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Original Article

Goodbye to serve and volley style of play: or do we need to change sport performance priorities?

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Abstract
Problem elaboration: Whereas the official game statistics represent the player's partial performance, the overall performance quality contains all factors of overall quality evaluated by experts. Therefore, it is essential to determine their opinion on the significance of coefficients for all the criteria which are defined with respect to a particular playing style in tennis. **Intended purpose:** The aim of this study was to establish and explain offence and defence priorities for elite serve-volley players. **Approach:** On the basis of expertise of seven tennis experts, this paper aims to determine the relative importance coefficients regarding serve-volley style of play for eighteen overall performance evaluation criteria. From each given matrix, importance coefficient vectors defined by each of the experts were calculated by means of the Geometric Mean Method and used to form an importance coefficient matrix for a serve-volley player. For this purpose, the vectors of arithmetic means and standard deviations were computed from the procured indices. **Findings:** The top of the offence hierarchical structure indicates that the *first serve quality* and the *second serve quality* have very high importance (AM 0.192; AM 0.166), whereas the *net shots quality* has high importance (AM 0.146). In addition, the top of the defence hierarchical structure indicates that the *second serve return quality* has very high importance (AM 0.229), the *first serve return quality* has high importance (AM 0.178), whereas the *defence backhand quality* has medium to high importance (AM 0.145). **Conclusion:** The study has defined defence and offence priorities for the serve-volley style of play. The findings of this study can be implemented by coaches in their selection of suitable tactical solutions and the optimization of the training process among elite tennis players.
Key words: multi-criteria decision making, elite tennis, hierarchies in sport, sports performance

Introduction

A new way of thinking about the behaviour of sports games in terms of the theory of dynamic systems, is gaining more importance among scientists (McGarry et al., 1999, McGarry et al., 2002), as well as in Palut and Zanone (2005) for a demonstration of tennis as a dynamic system. Accordingly, in order to explain the above dynamic interaction processes, it is necessary to connect the quantitative research which dominate in sports games with qualitative research. This study is the result of continued efforts to deal with the construction and evaluation of methods of overall quality assessment for elite tennis players (Đurović et al., 2015). Previous studies mainly tackled individual match details or match statistics (O'Donoghue, 2002; O'Donoghue & Brown, 2008; Barnett & Clarke, 2005; Djurovic et al., 2009; Filipcic et al., 2015; Meffert et al., 2021). This type of descriptive statistics does not contain any data on the sequential context of the game (for example, the series of actions that led to a Winner or Unforced Error), or any other data concerning the situational context of the specific action (for example, whether the observed phenomenon is a product of a counter-attack or a static position) (Lames & McGarry, 2007). Whereas the official game statistics represent the player's partial performance, the overall performance quality contains all factors of overall quality assessed by experts (Trninic, 2006; Trninic & Dizdar, 2000). Therefore, it is essential to determine their opinion on the significance of coefficients (weights, ponders) for all the criteria which are defined with regard to a particular playing style (Trninic et al., 1999; Trninic & Dizdar, 2000). In modern tennis, coaches and scientists can clearly distinguish four dominant types of motor behaviour (Roetert & Kovacs, 2011).

In this study, priorities for serve-volley style using the AHP method were analysed. By observing elite tennis players, from the Open Era to date, the number of specialists who prefer serve-volley style has decreased. A small number of tournaments on grass, higher psychophysical demands, higher quality of passing shots and transition attacks contributed to the above-mentioned situation. So, a study by Barnett & Pollard (2007) shows that players' performances are definitely affected by the court surface. The Fernandez et al. (2006) study singled out court surface, gender, ball type, match duration, and the style of play as the main influences on the proportion of aerobic to anaerobic demands on players. The aim of this study was to establish and explain offence and defence priorities for elite serve-volley players.

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Material & methods

The Criteria for the Evaluation of Tennis Serve-Volley Players' overall Quality – a Proposed AHP Model

A model for the assessment of tennis serve-volley players' overall quality was proposed and described in detail by Đurović et al., 2015 study. The proposed criteria for the assessment of overall quality of tennis players, primarily playing the following style of play: serve-volley, modern defence baseliner, offence baseliner, all-court player (displayed in Figure 1 & 2) is as follows:

1) The following ten criteria are proposed for the evaluation of the overall quality of elite tennis players in terms of offence: 1. first serve quality; 2. second serve quality; 3. net game movement quality; 4. net game shots quality; 5. baseline movement quality / offence tasks; 6. offence forehand quality; 7. offence backhand quality; 8. quality of initiative in rallies; 9. transition attack quality; 10. quality of playing multiple styles
2) The following eight criteria are proposed for the evaluation of the overall quality of elite tennis players in terms of defence: 1. first serve return quality; 2. second serve return quality; 3. passing shots quality; 4. baseline movement quality / defence tasks; 5. defence forehand quality; 6. defence backhand quality; 7. performance quality in long rallies; 8. quality of uncommon situation shots

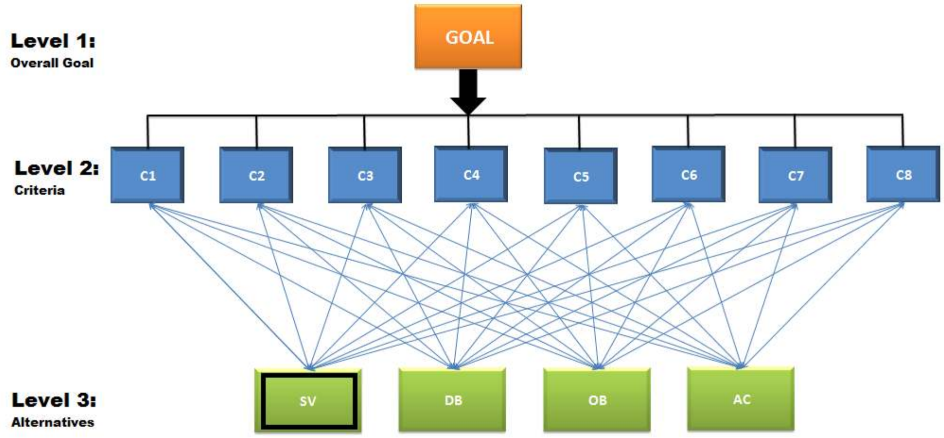

Figure 1 Structure of an AHP Model for defence.

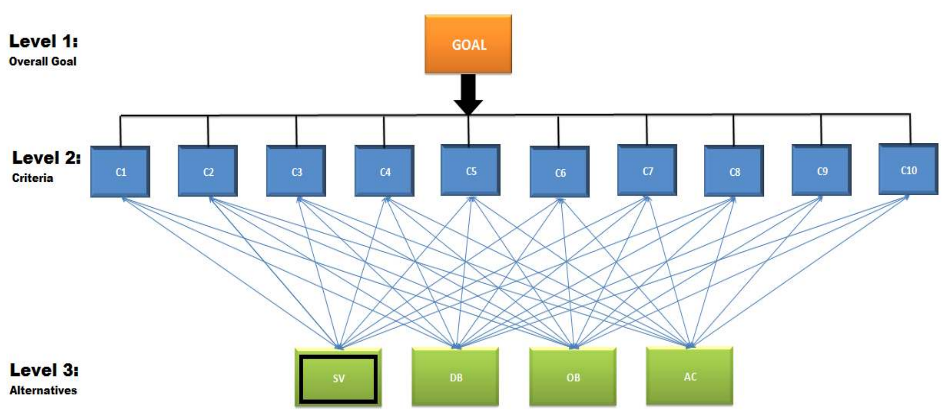

Figure 2 Structuring an AHP Model for offence

Tennis experts

Seven individuals, who are generally perceived as tennis experts/judges, included in this study were trainers that had met at least one of the three requirements: I. one of the top four places at an International competition (Fed Cup, Davis Cup, Grand Slam, Hopman Cup); II. One of the first four places in an ITF Pro Circuit tournament; III. one of the top two places in the National Championship as a head coach.

Data Acquisition and Processing Methods

Coefficients of importance within the defined set of offence and defence criteria for the overall quality of serve-volley players were determined by means of the AHP (Analytic Hierarchy Process) method for the multi-criteria decision making (Saaty, 1987; Dezman et al., 2001; Hraste et al., 2008). AHP method was implemented through the following four steps:

1. Each included expert attributed a numerical value to the significance of every observed criterion by comparing it with the set of other criteria and by recording the relative significance for serve & volley players. For instance, if criterion A is twice as important as criterion B, then value 2 was assigned to the position AB in the matrix of the pairwise comparisons, whereas the value ½ was assigned to the position BA. Therefore, every tennis expert yielded a square reciprocal matrix of grades for all serve-volley players;

2. The criterion coefficient of importance, which was derived from each matrix, was completed by employing the geometric mean method (GMM). Thus, one vector of the coefficient of importance was obtained for each criterion from every included expert and the matrix of coefficients of importance was established for all serve-volley players;

3. The vectors of arithmetic means and the standard deviations of importance coefficients for this particular style of play were subsequently computed from the obtained matrices (1 vector for defence, 1 vector for offence).

4. The vectors of arithmetic means of the importance coefficients were subsequently rescaled so that their sum equals one.

The level of credibility of the determined importance coefficients (weights) of the performance criteria for the serve-volley style was defined by computing the following: correlation means of experts' (RMS – rank means scores) agreement (interobservers' agreement) and Cronbach's reliability coefficient (α).

In fact, the eigenvector method, excluding the determination of the criteria weights, can be used as a basis for one of the most generally acclaimed decision-making methods, i.e., the Analytic Hierarchy Process (AHP). By way of said method, the designated decision maker (DM) evaluates the relative significance of two criteria and compares the significance of all possible sets of criteria. The number of evaluations expected from the decision maker is equal to the number of combinations without the replacement of the second order from *n* elements,

i.e. $\binom{n}{2} = \frac{n \cdot (n-1)}{2}$, where *n* is the number of criteria.

In order to define the criteria weights, the DM is required to estimate the relative importance of each set of criteria (X_i, X_j). The DM must opt for one of the following statements: both criteria are equally significant; criterion X_i is more significant than X_j; criterion X_j is more significant than X_i. The selection of any of these statements implies the relevant quantification of the criteria weight's ratio $a_{ij} = \frac{w_i}{w_j}$.

The original Saaty's scale for expressing these intensities consists of five degrees and four intermediate values on a scale from 1 to 9. Provided that criterion *i* has been attributed one of the said non-zero numbers when compared with criterion *j*, then *j* has the reciprocal value when compared with *i*. By using this scale, the importance ratios for all sets of criteria are defined and the elements of matrix *A* are merely estimates a_{ij}.

Matrix *A* is:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \dots & \dots & \dots & \dots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{bmatrix} \quad (1)$$

This reciprocal matrix contains all positive elements and the reciprocal property $a_{ij} = \frac{1}{a_{ji}}$; i.e., the element above the main diagonal equals the reciprocal value of the symmetric element below the main diagonal, since the following equation applies: $\frac{w_i}{w_j} = \frac{1}{w_j/w_i}$. In fact, if criterion *i* is twice as significant as criterion *k* ($a_{ik} = 2$) and criterion *k* is three times more important than criterion *j* ($a_{kj} = 3$), it entails that criterion *i* is six times more important than criterion *j*. If the elements of matrix *A* represent the exact ratio of the criteria weights, this condition applies. In fact, in that case the following equation holds:

$$a_{ij} = \frac{w_i}{w_j} = \frac{w_i / w_k}{w_j / w_k} = \frac{w_i}{w_k} \cdot \frac{w_k}{w_j} = a_{ik} \cdot a_{kj}$$

However, this property implies that the evaluations of importance ratios are completely consistent, which is rarely the case, specifically since we restrain the DM with the Saaty's scale.

The following is one of the ways to derive the criteria weights w_j from the matrix *A*. By multiplying *A* by the vector of weights *W*, the following equation applies:

$$A \cdot W = n \cdot W \quad \text{or} \quad (A - n \cdot I) \cdot W = 0 \quad (2)$$

Hence, in order to derive the scale from the matrix of ratios, the problem $(A - n \cdot I) \cdot W = 0$ must be solved. This is referred to as the system of homogeneous linear equations. It has a nontrivial solution if and only if the determinant of (*A* - *nI*) is eliminated, that is, *n* is the eigenvalue of *A*. In this case, *A* has a unit rank since every

row is a perpetual multiple of the first row (the second row can clearly be obtained by multiplying the first row with w_2 / w_1, the third by multiplying the first with w_3 / w_1, and so on). Therefore, all its eigenvalues except one are zero. The sum of eigenvalues of a matrix is equal to its trace, the sum of its diagonal elements. In this case, the trace of A is equal to n. Hence, n is an eigenvalue of A, and one has a nontrivial solution. The above-mentioned matrix of ratios of measurements is consistent. Its terms meet the requirements of the equation $a_{ij} = a_{ik} \cdot a_{kj}$, for all i, j, k. It should be noted that the ratio of two readings from a ratio scale is an absolute (dimensionless) number. If we apply judgment, this absolute number would be estimated by using Saaty's scale. When we apply judgment, consistency can no longer be guaranteed. Therefore, the precise values of w_i/w_j are unknown and must be estimated. Human judgment cannot be accurate to the extent that the equation $a_{ij} = a_{ik} \cdot a_{kj}$ is completely met. Generally, in any matrix small perturbations of coefficients imply small perturbations in eigenvalues. As a result, we choose the maximum eigenvalue from all eigenvalues of A (there are n of them in this case), and the difference between the maximum eigenvalue and number n (which is a unique eigenvalue in the completely consistent case) is used for measuring the consistency (or inconsistency) of evaluations provided in matrix A.
The consistency index of a matrix is presented by:

$$C\ I = \frac{\lambda_{\max} - n}{n-1} \tag{3}$$

where $\lambda_{\max}$ is the largest eigenvalue of A, and w can be obtained by solving the presented system of linear equations. The consistency index is compared to a value derived by generating random reciprocal matrices of the same size to yield a consistency ratio (CR) which is supposed to have the same interpretation regardless of the size of the matrix.
The consistency ratio is obtained by forming the ratio of CI and the appropriate RI, i.e.:

$$CR = CI / RI \tag{4}$$

A consistency ratio of 0.1 or less is generally considered acceptable. If CR is larger than expected, it is vital to explore the rationale behind the unacceptably high discrepancies of judgments. The establishment of the maximum eigenvalue □$_{max}$ is a fairly complex issue. In fact, the system (2) has a nontrivial solution only when the determinant of (A - nI) is eliminated. Therefore, in order to determine the eigenvalues of matrix A, the following equation must be solved:

$$\det(A - \lambda \cdot I) = 0 \tag{5}$$

This is the algebraic equation of n-th degree, which is not easily solvable. Hence, in order to determine the eigenvalues of matrix A (and consequently the coefficients of vector W), we can utilize specific approximation methods or a software (Expert Choice).
The criteria weights, whose ratios are presented in matrix A, can be obtained by tackling the following system of equations:

$$(A - \lambda_{\max} \cdot I) \cdot W = 0$$
$$w_i > 0,\ i = 1, 2, \ldots, n \tag{6}$$
$$\sum_{i=1}^{n} w_i = 1 ,$$

As a result, the aim is to obtain the solutions with the additional requirements of non-negativity, and to normalize the weights (their sum must be 1).

Results

Figure 3 presents arithmetic means (AS) and standard deviations (SD) of grades, which are obtained from 7 judges, for the relative significance of 18 criteria. The average Cronbach's measure of reliability (α) equals 0.968, while the average correlation of the judges ranges from 0.856 to 0.875, and indicates a high level of interobservers' agreement.
Serve-volley player (offence) – QFS first serve quality and QSS second serve quality have very high importance (AS 0.192; AS 0.166), QNS net shots quality has high importance (AS 0.146), QNM net game movement quality and QOF offence forehand quality have medium importance (AS 0.098; AS 0.093), QTIR quality of initiative in rallies has low to medium importance (AS 0.082), QOB offence backhand quality and QBM baseline movement quality / offence tasks have low importance (AS 0.068; AS 0.066), whereas QTA transition attack quality & QPMS quality of playing multiple styles have very low importance (AS 0.044; AS 0.044).
Serve-volley player (defence) – QSSR second serve return quality has very high importance (AS 0.229), QFSR first serve return quality has high importance (AS 0.178), QDB defence backhand quality has medium to high importance (AS 0.145), QBM-DT movement quality / defence tasks and QDF defence forehand quality have medium importance (AS 0.129; AS 0.119), QPS passing shots quality and QPLR performance quality in long rallies have low to medium importance (AS 0.076; AS 0.074), whereas QUSS quality of uncommon situation shots has low importance (0.049).

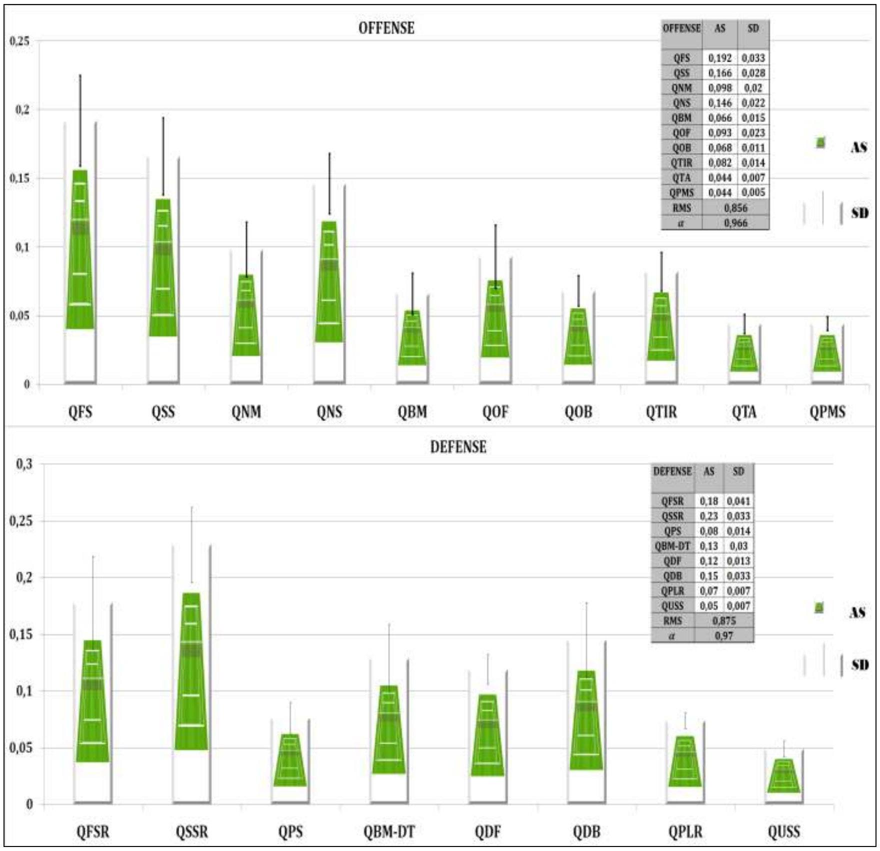

Figure 3
Arithmetic means (AS), standard deviations (SD), relative importance coefficients of the assessments provided by experts for the relative importance of eighteen performance evaluation criteria regarding a serve-volley tennis player, as well as the correlation means of experts (RMS) & Cronbach's alpha (α)
***Legend**: QPMS – quality of playing multiple styles; QFS – first serve quality; QTIR – quality of initiative in rallies; QOF – offence forehand quality; QTA – transition attack quality; QBM – baseline movement quality – offence tasks; QOB – offence backhand quality; QSS – second serve quality; QNS – net game shots quality; QNM – net game movement quality; QBM-DT – baseline movement quality – defence tasks; QFSR – first serve return quality; QPLR – performance quality in long rallies; QDF – defence forehand quality; QSSR – second serve return quality; QDB – defence backhand quality; QPS – passing shots quality; QUSS – quality of uncommonly situation shots*

Table 1 The proposed training structure – importance weights for a serve-volley tennis player in offence and defence

Criteria	Importance weight	Criteria	Importance weight
QFS	**Very high importance**	**QSSR**	**Very high importance**
QSS	**Very high importance**	**QFSR**	**High importance**
QNS	**High importance**	**QDB**	**Medium to high importance**
QNM	Medium importance	QBM-DT	Medium importance
QOF	Medium importance	QDF	Medium importance
QTIR	Low to medium importance	QPS	Low to medium importance
QOB	Low importance	QPLR	Low to medium importance
QBM	Low importance	QUSS	Low importance
QTA	Very low importance		
QPMS	Very low importance		
OFFENCE		DEFENCE	

Legend: QPMS – quality of playing multiple styles; QFS – first serve quality; QTIR – quality of initiative in rallies; QOF – offence forehand quality; QTA – transition attack quality; QBM – baseline movement quality – offence tasks; QOB – offence backhand quality; QSS – second serve quality; QNS – net game shots quality; QNM – net game movement quality; QBM-DT – baseline movement quality – defence tasks; QFSR – first serve return quality; QPLR – performance quality in long rallies; QDF – defence forehand quality; QSSR – second serve return quality; QDB – defence backhand quality; QPS – passing shots quality; QUSS – quality of uncommonly situation shots

Discussion

The findings derived from this study evidently indicate that the primary offence task is a short-rally play (finishing point within three/four shots) (Fernandez et al., 2006). By analysing the first five game priorities (first serve quality, second serve quality, net shots quality, second serve return quality and first serve return quality), it is discernible why the serve-volley players put extensive immediate pressure on their opponents (Roetert & Kovacs, 2011). Body height could certainly become the most considerable advantage in offence tasks, but also a substantial disadvantage in defence tasks (Vaverka & Cernosek, 2013). In particular, due to the specific body stature and low baseline situational-quickness, opponents are using tactical solutions on their backhand side (Liu, 2014).

Serve-volley players are renowned for their high serve rating, which raises the following questions: what seems to be the issue and what is happening with the serve return rating? The available official data indicate that serve-volley players are generally far from the top in the Return Standings criterion (which subsumes criteria such as first serve return points won percentage, second serve return points won percentage, return games won percentage, break points converted percentage). This study indicates that the two most important defence criteria are related to the Return of Serve. Therefore, coaches need to create and implement an effective training programme while targeting the key elements (main priorities). While developing the programme, the players' different style of the serve return and the level of training must also be observed (Djurovic et al., 2014). The data from this study could be used in terms of shaping the technical-tactical preparation for serve & volley players (Liu, 2014). According to Trninic et al. (2009; 2010), the shaping of the training process is preferable to simultaneously working on developing technical-tactical and specific psychosocial characteristics.

The quality of the defence backhand has medium to high importance for serve-volley players because this kind of shot is a very good solution for neutralization of an aggressive opponent's shots. This style of play is beneficial when playing on faster courts, such as Wimbledon and the US Open.

This research had a few limitations. Several coaches pointed out that it was laborious work in which it was exceptionally difficult to maintain concentration (due to the high number of criteria). Another limitation that may appear in future research is the ratio of inconsistency ($CR \leq 0.10$). Previous studies in other sports have demonstrated reduced objectivity indicators for game positions (Trninic et al., 2000, Trninic et al., 2002, Hraste et al., 2010). Similarly, we can expect low indicators of objectivity for serve-volley players in the future studies. In addition, the conventional methods of explaining the success in sports games ignore the dynamic interactions that the sports games are composed of (Lames & McGarry, 2007). The authors believe that the present assumptions ignore the interaction between the player and the opponents, which are important sources of variability within sports games. Therefore, future research may focus on non-linear and hybrid systems, the detection of neurotransmitter and hormonal factors, and the factors of diversity of motor programmes that determine individual quality differences in elite players (Trninic et al., 2010).

Conclusion

This study has defined defence and offence priorities for the serve-volley style of play. In addition, it would be essential to establish priorities for other styles of play and make a comparative analysis. The measurement of the overall player's efficiency in a tennis match was one of the main issues in the previous studies. The Hierarchical AHP model for solving multi-criteria decisions assists with the selection of the optimum solution among several alternatives across multiple criteria. The proposed model is not complete nor exhaustive but should be acknowledged as a starting point for empirical studies on the basis of which the model can be further modified and upgraded. Coaches must devise the training process so as to incorporate the most important offence criteria with the most important defence criteria, while concomitantly working on specific psychosocial criteria. The training system which incorporates physiology, psychology, biomechanics and tennis criteria allows the development of new neural programmes and training progress measurements. Assuming that several external factors (slower courts, slower balls, better fitness) affect our findings is rather discouraging. Instead, our proposed system is quite encouraging as it focusses on the circumstances that can be influenced (better training process where the coaches can target priorities). The findings of this study can be implemented by coaches in their selection of suitable tactical solutions and the optimization of the training process among elite tennis players.

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