Design and Development of an Observational Tool for Evaluating Table Tennis Singles Matches

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Abstract: **Introduction.** In the field of high level sport performance, evaluation of game actions during competition is a matter of great interest. Systematic assessment of table tennis matches represents a basic method to understand this sport, its physical training as well as its strategy and behavioral techniques. During a table tennis match, we can observe a high number of technical actions in a short decision time between one set and the following one. Due to this complexity, a systematic evaluation model of table tennis game actions is necessary to understand the strategy of each player, possibly improving their performance. The aim of this study was that of developing an observational tool for analyzing the different variables that characterize a table tennis singles matches. **Methods.** An observational method was applied for analyzing each match. The development of this tool was accomplished in different steps: 1. Design of the procedure for match video recording; 2. Development of an observational protocol; 3. Design of a database to organize and store the results; 4. Validation of the tool assessing its reliability. **Results.** The informatic tool provided data recording: the match time structure, the playing technique, the ball touching area on the table, the effectiveness of the playing technique in terms of performance. Data evaluation gave the possibility of predicting the player's game strategy as well as his effectiveness in terms of wining and loosing points, through the analysis of frequencies and delays. **Discussion.** The systematic evaluation of the data provided by the informatic tool represents a basic method to understand table tennis. Moreover, this tool allows identifying the physical, tactical and technical profile of the players. **Conclusions.** The informatic tool described in this study allows knowing which single technical-tactical elements led to the final result. The knowledge of these data may help the player and the coach to focus on the weak points and to understand what aspects of the training planning have to be improved or changed. In this way, the training process may be modified in the attempt of reaching the highest level sport performance.

Keywords: Informatic tool, Timing structure, Technical actions, Prediction levels, Notational Analysis.

1. INTRODUCTION

In the field of high level racket sport performance, evaluation of game actions during competition is a matter of great interest in scientific writings [1-4]. Systematic assessment of table tennis matches represents a basic method to understand this sport, its physical requirements as well as its strategy and behavioral techniques [5-7]. Considering this, observational methodology can be a valid scientific tool to describe the player's actions in the sport scene [8,9].

Single modern table tennis competition, and other racquet sports such as tennis, squash and badminton, takes place in an area of motor function in which two athletes carry out different conducts following a logical contrary interaction [10,11].

In each match we can see an important number of elements, all of them constituting the motoric body of table tennis: different techniques decided upon and executed within a short period of time and with a rapid succession from one action to the other. This complexity makes very difficult to study the sequences of motor interactions, so it is of great importance to establish a game's action systematic assessment model, that will provide knowledge of each player's strategy, and improve his/hers sport performance**.**

Thus, the aim of this investigation was that of creating a computerized instrument for observing, coding and analyzing every one of the different elements that take place in the single table tennis competition.

2. METHODS

An *ad hoc* observational instrument, made up by a combination of an organised system of categories and events has been designed to assess game actions in single table tennis competition. This taxonomic system has been made following the observational methodology rules [12,13]. All categories included in every observational criteria, are exhaustive and mutually excluded.

The development of this instrument was done in

consecutive phases:

1. Designing a competition recording procedure.
2. Designing an observational protocol for each match.
3. Designing a database to save and organize the observational results.
4. Verifying the instrument's validity, reliability and accuracy.

2.1 Taxonomic system

Interactions of the techniques that are used in single's table tennis competition have been taken into consideration when developing the system of categories. In a sequenced manner we have defined the variety of events in different levels. The point establishes the moment the ball is being played, as well as the moment that it is out of the game.

The situations we assess in this investigation are those in which the ball is being played, but we also consider those in which it is not being played, to later analyze the temporal structure of the whole match. The instrument that sequentially describes the players conduct interaction is made up by seven categories: start, end, player, racquet grip, strike, technique and bounce area.

Start category is made up by 4 events: PART, TANT, JUE, T_MU.

Start category	
PART	Match start
TANT	Point start
JUE	Game start
T_MU	Time out

End category is made up by 7 events: T_1, T_0, J_1, J_0, PA_1, PA_0, T_NUL.

End category	
T_1	The player wins the point
T_0	The player loses the point
J_1	The player wins the game
J_0	The player loses the game
PA_1	The player wins the match
PA_0	The player loses the match
T_NUL	Invalid point

Player category is made up by 2 events: JUG1, JUG2.

Player category	
JUG1	Player that starts serving
JUG2	Player that starts returning the service

Racquet grip category is made up by 2 events: ASIA, EUR.

Racquet grip category	
ASIA	Asian racquet grip
EUR	European racquet grip

Stroke category is made up by 2 events: DCHA, REVS.

Stroke category	
DCHA	Forehand
REVS	Backhand

Technique category is made up by 5 events: SERV, SPIN, CORT, SIN, OTRA.

Technique category	
SERV	Service
SPIN	Topspin
CORT	Backspin
SIN	No spin
OTRA	Not classifie

Bounce area category is made up by 6 events: Z_1, Z_2, Z_3, Z_4, Z_5, Z_6 (Figure 1).

Bounce area category	
Z_1	Left square close to the net
Z_2	Right square close to the net
Z_3	Left square on the middle of the table
Z_4	Right square on the middle of the table
Z_5	Left square back on the table
Z_6	Right square back on the table

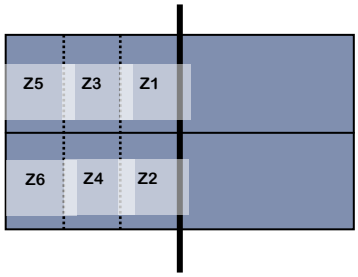

Fig. 1 Court area divisions.

2.2 Participants

To create this observational method high level matches belonging to the the Spanish elite division "la Superdivison", The Champions league, Spanish senior championships and the International Top12 ENEBE have been evaluated.

2.3 Materials

We used two cameras fixed in a lateral-superior angle in order to code each match. Each camera registered one half of the table (Figure 2).

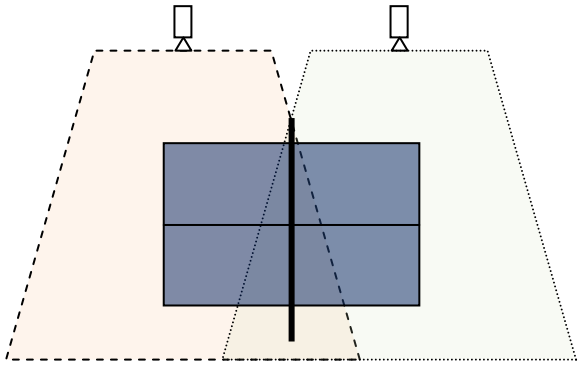

Fig. 2 Location of the recording spaces in the court area.

A total of 4 cameras (Panasonic NV-GA15), 4 telescopic supports 3 metres high (Manfrotto model 007U), 25 metres of cables, one staircase, 200 miniDV tapes and the computer program Match Vision Studio v. 3.0® were used to register and code the information (Figure 3).

Fig. 3 Example of computerized analysis using Match Vision Studio v. 3.0®.

2.4 Experimental design

The information has been coded and registered in a continuous and sequenced manner, two observers have been trained, using a protocol of observation, registering the matches at different times during the day. The analysis of the information is approached from two perspectives: one qualitative, where the concordance derives from a consensus between experts in table tennis, and the other is from a quantitative point of view, where we estimate correlations, concordances and the possibility of generalising the information from the different observations and between observers.

3. RESULTS

The results regarding the quality of the information are satisfactory. The numbers for validity and viability between observers and within each observer gave an error percentage under 5% (Table 1 and 2).

Table 1. Frequencies recorded for each category and observation.

	% Error intra-observer Observer A	% Error intra-observer Observer B	% Error inter-observer Observer A	% Error inter-observer Observer B
Set time 1	0.0	0.5	0.3	0.1
Set time 2	0.0	0.0	0.0	0.0
Set time 3	0.0	0.0	0.0	0.0
Set time 4	0.0	0.0	0.0	0.0
Match time	0.0	0.0	0.0	0.0
Play time set 1	1.8	3.6	2.7	1.8
Play time set 2	0.0	2.5	4.1	2.8
Play time set 3	1.4	2.7	4.6	2.6
Play time set 4	0.0	1.8	2.7	0.0
All play time	0.4	0.4	3.7	2.2
Rest time set 1	0.6	0.6	0.7	0.7
Rest time set 2	0.4	0.9	1.2	1.0
Rest time set 3	0.4	0.9	1.4	0.8
Rest time set 4	0.0	0.6	0.8	0.1
Rest time between set 1 y 2	0.0	0.0	0.6	0.2
Rest time between set 2 y 3	0.0	0.0	0.0	0.0
Rest time between set 3 y 4	0.0	0.0	0.1	0.4
All rest time	0.0	0.0	0.1	0.1

The instrument and its system of evaluation describe and analyze the strategic conducts developed by the players during the competition (Table 3), giving relevant information regarding the:

- Temporal structure of single game.
- Techniques used by the players.
- Areas of contact between ball and table.
- Efficiency-levels in the rendition of the techniques used.

Table 2. Reliability of scoring, stroke, technique and bounce area categories (Cohen's coefficient kappa*)*.

Categories	Intra-observer A	Intra-observer B	Inter-observer A-B
Scoring	0.889	0.665	0.935
Stroke	0.986	0.967	0.987
Technique	0.959	0.919	0.896
Bounce area	0.858	0.890	0.790

Table 3. Summary of all the variables under study when performing one observational analysis.

Time							
Match time	54'13"						
Set time	4'06"	5'46"	5'08"	6'03"	6'10"	10'23"	9'11"
Rally length	52"	58"	1'02"	1´13"	1'07"	2'36"	2'05"
Inter-point time	3'21"	4'50"	4'05"	5'21"	4'58"	8'26"	7'06"
Inter-set time	1'46"	2'	1'55"	1'58"	2'15"	2'08"	-
Points							
Win and lost points in each set (player A)							
Winner	6	4	2	3	1	5	4
Loser	1	4	3	4	4	6	5
Win and lost points in each set (player B)							
Winner	3	4	8	2	7	6	6
Loser	5	7	3	8	7	5	5
Strokes							
Total strokes	56	65	76	76	77	119	99
Total forehand strokes	39	43	47	49	45	75	59
Total backhand strokes	17	22	29	27	32	44	40
Total services	17	20	17	18	20	24	22
Total spin strokes	21	26	28	31	28	47	39
Total backspin strokes	5	10	6	11	10	12	11
Total strokes without effect	13	9	25	16	19	36	27
Number of bounces areas for each set							
Total in Z_1	2	4	2	4	5	5	3
Total in Z_2	3	1	4	7	2	7	11
Total in Z_3	14	14	20	12	12	33	14
Total in Z_4	12	21	18	15	20	26	21
Total in Z_5	6	4	10	15	9	13	15
Total in Z_6	5	7	10	10	11	19	17

When registered and processed in the appropriate manner, all this information provides a way to evaluate tendencies and preferences of the player in motor conduct, that is, establishing predicaments in the tactics used by the player, based on the analysis of frequencies and delays, and its efficiency shown in the production of winners and losers.

4. CONCLUSIONS

The systematic study of information gathered with this method, constitutes a basic method for enhancing the knowledge of table tennis. Assessment of the obtained information provides a picture of the physical profile needed in modern table tennis, because it studies the temporal structure of actions during the game. It is an objective and quantitative evaluation of the techniques and tactics used, together with the efficiency and performance of them.

This designed system may determine with precision and exactitude the elements of the game that determined a given result. All these data allow the athlete and the trainer to see the patterns of conduct (an essential information in recognizing the players weak areas and strong areas).

This instrument is useful for analyzing the athlete's structure of play. It gives immediate feedback as to how to improve aspects related to training and to the process of teaching-learning.

Definitively, the various practical applications derived from this study are relevant, as they will provide knowledge of the player's conducts in competition as well as their levels of efficiency.

For later studies it is necessary to amplify the criteria in the diversification of sample, including competition type and level, and also athletes gender to be able to explore the behaviour links that occurs during the evolution of the game.

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