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Design and validation of a tennis tool to control on-court technical and tactical training content

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Abstract

In high performance tennis, different aspects like physical-conditioning, strategy-tactic, technical-biomechanical, psychology and skills acquisition have received large attention from the researchers. Nevertheless, the programming, periodization and planning of training sessions and competitions have not been as studied in depth. Coaches still use their experience, trial-error and subjective perceptions as methods of conducting these fundamental tasks. This article presents the design and validation of an instrument to control the technical and tactical training content on-court. The instrument was conceived by 9 experts and validated by 23 experienced coaches, who used on-court tennis exercises examples. The instrument is a useful tool for helping the coaches to improve the control of the on-court technical and tactical content and the tennis training session contents in high performance tennis players.

Keywords

Drills, periodization, racket sport

Introduction

In tennis, research has extensively studied the physical preparation programmes and training prescriptions for high-performance tennis players in aspects such as the service speed, the neuromuscular performance, the improvement of overall physical condition, and the aerobic component or speed, among others.[1] The specific characteristics of different psychological training programmes for high-performance tennis players have also been investigated.[2] However, from the perspective of the design and prescription of on-court training programmes for high-level tennis players, there have been few studies.

These research agree that the control of the training content and the total training load (TL) are fundamental to better understand the process, to achieve the goals set, to avoid overtraining, and to improve performance. In addition, research has also found that current on-court training protocols for high-performance tennis players are often characterised by coaches' using integrated methods with exercises or drills combining technical, tactical, physical and mental contents.[3] Their main characteristics are usually decided on the basis of non-objective criteria. The overall load of the session as well as the type and order of priority of the contents is rather intuitive. In this scenario, coaches apply trial and error to identify whether a given exercise with a specific objective is beneficial or not for the player and they are usually guided by their experience, feelings, perception of the players' needs and other relevant aspects such as the period during the season, etc.[4] Coaches therefore manipulate the training variables (content, volume and intensity) with little or no scientific evidence.[5]

Several research studies have attempted to partially address this issue. Thus, TL (considering both training volume and intensity), has been measured using methods such as the perceived exertion, a low cost, easy to

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use and understand tool, which has been considered valid to monitor the training load[6,7] and quantify the internal training load (ITL)[8] in professional tennis players. In addition, this method has been used to analyse on-court tennis drills and it has been concluded that recovery and defensive drills, open play drills and playing points seemed more demanding than closed technical drills.[9] The number of strokes played (i.e., forehand and backhand) has also been used as an indicator of the work performed during each session.[9,10] Similarly, several studies have attempted, albeit partially, to obtain information on the quantification of physiological and performance responses in on-court drills of professional tennis players[3] and the calculation of training and competition loads using the session's volume and intensity.[10]

As it can be seen, the studies that have analysed the design of on-court training programmes have mainly focused on the study of the training load from a physical and physiological perspective. However, content and load quantification of on-court training sessions from a technical-tactical point of view has received very little interest from researchers. Due to this lack of evidence, there is some consensus among researchers, coaches and technical staff in suggesting that tennis needs to develop better technical-tactical, physical and mental protocols for the planning and periodisation of training based on guidelines obtained from scientific data. Thus, it is essential for training prescription to be built on programmes designed on scientific findings that will assist in acquiring the necessary skills needed for high-performance tennis play. Hence, the importance of reproducing in training simulated conditions which resemble or are similar to those that occur in a match (number and type of strokes, number of points, distances covered and changes of direction, etc.).[11]

Regarding the observational instruments used for the analysis and quantification of contents in tennis, Torres-Luque et al.[12] designed and validated an instrument to analyse technique and tactics in singles tennis matches. The instrument used the stroke as the unit of measurement, so that each time a player hits a ball, a total of 23 variables related to the game context, the result, and the technical-tactical information of the stroke are analysed. However, such tools are scarce, and researchers have pointed out that coaches currently have limited resources to describe and quantify the prescribed contents in elite tennis training sessions.[9]

In summary we can conclude that, as compared to the studies carried out on the quantification and description of the training contents and loads in the area of physical conditioning or psychology, the technical-tactical area has received less attention from researchers. Thus, the aim of this study was to validate a tool that could be used by coaches to control the technical-tactical characteristics of the content of the on-court training sessions of high-performance tennis players, by developing a taxonomy of training protocols that includes the technical-tactical contents worked on the court. Therefore, this study represents the first attempt, to our knowledge, to globally elaborate a taxonomy of regular on-court technical-tactical training protocols.

Methodology

Participants and procedure

The sample of participants who carried out the validation of the instrument consisted of a total of twenty-three experienced coaches (age 37.78 ± 7.65 years), of whom twenty were male (86.96%) and three were female (13.04%). The coaches had a professional experience of 15.83 ± 7.41 years. Five of them worked mainly with beginner players (21.74%), eleven worked with advanced players (47.83%) and seven worked with high-performance players (30.43%). In terms of their professional certification, 56% held an ITF level 1 coaching qualification (coach of beginners and intermediate players) or equivalent, 34.8% were ITF level 2 (coach of advanced players) certified or equivalent and 8.7% were certified at ITF level 3 (coach of high-performance players) or equivalent.

The design and validation of the instrument consisted of five different stages. Firstly, the authors of the research carried out individually a review of the scientific literature and the different possible variables, creating an initial proposal of items and item definitions based on research and on their previous experience in quantifying the content of exercises performed on-court. Secondly, this initial proposal was shared in order to reach a consensus on the items identified and definitions developed that formed the initial version of the instrument. Next, 5 male qualified expert coaches, 3 of them certified at ITF level 3 (Coaching High Performance Players) and 2 of them certified at ITF level 2 (Coaching Advanced Players). They had a professional experience of 25.4 ± 10.1 years. These experts were asked to carry out a qualitative and quantitative evaluation by analysing, evaluating and proposing improvements to the items and definitions included in the initial version of the instrument. Based on these proposals, a final version of the instrument was designed. Lastly, this final version was sent to the sample of coaches described above for review and confirmation. Together with the instrument, videos of 20 on-court exercises were provided for the coaches to record the different variables using the instrument. The records obtained from the sample of coaches were used for the validation of the instrument.

Instrument

The instrument was made up of eight categories that allowed to define the main characteristics of an on-court exercise. These are: 1. Game situation, 2. Goal, 3. General content, 4. Special content, 5. Methodology, 6. Number of players, 7. Interaction between players, and 8. Limitations. In turn, each of these categories included a series of specific variables that allowed the characteristics of the exercise to be defined more precisely. The definition of each of these variables is shown in Table 1.

Figure 1 shows an example of the codification of each category. It matchs with the validation of the tool, more specifically with an exercise included in it. This example displays the tool functioning and the variables measured.

Results

Krippendorff's alpha coefficient[27] was used to analyse inter-subject coding reliability in each of the observation categories. In observational studies, this coefficient allows to estimate the degree of agreement in the categories assigned to a variable by a group of expert coders or evaluators. Bootstrapping was performed with 10000 samples.

The values obtained showed adequate levels of reliability for all variables, although the "goal" variable showed an agreement which, although acceptable, was lower than for the rest of the variables (Table 2). For the interpretation of the alpha values, it was considered that a value of 1 meant that the coders performed the analysis identically and that values between 1 and 0.8 indicated a good degree of reliability, while values below 0.667 were unacceptable, and would require to review the categories and their definitions, or to train the coders.

Discussion

This article presents the different stages followed in the creation of a valid and reliable instrument for monitoring, describing and classifying the technical-tactical content of on-court tennis training sessions. In this section we discuss the results obtained in our work with those of the studies carried out in tennis that emphasise the importance of the variables included in this instrument for the quantification of the on-court content during training and match play.

The Krippendorff's alpha coefficients showed adequate levels of reliability for each of the variables included in the instrument. These levels indicate a high level of acceptance of the content of the instrument. Therefore, this tool can be considered adequate to describe, classify and control the elements of the on-court training sessions of players at all skill levels. Until now, to the authors knowledge, there was no tool available that allowed the control of the content of the on-court training sessions of high-level tennis players, so this instrument can be of considerable assistance to coaches and researchers wishing to quantify, prescribe and plan the training content of the on-court work of tennis players.

The high level of reliability obtained for the game situation variable indicates that these categories proposed in the instrument are useful for correctly describe and classify the exercises according to the game situation in which the drill is carried out. The control of this variable is very useful to ensure the specificity of the training, which allows for the situations proposed during the exercises to resemble the demands required during the competition. Several tennis studies have highlighted the importance of the specific on-court training for different game situations such as the serve and return of serve[11] or the baseline game.[28]

The variable related to the goal or objective of the exercise, although it obtained a lower degree of reliability than the rest of the categories, was also shown to be a reliable one when describing the main goal of the exercise. The importance of this variable lies in the fact that it allows for the quantification of probably the main characteristic of the exercise, as it facilitates the description and control of the purpose of the exercise: whether it is aimed at decision-making, stabilisation, application, or simulation of match situations, as pointed out by Krause et al.[16] or the learning of perceptual skills, which are fundamental in tennis, along the lines of what was stated by Williams et al.[29] Therefore, the use of this tool will allow coaches to precisely describe and quantify the objectives of the exercises carried out in each of the developmental stages of the players and the phases of the season.

The reliability obtained for the third variable, the "General Content" of the exercise, was considerably high. This result coincides with those obtained in previous studies related to the development of technical content on-court such as the serve movement,[19,30] the small adjustments in the strokes after several consecutive games,[31] the tactical content such as the improvement of the first serve percentage[32] or the variety of resources available to the players in decision-making process during tennis match play.[33] It also coincides with the principles for training practice proposed by Elferink-Gemser et al.[18] in reference to hockey tactics.

The fourth and fifth variables, "Special Content" and "Special Content 2" of the exercise, also obtained a high degree of reliability. This result is also in line with the importance that both variables have received in previous research.[34] Thus, Reid et al.,[35] for instance,

Table 1. Key variables that make up the instrument used.

Variable		Definition	Adapted from
Game situation	Serve	Game situation in which the ball is put into play at the start of the point with the player positioned behind the baseline and between the extensions of the singles sideline and the centre service mark.	[13]
	Return	Game situation that follows the serve. It is compulsory after the ball has bounced in the adequate service box of the opponent's court.	[14]
	Baseline game	Game situation in which the ball is usually hit after the bounce and the players are positioned close to the baseline.	[13]
	Net game	Game situation in which the ball is played close to the net and usually hit before the bounce. Strokes such as volleys and smashes are characteristic.	[11]
	Passing	Game situation in which the ball is hit, usually after bounce, with the intention of overcoming the opponent positioned to the net.	[13]
Goal	Learning	Exercises aimed at the acquisition of a new skill by the player, which he/she did not have before.	[15]
	Application	Exercises aimed at implementing previously learned, improved and automated skills in game situations.	[16]
General content	Technique	The tennis movement or gesture characterised by its effectiveness, efficiency, stereotype and adaptation.	[17]
	Tactics	The knowledge, understanding and implementation of on-court game adaptations, decision making and shot combinations.	[18]
Special ontent	Service	The shot used in tennis to put the ball in play.	[13]
	Return	The shot hit right after the serve has bounced on the service box.	[14]
	Forehand	A stroke hit on the player's skilled side, usually using only one hand.	[19]
	Backhand	A stroke hit on the unskilled side of the player. It can be performed using 1 or 2 hands.	[20]
	Volleys	A stroke hit during play and before the bounce of the ball.	[11]
	Smash	A stroke hit during play usually performed over the player's head before or after the bounce of the ball.	[11]
	Lob	A stroke hit with a high trajectory which usually aims to pass over the opponent positioned at the net.	[15]
	Drop shot	A stroke that bounces very close to the opponent's net side.	[15]
	Passing	A stroke usually hit after the bounce, with a linear trajectory and the intention of hitting through the opponent who is very close to the net.	[13]
	Topspin	Type of rotation or effect with which the ball is hit so that it clears the net high and has a high, weighted bounce on the opponent's side.	[15]
	Slice	Type of rotation or effect with which the ball so that it goes over the net at low height and has a low bounce on the opponent's side.	[15]
	Flat	Minimum possible spin imparted when hitting the ball.	[21]
	Attack	A stroke played when the player has the initiative of the point.	[22]
	Defence	A stroke played when the opponent has the initiative of the point.	[22]
	Neutral	A stroke played when neither player has the initiative for the point.	[23]
Methodology	Player only	Drill performed with just one player doing the exercise.	[15]
	Hand feeding	Drill performed with the coach feeding balls with the hand to the player.	[3]
	Basket feeding	Drill performed with the coach feeding balls from a basket with the racket to the player.	[16]

(continued)

Table 1. Continued.

Variable		Definition	Adapted from
	Rally with the coach	Drill performed with the coach and the player keeping the ball in play.	13
	Rally between players	Drill performed with the players keeping the ball in play, and the coach standing on one side outside the court lines to put a ball in play when necessary.	13
	Points	Drill performed with conditions similar to those of match play. Scoring is used and it does not require the serve to start the drill.	9
	Match	Drill performed with conditions closest to the real game situation. It resembles the intensity of competition and includes the serve as the initial game situation.	9
Player interaction	Co-operation	Drill in which the goal of both players is related. Each player achieves their goals if the other also does.	24
	Opposition	Drill in which the goal of both players is related, but in an exclusive manner. Each player achieves their goal if the other player does not.	16
	None	Drill in which the objectives of the players are not related. Both goals are independent.	24
Conditions / limitations	Score	Drill which includes limitations related only to the scoring system.	25
	Restrictions	Drill which includes limitations related to the area/zone, stroke, material and movement that challenge the player to find optimal solutions to achieve the goal of the task.	26

Exercise	Game situation	Goal	General Content	Special Content	Training Method	Number of players	Interaction	Conditions/ Limitations
1	Net game	Application	Tactics	Net game Attack	Playing points	3	Collaboration	Points

Figure 1. Example of the codification of a drill using the instrument.

considered that a forehand that adapts to the different effects and speeds of the ball was a key factor to be worked on with the players on-court. In this context, Busuttil et al.[20] also identified the generation of ball speed with the backhand as a special fundamental content in the sessions. Furthermore, the use of slice and topspin effects to improve service accuracy was a special content of great relevance in the training session as pointed out by Chow et al.[21] Fernández-Fernández et al.[36] recommended dedicating sufficient on-court practice time to some of the variables reflected in the "Special content 2" category to assist players in developing a tactical all-court game. Finally, these results also coincide with those proposed by Torres-Luque et al.[12] regarding the importance of the technical and tactical features of the strokes, since aspects such as the type of technical and tactical stroke, the ball rebound zone, the hitting zone and its effectiveness were found crucial for the description of the activity.

The sixth variable, the "method" used in the delivery of the drill, proved to be one of the most reliable. This data allows the coach to better describe the methodological aspect used in the exercise. It coincides with those obtained in previous research in terms of exercises carried out using the hand feeding methodology,[3] the rally between the players,[37] the point play method[38] or the player serving alone method.[39] In all these studies it was concluded that the method used was an aspect that should be taken into account when prescribing the type of exercises to be used depending on factors such as the period of the player's season.

The number of players participating in the drill, which is the seventh variable of the instrument, also showed a high degree of reliability. This is in line with the results obtained by Fernández-Fernández et al.[1] who emphasised the importance of the number of players taking part in an exercise as a crucial aspect in the design and main features of any drill or activity.

The eighth variable, the interaction between players, also obtained a high reliability coefficient. This result coincides with the principles proposed by authors such as Coll[24] in terms of learning in general, Krause et al.[16] as related to exercises based on the opposition of the

Table 2. Coded variables and coding reliability (Krippendorff's alpha).

Variable	Categories	kAlpha	LL 95 % CI	UL 95% CI
Game situation	Serve	0,945	0,939	0,952
	Serve and return			
	Serve and baseline			
	Serve and net			
	Return			
	Return and baseline			
	Baseline game			
	Net game			
	Passing			
	All			
Goal	Learning - Correction	0,730	0,701	0,758
	Stabilisation - Implementation – Match			
General content	Technique	0,873	0,859	0,887
	Tactics			
Special content	Forehand	0,810	0,799	0,842
	Backhand			
	Serve			
	Return			
	Volleys			
	Smash			
	Lob			
	Drop shot			
	Passing			
	Various situations			
Special content 2	Attacking serve + groundstroke	0,802	0,790	0,835
	Attacking serve + net shot			
	Defensive serve + groundstroke			
	Neutral serve + groundstroke			
	Attacking return + groundstroke			
	Attacking return + net shot			
	Defensive return + groundstroke			
	Neutral return + groundstroke			
	Attacking groundstroke			
	Attacking groundstroke + net shot			
	Defensive baseline			
	Neutral baseline shot			
	Attacking mid court + net shot			
	Attacking at the net			
	Defending at the net			
	Points			
Method	Player only	0,947	0,940	0,954
	Hand feeding			
	Basket feeding			
	Rally with the coach			
	Rally between players			
	Points			
	Match			
No. of players	Individual	0,956	0,936	0,974
	Group			
Player interaction	Co-operation	0,907	0,896	0,919
	Opposition			
	None			
Conditions / limitations	Score	0,807	0,785	0,829
	Restrictions			

players, Murphy et al.[9] in reference to collaborative exercises or, also, with those of Fernández-Fernández et al.[40] in relation to the absence of interaction between players.

The last variable, the conditions and limitations of the drill, also obtained considerably high values in the reliability analysis. This result is in line with the suggestions of Mendes et al.[41] and Sánchez-Pay et al.[42] who consider crucial to identify on-court exercises according to whether they use conditions and constraints or not. This is a fundamental variable, given the great relevance of the application of an ecological perspective and the manipulation of these limitations in a "constraints led approach" to different sports such as volleyball,[43] touch football,[44] golf, sailing and football.[45] In all scenarios, the aim has been to contribute to the autonomy of the athlete by prescribing activities that will help adapt to the multiple situations that occur during the process of acquisition of a skill, even in a tennis shot, which could be seen as a closed skill in nature, such as the serve.[45]

Conclusions

As for the practical applications of this research, this study has presented the stages of creation of a valid and reliable instrument for the control of the content of the technical-tactical training sessions on-court that can be used by tennis coaches and other supporting staff. The results of the reliability analysis of the nine variables of the instrument allow us to state that this is a reliable tool for achieving the goal of the study. Coaches have an instrument that will allow them to improve the planning and programming of on-court exercise prescription in order to contribute more efficiently to the development of players regardless of their level of play.

Study limitations and further studies

As it has been stated throughout this research, although the objectives, hypotheses, design, methodology and analyses are similar to studies carried out previously, our work is not without limitations. On the one hand, it should be pointed out that this is a new research in the tennis domain which, therefore, lacks a large number of previous studies that could serve as a broad theoretical framework on which to extensively base the research question. Furthermore, this scarcity of previous studies has meant that the design and validation of the instrument has been carried out using a certain number of coaches, specialists in sports science applied to tennis, and high-performance players which, obviously, could have been greater or could have a different profile to that of the sample of experts and players used.

The results obtained in our work open up different lines of research that we consider appropriate to suggest. On the one hand, subsequent studies could use this validated tool to accurately quantify the technical-tactical content of training sessions on-court in order to improve the criteria for prescribing and scheduling sessions. On the other hand, training content and quantifications could be compared depending on variables such as level of play, gender, period of the season, and playing surface, among others. Finally, studies could also be carried out in which the data obtained using this instrument could be used in combination with data from other tools that allow to monitor training variables such as heart rate, movements, RPE, etc. By doing this, through the combined use of several validated instruments, it would be possible to have more reliable data that would allow for a better understanding of the main characteristics of the variables involved in on-court tennis training.

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