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THE FACTOR STRUCTURE OF TECHNICAL AND TACTICAL ACTIVITY OF THE WORLD TOP TABLE TENNIS PLAYERS DURING MATCHES

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Abstract

The survey conducted for determining the fundamental dimensions of the space of technical and tactical activities the 154 matches in which 77 players have performed in the finals at the Olympic Games held in Beijing in 2008. were analyzed. Technical and tactical activity has been described through the set of 16 variables.

The factor model described 75.9659% of the total registered variance. The factor analysis of the matches data produced the factor structure with six fundamental dimensions that are interpreted as follows: The success of the players in the match factor, The match duration factor, The morphological dimensionality factor, The efficiency of the players in the defense factor, The player efficiency in the counterattack factor and The service efficiency in the match factor.

Keywords: Olympics in Beijing / technical and tactical activity / factor model.

Introduction

In the systematic training process, which table tennis players are subjected to, the analysis of competitive activities is the basis for the planning and programming of training. In this way, objective information about the presence and efficiency of execution of the basic technical and tactical elements in table-tennis game are obtained. Based upon these data and their analysis the relevant guidelines for providing initial and stepwise selection in the table-tennis sports can be identified, as well as upon the information making possible to rationally plan for the training process.The basis for such training approach should be the model's characteristics of elite table tennis players, which are currently unknown.This requirement is further compounded by lack of knowledge of the structure of space the technical and tactical elements of the game are manifested in.

Therefore, the research objectives are identified as a need for exploration of the structure of technical and tactical activities of top players in the world.In fact, virtually infinite number of different ways of performing technical and tactical elements, used by top table tennis players in the world, certainly can not be described through a limited set of fundamental skills, which were necessary to identify using appropriate methodology. Identification of the latent dimensions responsible for the variability that may occur in the observed technical and tactical elements, was the main task of the research. In this sense, conceptual apparatus adequate tothe needof exactexploitationof latent structure has been applied in the research, belonging to the multivariate statistical techniques and procedures.

In the scientific papers of researchers who analyzed the technical and tactical activity of table tennis players in the competition conditions prevailing description of athlete performance table-tennis players in major competitions - the Olympic Games and other major international tournaments (Cai, 1996).Thus, the analysis of women's singles at the 43rd World Table Tennis Championship points to the superiority of women's teams of China, both in technical and tactical sense, and in terms of mental qualities improving every day.The comparative analysis of Chinese and European players who have played in the doubles competition was conducted at the same competition (Tang, 1997). It was pointed out that the technique in capturing the position of service attacks, as well as for the defense of the service, were the main determinant of success in the game.The individual techniques of top players were analyzed - Ryu Seungmina during the finals at the 28th Olympic Games held in Athens (Hao et al., 2007). The analysis included semi-final and final matches, and have used the method of documentary review, video observation, calculation of the index and the three-phase mathematical description of the statistical techniques of technical-tactical activities.

Thevery scarce research handle technical and tactical elements of the top players in that table tennis surely includingZhang research (Zhang, 2006) in which the success of the Chinese table tennis players is primarily attributed to the training of tactical improvementof players quality. Practice tasks are carefully designed based on quantitative indicators which are often science-based analysis, the authors illustrate the description of the competitive behavior of players upon three levels of mastery. This work should certainly include the analysis carried out on the population of Chinese junior table-tennis players (Li et al., 2000).

Results of the factors analysis affecting the victory or the defeat of table-tennis matches may be important for this study (Wu et al., 1998). Authors in conclusionof the analysis included the top table tennis players emphasize that the results of the top sports results can only be achieved with significant outstanding voluntary component that should be followed by other psychological characteristics combined with excellent technique, tactical and physical training. Interestingly, the survey for the identification of items had the most significant factor influencing the effective playing table tennis (Wu and Zhang, 1993). The authors have identified the speed and spin as key factors in the study that proved that they are in a highly significant functional associations. The instrumentarium was used for research purposes, which is specially developed for the quantitative determination of the relevant spin parameters, which application came across some interesting facts about the connection between the level of mastery of sports players, physical properties of the racket, hand movements and techniques of spin intensity (Wu et al., 1998).

Generalization and fusion factors affecting the efficiency of table tennis players in terms of sports competition was the subject of the research conducted by Raz (Raz, 1991). The author emphasizes the need to lead the player to a state that maximizes his potential by developing individual methods.

Materials and Methods

The study was designed as observational, exploratory, *ex post facto* study, which aims to investigate the structure of the space in which it manifests technical-tactical activities of top table tennis players in terms of sports competition.

From the population of top table tennis players for the purpose of research was reviewed a sample of respondents including players participants in the final tournament of the Olympic Games held in Beijing in 2008. The effective sample of respondents are 77 players, which along with the fact that these are the best players in the world, is the sample on which it is possible to apply appropriate statistical procedures.

The sample was formed of 77 matches, which in statistical terms is a large sample needed for of relevant conclusions. Each of the matches was analyzed twice, for the winner and for the defeted, which makes the effective sample of 154 matches observation unit.

For each of the contestants were collected data in the following variables: the country a player comes from - PSTATE, Age of players - PAGE, Body mass of players - PBM, Body height of player - PBH, Body mass index of players - PBMI, Dominant hand players - PDH, Number of matches played by players - PNOMATCHS, Number of sets played by player - PNOGAMES, Final standings-ranked player - and PPLACER Players category - PCAT.

Matches were analyzed as described by the following variables: outcome of the match - MRESULT, round competition - MROUND, number of sets in a match - MNOGAMES, duration of a match - MTIME, conquered points in the match - MPTS, total service points won in the match - MSERVICE, percentage of points won by service in the match - MSERVICE%, total points scored by the third match ball - M3BALL, percentage of points won by third ball of the match - M3BALL%[1], total points scored in the match napadom2 - MATTACKING, attack percentage of points won in the match - MATTACKING%[2], total points scored defense in the match - MDEFENDING, percentage of points scored in the match - MDEFENDING%, total points scored in the match counterattack - MCTRATTACKING, percentage of points scored in the match counterattack - MCTRATTACKING%, total points scored in the match in another way - MOTHER and the percentage of points won in another way in the match - MOTHER%.

All collected data were analyzed according to the methodology of statistical analysis required to make judgments about relevant research hypotheses.

Statistical processing included: descriptive statistical analysis, analysis of quantitative differences, correlation analysis and multivariate analysis.

Results and Discussion

Table 1. Eige

Value	Eigenvalues			
	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	3.555291	22.22057	3.55529	22.22057
2	2.692100	16.82563	6.24739	39.04619
3	2.019984	12.62490	8.26737	51.67109
4	1.441921	9.01201	9.70930	60.68310
5	1.357672	8.48545	11.06697	69.16855
6	1.087576	6.79735	12.15454	75.96590

[1] A term used to describe the activities of players who served, and who often scores points by so called third ball, with service is the first ball and return service the second ball.

[2] Point scored by attacking - severe blow, top spin, aggressive block, etc.

Table 2. Factor loadings

Variable	Factor Loadings Normalized Varimax					
	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
MRESULT	0.559738	0.043839	-0.172062	0.406121	0.048737	0.353401
MROUND	-0.706194	0.009909	-0.123921	0.343254	0.077410	0.265567
MNOGAMES	-0.199139	0.839389	0.009372	0.291993	-0.212467	0.145371
MTIME	0.040351	0.857774	0.168898	0.125863	-0.221481	0.069532
MSERVICE	-0.129454	0.232249	-0.291623	0.428373	0.031862	0.520290
M3BALL	-0.044935	-0.010332	0.047909	-0.007092	-0.071928	0.862389
MATTACKING	0.158826	0.836666	-0.082284	-0.161599	0.184978	-0.038974
MDEFENDING	-0.069100	0.123396	0.167368	0.861295	0.040607	-0.005679
MCTRATTACKING	0.155259	0.022564	0.111560	0.005380	-0.847469	-0.022327
MOTHER	0.012286	0.108838	-0.084500	-0.036633	-0.770182	0.040540
PAGE	0.186961	0.219639	0.342382	-0.382833	0.141163	0.434434
PBM	-0.147022	-0.051734	0.900130	0.095835	0.003849	0.020265
PBH	0.033275	0.109283	0.896346	-0.015178	-0.033385	-0.025453
PNOMATCHS	0.938130	-0.081900	-0.042796	0.006328	-0.072801	0.035904
PNOGAMES	0.902600	0.082250	-0.042712	0.041437	-0.058435	0.086262
PPLACER	-0.878287	-0.035501	0.025189	0.139078	0.046936	0.111812

In addition to the body mass index variable, this analysis excluded variables that represent aggregate indicators, such as variable points scored in the match, and the nature of any performance indicators are all expressed in percentage variables. Their inclusion in the analysis of the correlation matrix coused collapse during its transformation process, making it impossible for further analysis.

Factor analysis was conducted into the manifest space defined by 16 research variables. The results point out that the foundation of latent structure of space determined by six fundamental dimensions (Table 1). Such a model described 75.9659% of the total variance registered.

In the model of latent dimensions of the analyzed area 1. Varimax factor extracted drew 22.2205% of the total variance registered. This factor is significantly saturated five manifest variables analyzed (Table 2). Saliant values of this latent dimension projected the following variables:

- Number of games played by player - PNOMATCHS (0.93813)
- Number of sets played by player- PNOGAMES (0.9026)
- The final rank of players - PPLACER (-0.878287)
- The competition turn - MROUND (-0.706194)
- Outcome of the match - MRESULT (0.559738)

The structure of the first extracted Varimax factor indicates the logical relationships of variables that are logically consistent and positive, so that the latent dimensions can be interpreted as a factor of the players success.

Further analysis of the projection of variables that have been saturated by this factor below the threshold of statistical significance, it can be concluded that the success of players displayed a tendency to bind with the indicators of efficiency in service, in the attack and counterattack. Of interest for further analysis of the trends and performance of connecting older players, which indicates the importance of experience, but less pronounced body mass,

which probably speaks for intense physical training and sports loads of successful contestants. In the latent dimensions analyzed model space 2. extracted Varimax factor drew 16.82563% of the total variance registered. This factor is significantly saturated 3 manifest variables analyzed (Table 2). Saliant values of this latent dimension projected the following variables:

- Duration of a match - MTIME (0.857774)
- The number of sets in a match - MNOGAMES (0.839389)
- Total points scored in the match attack - MATTACKING (0.836666)

The nature of the leading variables saliant other saturated projections extracted Varimax factor allows to be interpreted as a factor of the match. Of interest for the analysis is the fact that higher scores on this factor, and longer duration of the match, the players scoring more points by attacking.

In the model, the latent dimensions of the analyzed space 3. Varimax factor extracted drew 12.6249% of the total variance registered. This factor is significantly saturated 3 manifest variables analyzed (Table 2). Saliant values of this latent dimension projected the following variables:

- The weight of players - PBM (0.90013)
- Body height of player - PBH (0.896346)

In addition to these variables on this factor has projected unsaliant, but still statistically significant and the value of the variable players age - PAGE (0.342382).

The structure and relationships between variables saturated third extracted Varimax factor allow to conclude that this is a factor of morphological dimensionality.

Analysis of the relationship of this factor with the technical and tactical efficacy variables talks about the tendency that players with lower scores on this factor are characterized by a higher probability of winning the match and achieving greater efficiency in service points, but with reduced efficiency in achieving the elements of the defense points.

In the model, the latent dimensions of the analyzed area fourth Varimax factor extracted drew 9.01201% of the total variance registered. This factor is significantly saturated five manifest variables analyzed (Table 2). Saliant values of the latent variable dimension projected total points scored in the match defending - MDEFENDING (0.86 295).

In addition to the variables in this factor were projected unsaliant, but still statistically significant values of the following variables:

- Total points scored in the match service - MSERVICE (0.428373)
- Outcome of the match - MRESULT (0.406121)
- Age of players - PAGE (-0.382833)
- Turn the competition - MROUND (0.343254)

Leading technical and tactical efficiency variable saturated saliant fourth Varimax factor determines its nature, and therefore the latent dimension is defined as the efficiency factor of players in defense.

Interesting are the functional relationships that can be seen from the structure factor. The players who have a viable defense and have a high probability of being more efficient in service. All this follows the younger chronological agebut also the more likely winning the match.

In the model, the latent dimensions of the analyzed area fifth Varimax factor extracted drew 8.48545% of the total variance registered. This factor is significantly saturatedin 2 manifest variables analyzed (Table 2). Saliant values of this latent dimension projected the following variables:

- Total points scored in the match counterattack - MCTRATTACKING (-0.847469)
- Total points scored in the match inanother way - MSERVICE (0.52029)
- Age of players - PAGE (0.434434)

In addition to these variables on this factor is projected unsaliant, but still statistically significant and the value of the variable outcome of the match - MRESULT (0.353401).

The first two variables that saliant projections saturated sixth extracted Varimax factor are functional in high regard. The nature of these variables requires their thorough consideration, because the service is the first shot of the set, which is to a large extent determined the development of the battle that follows.

Efficiency of service is reflected primarily through direct scoring points, but also by bringing the opponent in a subordinate position, which usually manifests itself in points scored by third ball. In analyzing the nature of this factor should be kept in mind that the variable efficiency of the service is relatively high projections connected with three latent dimensions, which results in a reduction of its projection on the factor that is interpreted. Above leads to the conclusion that it is a factor of efficiency of the service.

Players with higher scores on this factor and the older players have an increased probability of winning the match.

Conclusion

The study characteredas the observational exploratory *ex post facto* study investigated the structure of space in which to manifest technical and tactical activities of top table tennis players in terms of sports competition.

The survey was conducted among 77 players who participated in the final tournament of table tennis competition at the Olympic Games held in Beijing in 2008. The sample analyzed included 154 matches observation unit and analyzed 846 sets. Each of the players has been described in more than 9 variables. Technical and tactical activities of players in matches and sets was described by a set of 17 variables.

In terms of basic research, where the goal was tasked to be selected on the basis of technical and tactical elements, performed by a top table tennis players in terms of competition, provide insight into the structure of the space of technical and tactical actions, it was concluded that it is fully achieved.

The factor analysis of matches data produced a factor structure with six fundamental dimensions that are interpreted as follows:

- The performance of players in the tournament factor
- The match duration factor,
- The morphological dimensionality factor,
- The efficiency defenders factor,
- The efficiency of players in counterattack factor and
- The efficiency service in the match factor.

The fact that the study included all the players and all the matches of the final tournament in the Olympic table tennis of the Olympic Games held in Beijing in 2008, gives this study special a significance. We can practically talk about the research that is conducted on a sample, but the population is really the best athletes in the world. Although the selection of variables was dictated by the available statistics, the results prove the claim that the tactical technical activity of the player was adequately covered with a minimum loss of validity.

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