185 - THE USE OF A TECHNOLOGICAL SYSTEM OF MEASURE TO ANALYZE THE VARIABILITY IN THE EXECUTION OF TENNIS SERVICE AND THE EVALUATION OF ITS RESULT

Ruperto Menayo Antúnez; Francisco J. Moreno Hernández;
Osvaldo André Furlaneto Rodrigues; Juarez Müller Dias; Juan Pedro Fuentes García
University of Extremadura (UEx) - Spain
University Miguel Hernández of Eleche (UMH)- Spain
Universidade Federal de Santa Catarina (UFSC) -Brazil
ruper@unex.es

INTRODUCTION

In the line of the investigations developed by Moreno and collaborators in the Motor Control and Learning of the School of Sport Sciences from the University of Extremadura about the development and application of automated systems to analyze the human movement and the motor behavior processes that determine the performance in the motor skills. So, we present an automated protocol, designed to rate the consistency in the execution of tennis service and the results obtained, in order to use it to evaluate the players performance in this decisive action of the game. In this sense, the investigation is sustained on the investigating trajectory achieved by our group, about these technological systems, (Ávila & Moreno, 2002; García, Moreno, Luis y Ávila, 2003; Ruiz, Reina, Luis y Moreno, 2003; Luis, Reina, Sabido, Sanz, Ruiz y Moreno, 2003; Reina, Sanz, Luis y Moreno, 2003; Sabido, Salgado y Moreno, 2003; Damas, Moreno, Reina y Luis, 2004; Reina, Luis, García, Sanz, Sabido & Moreno, 2004; Menayo, Fuentes, Luis y Moreno 2004; Menayo, Fuentes, Sabido y Reina, 2005), that contribute to the necessary bases to carry out this work. To part of the mentioned investigations, there are numerous studies that have used the automated systems in different sport contexts. This way, we find works developed in situations of simple reaction time , as those of Rossi y Zani, (1991) Arellano y Oña (1987), Martínez, (1994) y Oña, Martínez, Moreno, Serra y Arellano (1994) y en situaciones de tiempo de reacción de elección en deportes abiertos, como los de Alain y Sarrazin, (1990), Christina, Barresi, y Shaffner (1990), Abernethy (1991), Starkes, Edwards, Dissanayake y Dunn, (1995), Cárdenas y Oña, (1997), Moreno y Oña, (1998), Castillo, (2000), Párraga, Gutiérrez-Dávila, Rojas y Oña, (2002), Barbero, Granda y Mohamend, (2003) y Hernández, (2005).

Starting these works, we designed a study that integrates an automated system to registrate data in real time, inside the practice context, with the purpose to obtain information about one of the variables that are necessary to determinate the practice conditions, as the cinematic variability in the execution of tennis service and their influence in the action objective attainment.

In this sense, we consider the qualitative aspects in the movement execution that determine the neuromuscular coordination level required to the beginning and later movement (Oña et all., 1999). This way, among determinant qualitative aspects to execute motor skills (in tennis service) we will fix our objetives in variables as the speed and precision that is required to execute it. This variables indicate us the commitment between both parameters when the dificulty task execution is high, as it happens in tennis service, since performance won't be influenced so much by the necessary speed, but the capacity to carry out the appropriate neuromuscular control that allows to obtain an effective movement.

With relationship to our study, it becomes necessary to establish the difference among the concepts of variability in the execution and variability in the result. As for the first one, it is evident that to achieve a motor skill, two exactly identical executions don't exist because the variability of the movement is inherent to the biological systems. This way, if we analyze the decisive parameters in that movement (force, speed, acceleration, position, height of the hit, intensity of muscular contraction, etc.), we will observe that they can approach to similar values in the different trials we have make, but they will never be the same ones and probably will exist a range in which these parameters will be located. In these cases, following Newell and Corcos (1993), the system sensory-motor responsible to execute the movement, presents multiple degree of freedom,which increase it as we deepen in the units that conform it (muscles, articulations, muscular fibers, units motorboats, cells, etc.), with that which, the movement variability will be associated to the intervention of these elements. As for the result variability, we can affirm that it is more defined, since it has been used in the studies related with Motor Control like performance measure or movements efectiveness, using statistical as the typical deviation or variation coefficient.

However, the relationship among two concepts of variability is not at the present time totally explicit, existing numerous studies that try to determine the possible connection among both. This way, comparing the movement development with the consequences of the same one, it could not still be affirmed rotundity that the variability in the execution of the same one takes associated the variability in its result and, probably, the relationship depends in great measure of the type of motor skill executed . That is to say, although concrete cinematic studies have been carried out in this respect (in tennis service) as those of Subijana y Navarro (2003), Elliot, Fleisig, Nicholls y Escamilla (2003), Fleisig, Nicholls, Escamilla y Elliot (2002), Ito, Tanabe y Fuchimoto (1995), Lo, Wang, Lin y Su (2003), Papadopoulus, Emmanouilidou y Prassas, (2000) y Wang, Wu y Su, (2000), it doesn't seem empiric evidence that confirms to exist that the variability in the parameters that intervene in the movement (mentioned previously), also produce variability in its result.

METHOD

Sample

The sample for the system validation is composed by 18 tennis players in improvement level, with experience in regional competition. Previously to the beginning of their intervention, all the players sign a questionnaire informed consent.

Variables

As dependent variables are considered the following ones:

1. Consistency in the execution, measure through the analysis of some segment corporal trajectories space, determinant to the final ball trajectory (speeds, accelerations and space positions).

2. Ball speed, measure through a radar.

3. Precision in action, measure through the difference among ball localization when it arrivals and theoretical position in which should have concluded, using the space error parameters (absolute error, constant error and variable error).

As independent variables are defined the following ones:

1. Interferences. Modifications forced in the sportsman movement execution taken by physical alterations of the material used in the movement.

2. Ball speed, measure through the radar.

Registration equipment to the motor behavior

An adapted protocol is designed starting from other employees for the registration of the motor answer in open skills (Moreno et al., 2003; Damas et al., 2004; Menayo et al., 2004; Sabido, Moreno, Menayo and Damas, 2005.). This way, the following instrumental location is programmed:

- Portable computer Toshiba Satellite 1900, used to registrate, store and analyze the cinematic variables corresponding to executed services, through a virtual instrument programmed in language LabView. The developed application under this language facilitates the obtaining of data from instrumental external, which is connected to computer through the ports series and parallel.

- Polhemus Fastrak (figures 1). It is an electromagnetic analyzer of trajectory with three degrees of freedom, with a precision of 0.08 cm. for the position receiver "x", "y" and "z" and of 0.15º for the orientation receiver, with a resolution of 0.0005 cms/cm and 0.025º. The number of data, when an only receiver is used, it is 120 Hz.

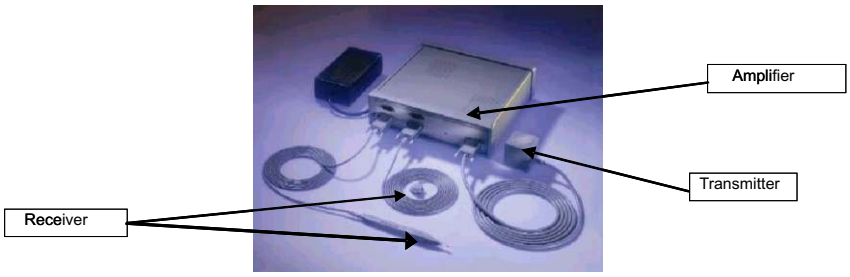

FIG. 1. Polhemus Fastrak for the hits cinematic valuation.

- Radar that will allow us to visualize the ball speed at every moment in the services executed by the players through a panel digital marker.

- Wireless microphone and system of sound reception that will be used to register the impact of the ball on the racket strings.

- Television monitor and magnetoscope that will be used to register the precision and later digitization process.

- Digital Videorecoreder to film the balls bounces from each tennis player's services.

Procedure

The figures 3 and 4 illustrate the procedure to continue during the trial of data taking. This way, they will register hit series with different speed requirements through a protocol of instructions.

In the same way, it will be requested to tennis players the execution of different tasks that imply an arm executioner trajectory modification to carry out the service. The tasks to develop will be the following ones:

A) Service without modification that will be used for the initial variables dependent description:

- Task 1. Carry out 10 plane services (10 of heating) looking for the maximum precision and the normal power hit of each player.

B) Services modifying the hit power.

- Task 2. Carry out 10 plane services to the maxim potentializes trying to be necessary.
- Task 3. Carry out 10 plane services to 65% of the maximum power trying to be necessary
- Task 4. Execute 10 plane services to the minimum power trying to be necessary.

C) Services modifying the arm executioner trajectory (hand-racket) being the most precise thing possible to the maxim it potentializes.

- Task 5. Carry out four series of 10 plane services in block sequence using a tennis racket, one of padel and palette rubber, using tennis balls, rubber balls and scuash balls.
- Tasks 6. Carry out four series of 10 plane services in random sequence using the materials of the previous series.

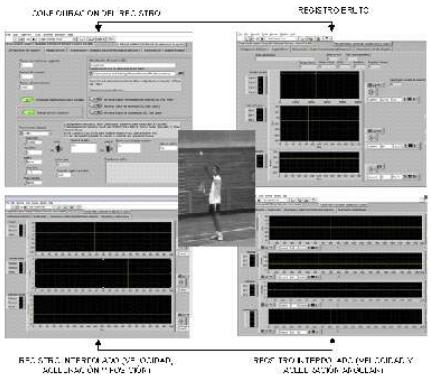

FIGURA 3. First step: registration program configuration.

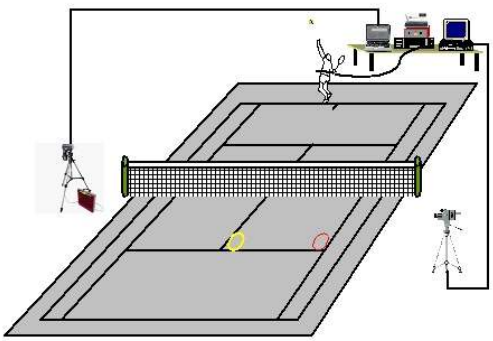

FIGURE 4. Process of registration with equipment connected and the tennis player located to the service.

RESULTS

In the figures 5 and 6 an example of a series of rehearsals is shown carried out by one of the subject that achieved the system validation. The differences are observed in the segment hand trajectories in different rehearsals. The protocol also facilitates the registration synchronization of these movements with external devices that allow us to know the execution characteristics and its evaluation in time in function of certain events (ball impact on the racket strings, ball bounce in the court,

moment of more or smaller joint angle in elbow or wrist).

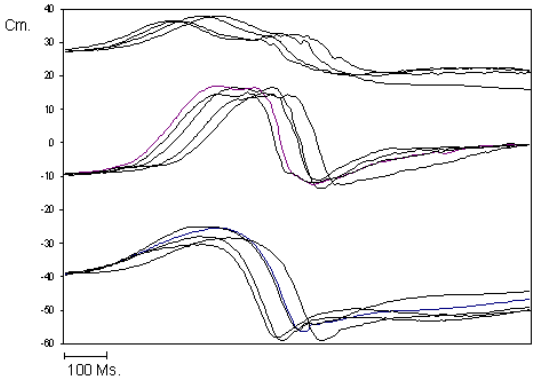

FIGURA 5. Graphic representation of a launchings series in the three space planes.

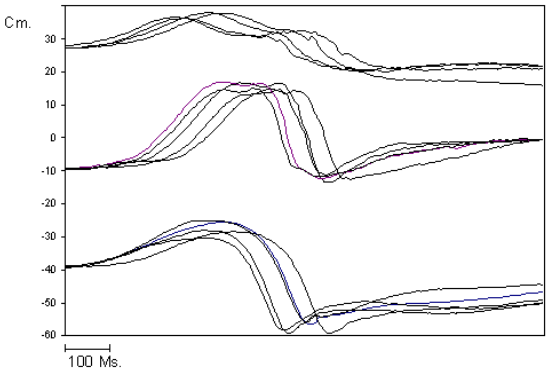

FIGURE 6. Graphic representation of a launchings series in the three axes planes.

These results should be analyzed in function to the moment that is introductioned the interference, since the cinematic variables registered in the corporal segment analyzed will be different in function of the task characteristics used as variability source (they will affect to the execution result) . This way, the registration program will allow us to extract information of these curves about the modifications taken place in hand trajectory described during the service execution along the different temporary moments that it is developed and in each one of the three axes and space planes, evaluating variables as the lineal and angular speeds of the hand during the trajectory, the accelerations and the positions of the same one, parameters that will be used to value the movement consistency in different phases of the study.

CONCLUSIONS

By means this investigation development we will try to respond to the following questions:

1. Determine in what measure a performer with more precise results is more or less consistent in the execution that those less precise ones.

2. Specify in what measure a more precise player is able to adjust his movement when this interferences on the execution take place on him.

3. Identify what effect have the interferences about the consistency in the execution.

4. Check what effect have the interferences about the precision in the results.

5. Check if modifications take place in the relationship among those mentioned variables, according to the force or speed applied to the movement.

6. Evaluate the effects of the learning in the service under variability conditions through tasks that modify the patron motor of the service.

REFERENCES

- Abernethy, B. (1991). Visual search strategies and decision making in sport. International Journal of Sport Psychology, (22), 189-210.
- Alain, C. and Sarrazin, C. (1990). Study of decision-making in squash competition: to computer simulation approach. Canadian Journal of Sport Sciences, (15), 193-200.
- Arellano, R. and Oña, A. (1987). Differential effect of the intervention has more than enough expectations attention in the swimming exit. Motricidad, (0), 9-15.
- Ávila, F. & Moreno, F.J. (2002). Visual search strategies elaborated by tennis coaches during execution error detection processes. Journal of Human Movement Studies, (44), 209-224.
- Barbero, J.C., Granda, J. and Mohamed, N. (2003). Develop of a technological system for the valuation and training of the speed and the capacity of carrying out intermittent efforts of maximum intensity. Granada: II World Congress of Sciences of the Physical Activity and of the Sport.
- Brody, H. (2003). Bounce of a tennis ball. Journal Science and Medicine in Sport, 6 (1), 113-119.
- Cárdenas, D. and Oña, A. (1997). The development and application or fan automatic system for the improvement of behavioural variable of the pass in basketball. Journal of Movement Studies, (32), 227-239.
- Castillo, J.M. (2000). Effect of a visual training by means of an automated system of stimuli emission about the penalty pitcher's effectiveness in soccer. Doctoral thesis. University of Granada.
- Christina, R.W., Barresi, J.V. & Shaffner, P. (1990). The development of response selection accuracy in football linebacker using video training. Sport Psychologist, (4), 11-17.
- Damas, J.S, Moreno, F.J., Reina, R. and Luís, V. (2004). Presentation of an automated system for the analysis of the receivers effectiveness in volleyball. Motricidad, (11), 105-119.
- Elliot, B., Fleisig, G., Nicholls, R. & Escamilla, R. (2003). Technique effects on upper limb loading in the tennis serve. Journal of Science and Medicine in Sport, 6 (1), 76-87.
- Fleisig, G., Nicholls, R., Escamilla, R. & Elliot, B. (2002). Kinematics and kinetics of the high velocity in tennis serve. Medicine and Science in Sports and Exercise, 34 (5), 105.
- García, J., Moreno, F.J., Luís, V. and Ávila, F. (2003). Manipulation of the sequences review by means of occlusion technical to determinate of the localization the goal launching in handball. Granada: II World Congress of Sciences of the Physical Activity and of the Sport.
- Hernández, E. (2005). Effect application of an automated system of precues projection in the improvement of the blockade action effectiveness in volleyball. Doctoral thesis. University of Granada.
- Ito, A., Tanabe, S. & Fuchimoto, T. (1995). Three-dimensional kinematic analysis of the upper limb joint in tennis flat serving. In K. Hakkinen (Ed.), Jyvaskyla: XVth Congress of the International Society of Biomechanics.
- Him, K., Wang, L., Lin, H. & Its, F. (2003). Momentum transfer of upper extremity segments during the tennis serve. In, S. Miller, Tennis Science and Technology, 2, pp. 185-191. Canada: Webcom Ltd.
- Luis, V., Reina, R., Sabido, R., Sanz, D., Ruiz, A. and Moreno, F.J. (2003). Influences of perceptive-visual programs about the reaction answer and answer precision in an approach task to net in tennis. Granada: II World Congress of Sciences of the Physical Activity and of the Sport.
- Martínez, M. (1994). Feedback effects administration in the motor effectiveness through an automated system: Application to

the Sport Exit. Doctoral thesis. University of Granada.
- Menayo, R., Fuentes, J.P., Luis, V., and Moreno, F.J. (2004). Application of an automated protocol for the temporary parameters analysis for the reaction answer in tennis players during split-up-step and volleys execution. Motricidad. European Journal of Human Movement, (12), 87-105.
- Menayo, R., Fuentes, J.P., Sabido, R. and Rena, R. (2005). Develop of an automated protocol to learn and train the tennis hits manipulating the practice conditions. Madrid: International Congress UEM.
- Newell, K. M., & Corcos, D.M. (1993). Variability and motor control. Champaign, IL: Human Kinetics.
- Oña, A., Martínez, M. Moreno, F., Serra, E. and Arellano, A. (1994). Description of a computerized system of registration and control applied temporary information to the sport. Files of Medicine of the Sport, (11), 163-171.
- Papadopoulos, C., Emmanouilidou, M. & Prassas, S. (2000). Kinematic analysis of the service stroke in tennis. In S.J. Haake and A.O. Coe (Eds.), Tennis Science and Technology, pp. 383-387. London: Blackwell Science Ltd.
- Párraga, J.A., Gutiérrez-Dávila, M., Rojas, F.J. & Oña, A. (2002). The effects of visual stimuli on response reaction cheats and kinematics factors in handball shot. Journal of Human Movements Studies, (42), 421-439.
- Reina, R., Sanz, D., Luís, V. and Moreno, F. (2003). Study of the answer tennis players' reaction and wheelchair tennis players in service rest in field situations and laboratory. La Coruña: II International Congress of the AIESEP.
- Ruíz, A., Rena, R., Luis, V. and Moreno, F. (2003). The visual strategies search developed by the basketball referees in line position. Granada: II World Congress of Sciences of the Physical Activity and of the Sport.
- Reina, R., Luis, V., García, J., Sanz, D., Sabido, R. & Moreno, F. (2004). The effect of the server perform-side on the visual behaviour of tennis and wheelchair tennis players. Journal of Human Movement Studies, (47), 025-045.
- Rossi, B. and Zany, A. (1991). Timing of movement-related decision processes in clay-pigeon shooters ace assessed by event-related brain potentials and reaction cheats. International Journal of Sport Psychology, (22), 128-139.
- Sabido, R., Moreno, F.J., Menayo, R., Damas, J.S. (2005). Proposal of a measure chain for description and control of the jump capacity in acrobatic sports. Madrid: International Congress UEM.
- Sabido, R., Salgado, F. and Moreno, F.J. (2003). Design of an automatic system for the reaction answer analysis in kárate. Granada: II World Congress of Sciences of the Physical Activity and of the Sport.
- Sherrington, C.S. (1906). The integrative action of the nervous system. New Haven: Yale University Press.
- Starkes, J. L., Edwards, P., Dissanayake, P. and Dunn, T. (1995). A new technology and field test of advance it uses in volleyball. Research Quarterly for Exercise and Sport, 2(66), 162-167.
- Subijana, C. & Navarro, E. (2003). An approach in determining adequate filming frequency in to biomechanical analysis of tennis serves. In S. Miller, Tennis Science and Technology, 2, (pp. 211-216). Canada: Ed. Webcom Ltd.
- Wang, L., Wu, C. & Su, F. (2000). Kinematics of trunk and upper extremity in tennis flat serve. In S.J. Hake and A.O. Coe (Eds.), Tennis Science and Technology, pp. 395-400. Lenders: Blackwell Science Ltd.

Faculdade de Ciências do Esporte
Avda. De la Universidad, s/n.
Cáceres - C.P. 10071
Extremadura - Cáceres - Espanha
EMAIL PARA CONTATO: ruper@unex.es
TELEFONE: +34 927 257 460

THE USE OF A TECHNOLOGICAL SYSTEM OF MEASURE TO ANALYZE THE VARIABILITY IN THE EXECUTION OF TENNIS SERVICE AND THE EVALUATION OF ITS RESULT

ABSTRACT - Through this study, we present a measurement protocol to analyze kinematics variables that affect to variability and precision in the performance of a sport skill like the tennis service. From the knowledge generated in this previous analysis, we will analyze how are influenced different variables as ball speed and perturbations caused during the movement in trajectory of executing arm, on motor pattern consistency and precision reached in strokes. Thus, in this document, we presented a developed technological protocol to collect the referred data about the mentioned variables, with the purpose of having optimized and validated instruments applied to reliable collection of the parameters specified in our study. **KEY-WORDS**: variability, consistency, kinematics analysis.

EMPLOI D'UN SYSTÈME DE MESURE POUR L'ANALYSE ET LA VARIABILITÉ DANS L'EXÉCUTION DU SERVICE DANS LE TENNIS ET L'ÉVALUATION DE SON RÉSULTAT.

RÉSUMÉ - Le but de cette étude est de proposer un protocole afin d'analyser les différentes cinématiques qui touche la variabilité et la précision obtenue dans la réalisation d'une habilité sportive telle que le service dans le tennis de champ. A partir des connaissances démontrées dans cette analyse préalablement menée, nous analyserons différents changements tels que la vitesse du déplacement de la balle et les perturbations provoquées durant la projection de la cinématique, influençant la trajectoire et la position du bras "exécuteur", sur la consistance du modèle "moteur" et sur la précision obtenue durant le frappement. Ainsi, ce document nous présente le protocole technologique lancé par l'obtention de données se référant aux changements déjà cités, avec la finalité de disposer d'un instrument extrêmement compétent et sûr qui permet d'enregistrer et de s'en remettre à des paramètres spécifiquement détaillés dans l'étude ainsi que sa considération durant la phase d'action. **MOTS-CLÉS**: variabilité, consistance, analyse cinématique.

EMPLEO DE UN SISTEMA TECNOLÓGICO DE MEDIDA PARA EL ANÁLISIS DE LA VARIABILIDAD EN LA EJECUCIÓN DEL SERVICIO EN TENIS Y LA EVALUACIÓN DE SU RESULTADO

RESUMEN - A través de este estudio se propone un protocolo de media para el análisis de aquellas variables cinemáticas que afectan a la variabilidad y a la precisión obtenidas en la ejecución de una habilidad deportiva como es el servicio en el tenis. A partir del conocimiento generado en este análisis previo analizaremos cómo influyen diferentes variables, como son la velocidad de traslación del móvil y las perturbaciones provocadas durante el desarrollo de la cadena cinética influyentes en la trayectoria del brazo ejecutor, sobre la consistencia del patrón motor y sobre la precisión alcanzada en los golpeos. Así, en este documento presentamos el protocolo tecnológico diseñado para la obtención de los datos referentes a las variables citadas, con el fin de disponer de un instrumental optimizado y validado que nos permita el registro fiable de los parámetros especificados en nuestro estudio y su consideración durante la fase de intervención.
PALABRAS CLAVE: variabilidad, consistencia, análisis cinemático.

EMPREGO DE UM SISTEMA TECNOLÓGICO DE MEDIDA PARA A ANÁLISE DA VARIABILIDADE NA EXECUÇÃO DO SAQUE NO TÊNIS E AVALIAÇÃO DE SEU RESULTADO

RESUMO

O objetivo deste estudo é propor um protocolo para a análise das variáveis cinemáticas que afetam a variabilidade e a precisão obtida na execução de uma habilidade esportiva como é o saque no tênis. A partir do conhecimento gerado nesta análise prévia, analisaremos como influem diferentes variáveis, como são a velocidade de deslocamento da bola e as perturbações provocadas durante o desenvolvimento da cadeia cinética influentes na trajetória do braço executor, sobre a consistência do padrão motor e sobre a precisão alcançada nas batidas. Assim neste documento apresenta-se o protocolo tecnológico projetado para a obtenção dos dados referentes às variáveis citadas, com a finalidade de dispor de um instrumento otimizado e validado que permita o registro confiável dos parâmetros especificados no estudo e sua consideração durante a fase de intervenção.
PALABRAS-CHAVE: variabilidade, consistência, análise cinemática.