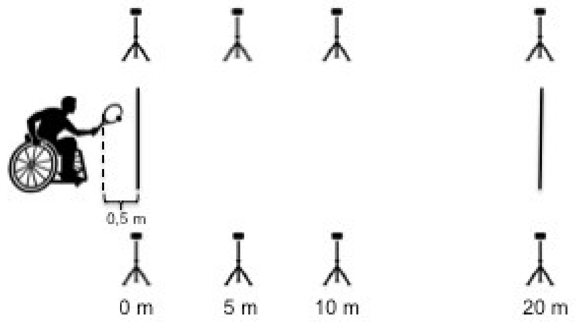

Figure 1a. Displacement speed test.

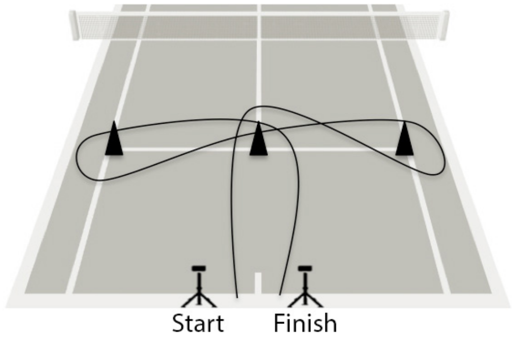

Figure 1b. Agility test (T court test).

- Agility test (T court test): The participant is positioned in the centre of the court, behind the baseline, and must go to the intersections of the singles and service lines, always crossing the central area (T) and returning to the starting point (Figure 1b). Each participant took the test 3 times without a racket, and three times with the racket with a resting time between each 2 minute repetition. Average values of the three repetitions were recorded. The times were measured with Chronojump Photecell® (Chronojump, Barcelona, Spain) and a Cronojump software version 1.7.1.8 for MAC with a gate placed at the baseline to record the beginning and the end of the test.

Data analysis

The descriptive analysis of the data included the mean and standard deviation (M ± SD) of the variables in question. The Shapiro-Wilk test was used due to the size of the sample to contrast the normality of the data registered for each variable. A Student's t-test was used to compare the mean between the level groups (Group 1-National Team, and group 2) and for the tests with and without a racket, setting the significance level at p<0.05. Finally, the correlations between the 20 m. variables, with and without a racket, were studied in relation to the rankings through the Pearson r coefficient. Analysis was performed with SPSS software for Windows (Version 20.0. Armonk, NY:IBM Corp.).

RESULTS

	Without a racket				With a racket			
	5m	10m	20m	T-Test	5m	10m	20m	T-Test
	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD
Group 1	1.47 ± 0.7^	2.61 ± 0.16**^	5.06 ± 0.34**	11.91 ± 0.87	1.55 ± 0.06*	3.00 ± 0.32	5.32 ± 0.39**	11.96 ± 0.86*
Group 2	1.64 ± 0.15^	3.09 ± 0.18^	6.06 ± 0.43	13.13 ± 0.79^	1.84 ± 0.18	3.36 ± 0.30	6.33 ± 0.39	13.56 ± 1.05
Total	1.57 ± 0.14	2.88 ± 0.30	5.62 ± 0.64	12.59 ± 1.01	1.71 ± 0.20	3.20 ± 0.35	5.88 ± 0.64	12.85 ± 1.24

*: Differences between Group 1 and Group 2. * = p < .05; **= p < 0.01; *** = p < 0.001
^: Differences between with and without a racket ^= p < .05; ^^ p < 0.01; ^^^ = p < 0.001

Table 2. Mean values (M) and standard deviation (SD) of speed and agility tests with and without racket in both level groups.

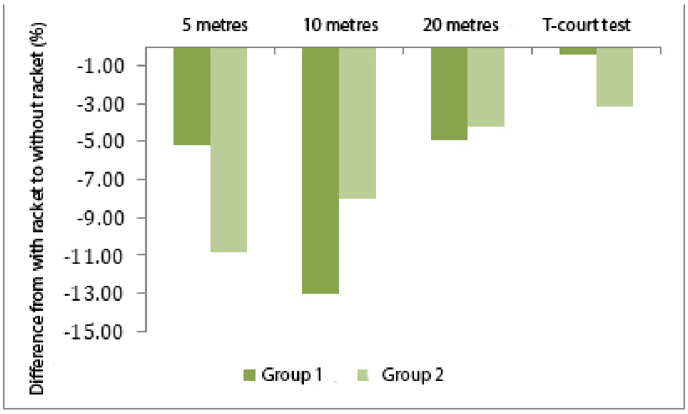

Figure 2. Percentage of time lost in movement from with a racket to without a racket in high (group 1) and lower (group 2) level players.

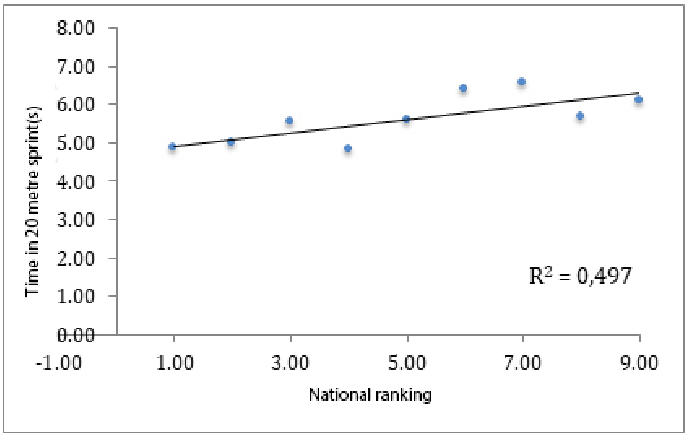

Figure 3. Correlation of the 20 m. sprint without a racket, with the ranking position of the player.

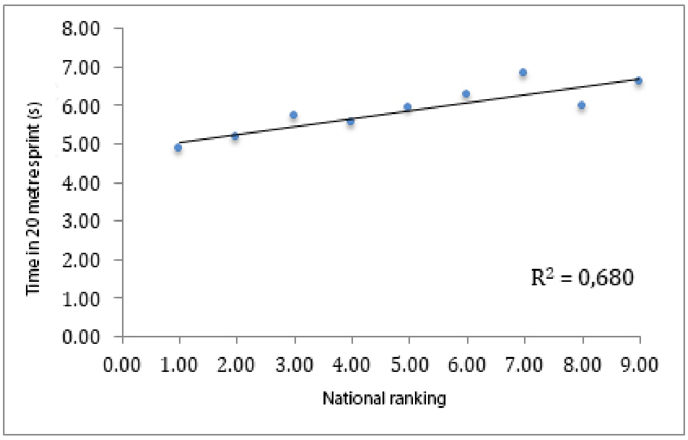

Figure 4. Correlation of the 20 m. sprint with a racket, with the ranking position of the player.

COMMENTS AND CONCLUSIONS

The target of this study was to analyze the influence of the racket when accelerating and changing direction in WT players, and to discover possible differences in relation to player levels.

The findings of this study show how the use of the racket in WT player displacement impacts negatively on the time of this displacement (Table 2). High and low level players take statistically longer to cover 5 and 10 metre distances when using the racket, but this is not so in 20 m. Data seem to indicate that the acceleration

capacity from a static position is affected by the use of the racket in the first metres; however, maintaining high speed levels does not seem to be significantly affected when using the racket. This may be due to the fact that once the initial inertia of the chair in a static position is overcome, the chair itself facilitates the displacement when in movement. Higher level players waste 5% on their time in the first 5 m. and 13% up to 10 m. (Figure 2). Lower level players waste 11% in the first 5 m. and 8% up to 10 m. This loss of speed in the use of the racket in the impulse on the wheels translates in reaching the ball later and not being able to hit it correctly (Filipcic & Filipcic, 2009).

WT players do not move exclusively in a straight line, they start, sprint, stop and turn (pivot) (Sanz, 2003), and these are more specific movements in this sport specialization. In this sense, higher level players show no differences in the agility T court test with or without the racket (table 2), with a time waste of 0.5% (figure 2), this occurring among lower level players. This seems to indicate that specific mobility in WT (when using the racket) is more efficient among higher level players. Graphs 4 and 5 show the correlation between the time of displacement in 20 m. (with and without a racket) with the ranking of the player. The use of the racket shows a greater correlation with the ranking of the player ($R2 = 0{,}680$) when compared with the displacement without the racket ($R2 = 0{,}497$). This greater correlation may indicate that apart from the fact that better ranked players move more quickly than lower ranked players, they are more efficient when moving with the racket. All this may be due to the fact that, among other things, higher level players have a better technique to impulse the chair both with and without the racket. On the other hand, we could consider that they provide more strength in the first impulses due to a possible difference in their physical fitness, an aspect which has not been studied.

As a conclusion, higher level players move more quickly than lower level players. Furthermore, the use of the racket impacts negatively in the time of displacement, although not in the same way in its different sections, nor depending on the players level. Higher level players, who are supposed to have a better and more efficient displacement technique, because of their physical fitness, and the way they use strength, are better than lower level players. Therefore, the differences are greater in short (5 m.) and long displacements (20 m.) as well as in displacements with change of direction (T court test). This is a very important issue and as WT displacements during a match are less than 10 m., the large number of small movements of around 5 m. makes it a very specific task, particularly when starting the first 2 or 3 impulses, which means that they must be practiced in a specific way and with the racket, so as to improve these actions. This fact can be seen in the first 5 m. and in the agility test where higher level players waste less time (%) than lower level players (Figure 2). The results shown here, as well as from being useful as reference values for WT coaches, encourage the practice of specific mobility physical exercises in WT, as much as possible, and always, with the racket.

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The costs of access to playing tennis in selected countries of the world: An introductory study

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ABSTRACT

While many studies have focused on the financial situation of professional team sports, little attention has been paid by research to individual sports from an economic point of view. The aim of this article is to provide some initial data on the cost of access to tennis in different countries in the world. It is hoped that these figures will assist in providing a better understanding of the participation landscape worldwide in order to design and deliver the appropriate development policies needed by the end users.

Key words: economy, participation, expenditure, development

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INTRODUCTION

In the past, tennis used to be considered as a sport available only for the wealthy people (Barget, 2006). However, this situation is gradually changing and our sport is becoming more and more accessible to people from different social classes; however, it has still been shown that over 79% of the countries where tennis is prevalent are considered to be more economically developed (Martin 2015).

The ITF recently presented the results of its Tennis Participation Survey which included data from 190 out of the 210 ITF member nations. The most relevant figures from this Survey are included in figure 1.

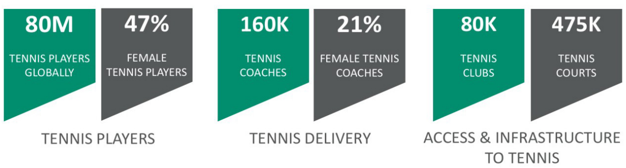


Figure 1. Some of the data collated in the ITF Tennis Participation Survey (ITF, 2018).

Following up on this data, the aim of this article is to provide an insight on the accessibility of tennis in different countries in the world. Our hypothesis is that accessibility to tennis is not the same all over the world. Even though this statement may seem obvious, to date there has been no research studying this issue, and this is an issue which could help drive participation in tennis worldwide.

METHODOLOGY

In order to better understand the accessibility to tennis, the following variables were identified as important measures: cost of a tennis racquet; cost of renting a tennis court (1 hr); and, average cost of a 1 hr lesson with a tennis coach. To expose the disparity of costs of playing tennis, it is hoped that the data will show how big a part of the average monthly income of citizens of different countries is needed to pay for the mentioned variables.

All the costs of tennis participation are compared to the average monthly income in (USD) in the selected countries of the sample. This approach allows us to show the amount in percentage of the monthly income that people need to buy a tennis racquet, rent a tennis court or receive a lesson with a tennis coach once a week. Data was collected from 21 countries from all around the world. These countries provided different macro-level economic, social and cultural features such as: economic welfare, population, geographic and climatic circumstances (De Bosscher, 2003). All the costs were estimated according to the data provided by local tennis experts, feedback from facebook tennis groups, a survey from the website "numbeo.com" and top "google.com" searches. Table 2 includes the list of the countries in the sample:

Continent	Country	Total
Europe	Spain, Poland, Sweden, United Kingdom, Bulgaria, Russia, Germany	7
Africa	Egypt, Ghana, South Africa	3
Asia and Oceania	Lebanon, Japan, Australia, India	4
North and Central America and the Caribbean	USA, Canada, Guatemala,Trinidad & Tobago	4
South America	Argentina, Brazil, Colombia	3

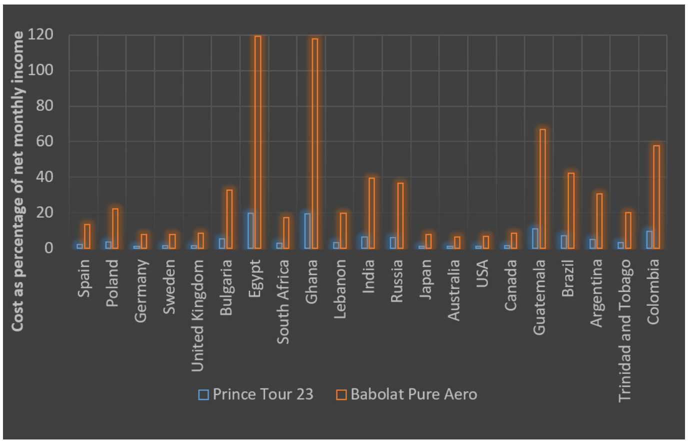
Table 1. List of countries participating in the study.

RESULTS

The results of the study will be presented attending to the different variables identified: cost of racquets, cost of renting a tennis court and cost of one-hour lesson with a coach

Racquets

Two popular racquet models were chosen for our study. The first one was a Prince racquet for kids, the "Prince Tour 23", available for approximately 33$ all around the world. The second one was the "Babolat Pure Aero", which is a well know model among both amateur and high-performance players. The cost of this racquet



oscillates at around 200$ worldwide.

Figure 2. Cost of the racquets related to the national monthly income.

Figure 1 shows the amount of the monthly income that citizens of the chosen country needed to use to pay for the racquet. Usually more developed countries have higher average monthly income, so the relative cost of tennis rackets is lower. In the case of less developed countries, the relative cost is higher. Citizens of Ghana and Egypt need to contribute almost 120% of their net monthly income to afford a “Babolat Pure Aero”. On the other hand, in Sweden, United Kingdom, Japan, Australia, USA and Canada, people needed to spent less than 10% of their income for the same racquet. “Prince Tour 23” is a racquet for kids and because of its lower price, it is more affordable. The main objective here was to make tennis aficionados aware that tennis equipment is not at the same level of accessibility in every country and the differences are big.

Renting a tennis court

The cost of renting a tennis court depends on several factors. The main one is the demand, understood as the ratio of available tennis courts in a given country to the number of active players. The higher the demand, the higher the price. Another factor is the weather; in some countries like Poland for example, weather conditions allow for playing outdoors for half of the year. Usually renting of indoor courts is considerably more expensive than renting outdoor ones. In more developed countries the wages are higher, but so the costs of living; therefore, tennis court rental is more expensive too.

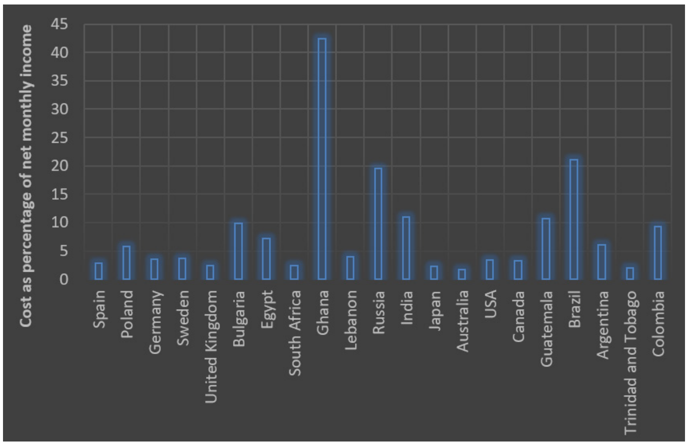


Figure 3. Cost of renting a tennis court related to the national monthly income.

Figure 2 shows the amount of monthly income tennis players in different countries use in renting a court once a week for a month. Ghana, Russia and Brazil are the countries where renting tennis courts is the most expensive. Citizens in those countries need to contribute over 19% of their monthly income to afford to play tennis regularly. The cheapest tennis court rentals are in United Kingdom, South Africa, Japan, Australia and Trinidad& Tobago. Citizens of those countries need to spend less then 2.5% of their income to play tennis weekly.

One-hour individual lesson with a coach

The main factors that influence the price of an individual tennis lesson with a coach arethe qualification and experience of the coach. Another relevant factor is the competition among coaches. The higher is the number of available coaches the lower the price is. The economic development of the nation also influences the cost of a tennis lesson. Higher wages mean that tennis coaches also earn more, so that the price of tennis lesson will be higher.

Figure 3 shows the amount of the monthly income tennis players in different countries need to allocate to play tennis with a coach regularly once a week for a whole month. Citizens of Egypt, Ghana, Guatemala and Brazil need to spend over 25% of their net monthly income on an individual tennis lesson with a coach. Japan offers the cheapest tennis lessons with the cost being around 3% of the monthly income contribution.

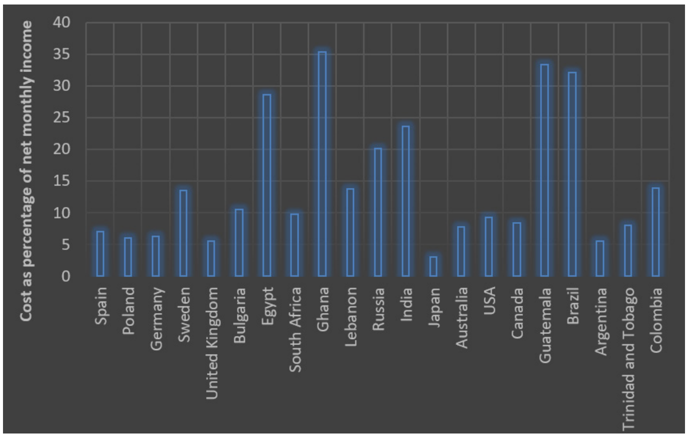


Figure 4. Cost of individual tennis lesson with a coach related to the national monthly income.

SUMMARY

The costs of tennis in some countries are higher than in others. Sport participation is positively associated with household income (Farrell & Shields, 2002), and this is why western success in professional tennis is closely correlated with aggregated income in the country (Griginov, 2007). In poorer countries, fewer people can afford to buy equipment and pay for tennis court hire or lessons with a coach. What is more is that these countries have fewer sports facilities and less money for development. Because of these facts, participation in tennis in those countries is lower. Consequently, those countries are not able to produce as many professional players as the wealthier ones. For this reason it is crucial to support participation in less developed regions, through programmes such as the ITF Development and Coaching programmes, ITF Training Centers and the Junior Tennis Initiative.

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Different types of variability in tennis practice

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ABSTRACT

Variability is a term that is gaining traction in the tennis coaching world; traditional approaches which emphasise either a one-approach-fits-all 'text'-book' model of instruction are being abandoned as a result of the acknowledgement that people have differences and the acknowledgement that even the top players show variability. This article summarises some of the different types of variability that might occur in tennis practice, and gives recommendations for coaches.

Key words: Variability, tennis practice, dynamic systems, differential learning

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INTRODUCTION

Approaches that emphasise variability are fast gaining support over more traditional approaches to learning and training, which are linear and therefore ultimately (and obviously incorrectly) suggest that the same instruction to a group of players will result the same for all players. Traditional approaches have also sought the reduction of error (variability in a skill) so that the skill corresponds to a putative text-book model. This obviously no longer to stands to reason because it is known that top players have varied technique (although they all make use of effective biomechanical concepts). Also, individual differences imply that everyone learns differently. Furthermore, modern tennis training has evolved in a way that makes it more holistic, as this can create more complete players (Crespo, 2009).

At a glance, variability could occur in tennis practice through varying: the incoming ball, tactical situations, technique or shot outcome (height, spin, spin, direction or depth). Drawing from many theories and definitions of variability, which often overlap, this article gives practitioners recommendations and the theoretical grounding that they could use to better their sessions.

DIFFERENT TYPES OF VARIABILITY

Variable, varied and random practice

One of the precursors to all other types of variability, Schmidt (1975) suggested that with increased and wider experience, we develop a generalised motor programme, constantly updating rules of how to recall and use skills better. Similarly, contextual interference (Shea and Morgan, 1979) suggests that by switching skills in a random order (and possibly different variations of skills or different situations), more conscious effort is used to recall the different skills, which in turn leads to better and longer term learning. The result in tennis practice is that coaching should be variable, varied and random as it leads to learning skills faster and more robustly (Reid et al., 2007; Schmidt et al., 2018) but also mimics match conditions (Pankhurst, 2013).

Recommendation for Coaches:

- Vary the situation in which a skill is practiced (variable practice), i.e. position, incoming ball and possibly shot outcome
- Have players switch between skills in practice (varied practice), and vary the order of practice (random practice).
- Apply these types of variability even when focusing on a specific skill or with beginners, although maybe to a lesser degree in these cases and in closed practice.

Discovery or guided-discovery learning

Discovery learning involves a learner exploring different solutions in order to find effective solutions usually through the use of task/goal constraints such as targets and then the player testing hypothesis about skills to achieve the desired outcome. Thus variability is encouraged through trial and error. As a teaching methodology it contrasts to the traditional prescriptive method (Reid et al., 2007) and it has been argued that discovery learning is implicit and therefore allows for learning quicker as the learner adapts without as much conscious control or intention as if they were instructed (Liao and Masters, 2001; Masters and Poolton, 2012). This may not be the case fully as discovery learning involves hypothesising about solutions in order to achieve an outcome; however, the joint focus on task as well as solution may make this approach as least semi-implicit, allowing for some of benefits of implicit learning. Whilst discovery learning might imply that the coach should not impart any knowledge onto the learner, this should not be the case (Reid et al., 2007) and coaches should still impart knowledge and direction. Hence the more apt term guided discovery where a coach will guide solutions within effective ranges, biomechanical principles and concepts.

Recommendations for Coaches:

- Set tasks which force players to find effective and efficient technical solutions
- Use physical targets, impediments or modifications, i.e. ropes going parallel over the net in order to encourage height.
- Instruct players to force a certain effect on the opponent (i.e. push them back at the baseline or hit a low volley at the net) (Buszard et al., 2013).
- Give players parameters or concepts to work within, e.g. for a player working on an attacking forehand it would be important that the player make use of the BIOMEC principles and have a flatter swing but configurations of the swing may differ player to player within this.

Dynamical systems and the constraints-based approach (adaptability)

Dynamical systems theory and the constraints-based approach take the discovery learning approach further, suggesting that expert performance can be a direct result of variability and adaptability (Seifert et al., 2013), whereas discovery learning could be taken to suggest that once a correct solution is found, variability is decreased. From a dynamic systems or constraints-based approach (Davids et al. 2008; Crespo, 2009) the player has an internal movement pattern landscape based on interacting task (tactics, objectives, etc.), individual (abilities, attitudes, training, etc.) and environmental factors (weather, oncoming ball, etc.), which govern skills and success. In tennis terms, a new situation creates an imbalance in the movement landscape which the player tries to resolve by reorganising the skill components (Sanz and Moreno, 2013). Improvement occurs as the landscape where these factors meet is explored (through practice and variability) and stable states or 'attractors' are developed (states where the different components of the system meet for a successful response). Many movement patterns can be developed, allowing for successful switching between skills and variations of skills, which in turn allows for the creation of more complete players as a player is actively able to adapt better to different or even new conditions.

Recommendations for coaches:

- Encourage constant adaptation and variability even when effective solutions are found but also encourage 'attunement' to 'affordances', i.e. awareness of opportunities dictated by the situation (Davids et al., 2008)
- Use targets, goals, court modifications and impediments for drills to force exploration of new solutions
- Use the tactical effects against other players to guide exploration
- Guide solutions within solid biomechanical principles

Structured task-goal variability

Structured task-goal variability is a newer theory and an off-shoot of variable practice and possibly the constraints-based approach, and it involves changing the skill outcome in practice. Research has shown that will allow for more control in a test of changing outcome; however, the individual who practices the same outcome over and over will be better at that constant test (Ranganathan and Newell, 2010; 2013). This might seem simple but it partly contradicts the variability of practice theory posited by Schmidt (1975) because it suggests that practice at one outcome is best for learning if variability is not needed in competition; although, given the need to constantly vary outcomes constantly in tennis, deliberate variability of the outcome in practice seems more suitable than constant practice.

Recommendations for coaches:

- Have players actively vary outgoing shot properties such as height, speed, spin, depth and direction (even during practice of a specific situation) as this will allow the player to vary the outcome better under pressure, effectively improving their general accuracy
- Use targets, impediments and goals to induce variation of outgoing ball flight characteristics
- Be aware that this approach may not be best when one specific outcome of shot needs to be practised such as a flat 1st serve

Differential learning

Differential learning draws on some of the aspects of a dynamic systems approach but emphasises perturbations and disturbances (Sanz and Moreno, 2013) through no repetition or even random instruction, which allows the player to refine their technique unconsciously. This is due to the signal from the noise or the randomness resonating against the signal of the movement pattern, which allows for greater feedback to the player (Schollhorn et al., 2006; 2009) or forces the player to develop their movement dynamics (Sanz and Moreno, 2013). The emphasis here is to bring external noise to a level where it interferes with the internal noisy signal of the skill, thus forcing the player to refine the skill. Beginner players already have this large amount of noise from a lack of a yet developed motor pattern and so this might not be appropriate for them. This type of practice might be better suited in warm-ups or in short coordination exercises given its lack of realism to a match.

Recommendations for coaches:

- Coaches should encourage a no-repetition policy in practice, or even add in 'noise' with random instruction
- Set instructions of different body and arm finishing positions for strokes
- Set instructions to never repeat shots exactly
- Tell players to wear temporary sight impairment devices
- Have players use other rackets with different weight, sizes, materials and strings
- Tell players to start facing the other way or run round cones between shots
- Be aware that too much of this type of practice is not very realistic to match situations
- Still ensure players act within the tactical context
- Use this type of practice in warm-ups and for coordination drills only

Execution redundancy

Execution redundancy (Ranganathan and Newell, 2010; 2013) refers to changing technique for a given outcome, and is related to differential learning and a dynamic systems approach, and could be seen as another type of perturbation to the dynamic movement system (Sanz and Moreno, 2013) which further develops player's ability to adapt. It has been suggested that execution redundancy in practice might allow for the benefits of finding optimal solutions but also generating more flexibility (Ranganathan and Newell, 2010; 2013). Thinking of the top players, the level of the game dictates that players will need to improvise and hit with control in situations where time and space has been taken away from them; it has been said that experts are more able to do this (Seifert et al., 2013; Unierzyski et al., 2018). In a study of experienced club tennis players, the group asked to vary technique whilst rallying improved in accuracy significantly wheras the group not asked to vary technique, the constant condition, did not (Davis-Higuera, 2018).

Recommendations for coaches:

- Encourage players to actively change their technique for a given outcome as this will lead to the player being more flexible as well as refining their skills.
- Ensure technique is still within accepted biomechanically correct ranges
- Ensure that the technique is attuned to the tactical situation
- Vary different swing configurations (grip, contact position/height, arm angle at contact, swing size, etc.)

CONCLUSIONS AND FINAL RECOMMENDATIONS FOR COACHES

Variability in tennis practice can develop players who are free of injury, have effective and efficient technical skills, but also have personalized and adaptable skills, which is likely to allow for more enjoyment, greater success as well as a longer career. A lot of the theories of the different types of variability overlap and are not mutually exclusive in practice, and this is likely to be because they all have similar mechanisms, conceptualised in different ways. Coaches should use common sense, using the level of the player and goals to dictate where variability should take place in practice. All of the types of variability can be used within currently accepted methodologies for conducting sessions, which usually involve (once a warm-up, observation and evaluation has been carried out) picking a technical or tactical aspect to work on, starting from closed practice, and then adding levels of realism until the skill is ready to be tested in match play.

Adding layers of realism to drills with follow up shots or different decisions, naturally adds variability to practice in some ways but coaches should be aware of all the ways that variability could be induced in closed practice when working on a specific skill, situation or intention. Table 1 shows how to introduce the different types of variability for the closed practice of rally neutral baseline groundstroke skills and a wide attacking 1st serve.

Type of variability	Considerations for closed practice of baseline groundstroke rally (neutral) skills	Considerations for closed practice of the 1st serve flat wide (attack) skill
Variable practice – different incoming balls	Feed to slightly different locations with different speeds/heights/spins.	Player changes side and position they serve from. Player could also change ball toss height
Varied practice - switching between skills	Players switch between forehands and backhands, even using variations such as slice, topspin and extreme topspin	Players switch between flat, topspin and slice serves, or even serves in different directions
Random practice – practice another skill	Mix groundstrokes with attacking groundstrokes or volleys in a multiple ball drill, or work on serves simultaneously	Mix serves with groundstrokes or volleys in multiple ball drill or working on another skill at same time
Discovery and Guided discovery – show desired result and encourage adaptation	Put cones down for depth in rally shot, and set up drills which encourage depth and keeping opponent back. For guided discovery, make sure players have an idea of what an effective groundstrokes with effective BIOMEC principles is.	Put cones down for direction and speed (2nd bounce target) of wide serve, or set up drills which encourage players to put returner under pressure and move them off court
Dynamic systems and constraints based approaches - link different factors and explore	As above but more exploration of effective technique variations for groundstrokes based on factors. E.g. a shorter player might suit more physicality and spin; wider incoming balls require different footwork	As above but more exploration of effective technique variations for serves based on factors. E.g. extreme wide serve requires more spin and less speed
Task goal structured variability -	Use targets/instructions to have players hit higher/lower, wider/central, flatter/more spin rally shots	Have players hit wide fast 1st serves with different amounts of slice/kick, and some wider than others.
Differential learning – add randomness	Use different types of balls and rackets. Use temporary sight impairing devices. Instructions to touch side line between strokes, hit with different stances or finish stroke with racket over shoulder, arm or just after contact.	
Execution redundancy – diff. techniques for specific outcome	Have player hit with different contact positions (higher/lower/more in front/more in front), slightly different finishing arm positions, different stances, etc.	Have player change ball toss at different heights, different backswings, slightly different accepted service grips

Table 1: Example of different types of variability for the closed practice of groundstroke baseline neutral rally skills and a 1st serve (attack) wide skill

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Letter to the editors: Comment on "Muscle memory and imagery: Better tennis. An introduction"

Dear Editors and Editorial Board of ITF Coaching and Sport Science Review:

After reading the article entitled "Muscle memory and imagery: Better tennis. An Introduction" by Archie Dan Smith published in the April 2018 issue of ITF Coaching and Sport Science Review (ITFCSSR), we felt compelled to share our scientific and coaching concerns. Unfortunately, this article does not meet the high-standards and peer-reviewed nature of ITFCSSR. In addition, Mr. Smith is author of a book with the same title, and his article is an unequivocal endorsement of his book. Examples of specific concerns about this article include:

- The colloquial phrase "muscle memory" is simply inaccurate and could certainly be misunderstood since it promotes the notion that somehow our muscles can store memories which are a brain function. Two explanations are provided in the article: "Muscle memory is what determines your strokes and makes your tennis game what it is – for the good or for the bad" and "Muscle memory is performing a specific motor action without conscious effort." Several hundred years of kinesiology/exercise and sport science (KESS) research and neurophysiological study have not been able to demonstrate that skeletal muscles have any memory, rather, they work in concert with complex brain and spinal cord pathways that are influenced by numerous internal and external events. The term "procedural memory" is well accepted in the scientific literature related to a variety of disciplines as an explanation for the retention of "how to do" a physical action, skill or procedure. An example of procedural memory is hitting a forehand or backhand ground stroke in tennis.

- The term imagery is also used in the title but there is no apparent reference to "imagery" throughout the article. It is misleading for the reader who will likely expect some discussion of the use of imagery in learning tennis skills which would require a much different focus. This article does not even pretend to address the topic.

- The author proposes seven "laws" of muscle memory by stating: "I propose the following laws of muscle memory. By understanding these laws, you can apply them to your training and your tennis game. You will become a better player." Since a "law" is defined as a statement of an order or relation of phenomena that so far as is known is invariable under the given conditions, the author's comments do not qualify as sport science "laws," but rather opinions or conjectures. Proper examples of "laws" would be Sir Isaac Newton's three laws of motion. Using the term "law" in this publication could likely mislead many readers in that the information shared has been properly tested, shown as invariable with repeated testing over time and conditions.

- The author defines "repetition over a concentrated period of time, as it applies to tennis strokes, as 45-90 minute sessions 3 to 4 times per week over a 3-week period." The author provides no evidence-basis for this recommendation, and we are concerned that tennis coaches may assume this is a proven "law" which it is not. What research is there to verify this conclusion? Were control groups and other design features used that ensured these results are reliable and achieved the best outcomes? These are important questions to answer prior to recommending training methods/sessions to a large audience of tennis coaches.

- Under "Law #5", the author uses the term "forgetting" and "interference" interchangeably. These are different cognitive events and should not be interchanged. Further he states that "if you practice your forehand then immediately practice your backhand, science suggests the short-term improvement in your forehand is transient and will be lost in terms of long term retention. In effect, you just wasted the entire time spent practicing your forehand related to establishing muscle memory". The author describes interference. What is not addressed, however, is if there is any positive, beneficial transfer. As an example, the notion that working on one tennis skill will negatively affect previous learning has little basis. In fact, in teaching the importance of a low to high swing to impart topspin on ground strokes, learning first to do it on the forehand side typically promotes a positive transfer of learning to the backhand side. The author cites dated non-tennis-specific literature which could confuse readers to incorrectly believe that forehands and backhands are to be considered truly unrelated activities. The author does not cite emerging KESS research on this issue.

- The author's concept of practicing only "good shots" is not specific. How is a "good shot" defined and evaluated? He defines "good shot" as one that wins a point. However, this depends on the opponent's position and skill not just whether a shot wins a point as the author appears to imply.

- The references cited do not include any tennis-specific studies, nor does the author address the considerable limbic (emotional) input of procedural memory. In essence, we don't know if the author's ideas apply to tennis. The article should have cited a body of motor learning research related to learning tennis strokes published in a variety of KESS and tennis-focused journals like ITFCSSR.

- Scientific journals typically publish independent reviews of books by recognized scholars from a similar field of study, not promotional excerpts that are often published by for-profit magazines. This article appears to be more of the latter without explicitly noting this potential conflict of interest.

We recommend that future ITFCSSR book reviews be free of potential conflict of interest. Book reviews should be written by independent (in this case motor learning) experts in the field. In addition, standards, similar to other scientific journals, should be followed. We encourage the editorial team to exercise greater vigilance in expert peer-review of articles submitted to the journal. Tennis coaches need critical integration of KESS and tennis-specific research on which to establish evidence-based instruction and development.

Respectfully submitted,

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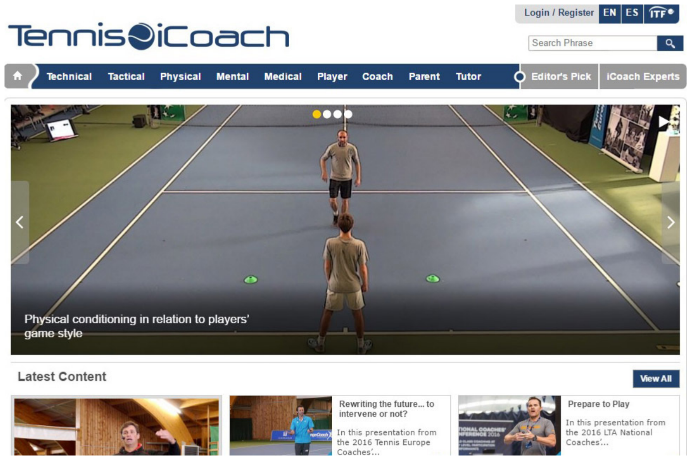

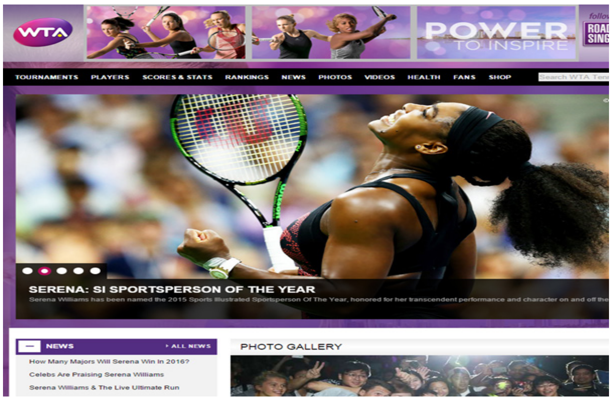

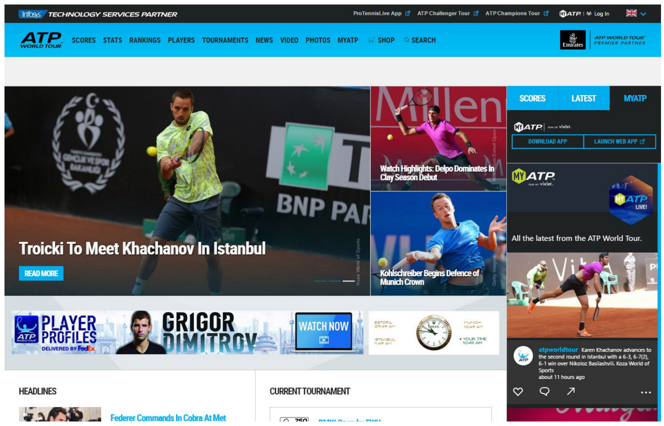

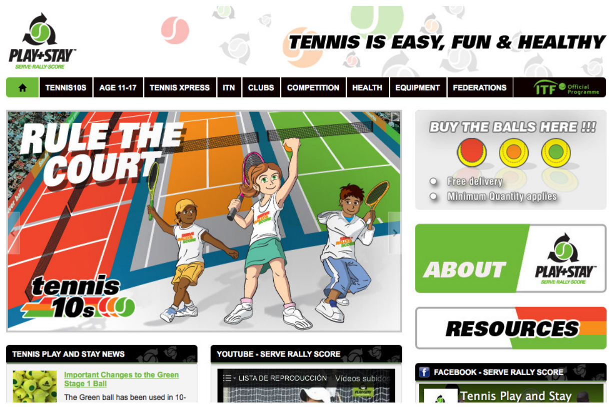

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- ✕ Betting companies **MUST NOT** sponsor, employ or provide any other benefits to you in exchange for yours or your player's services

Match Fixing

- ✕ **DO NOT** ask or help any player to fix the outcome or any aspect of a tennis event (this includes spot fixing of points, games or sets or attempting to manipulate the draw in any way)
- ✕ **DO NOT** ask or help any player to perform below their best efforts in a tennis event

Inside Information

- ✕ **DO NOT** share non-public, sensitive information about a tennis event or a player for betting purposes with anyone
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Wild Cards

- ✕ **DO NOT** accept or give money or any form of compensation in exchange for a wild card on behalf of or for the benefit of a player, whether or not the player has knowledge of your actions

Reporting Obligations

- ✓ **YOU MUST** report any knowledge or suspicions of corruption to the TIU
- ✓ **YOU MUST** inform the TIU as soon as possible if you are approached by any person who offers money or any benefit to influence the outcome or any aspect of a tennis event or asks for inside information
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⚠ **You have a responsibility to ensure that you and your players are aware of and comply with the rules of the TACP.**

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