International Tennis Federation
www.itfcoachingreview.com
December 2014. 22nd Year. Issue 64. 8-11
ISSN 2225-4757
https://doi.org/10.52383/itfcoaching.v22i64.516

Adaptive and reactive skills involved in the return of serve in tennis.

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ABSTRACT

Some years ago, Nick Saviano notified qualitative observations. In this study we have made a chronometric analysis of the split -step and the response times of experienced returners to prove qualitative observations in a quantitative way. The research included the relationship between the different phases of the split-step and the reaction of the players. A 250 fps. high speed camera was used. The results partially confirm landing with the opposite foot. The ability to adapt the landing of the feet in a functional way was implemented by three of the five participants. It was also proved that those players who were faster to land, were also faster to react. There was also a relationship between the national qualification of the participants and the ability to react, since the best male player (M1) and the best female player (F1) had shorter response times.

Key words: Split-step, Taking off, Adjustments before landing, Reaction.
Received: 14 September 2014.
Acepted: 28 October 2014.
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INTRODUCTION

The talent that professional tennis players exhibit on court is the product of many years of practice and implicit and explicit perceptive motor learning processes. This hard work is directed at becoming a top level returner with the capability of quickly perceiving the direction of the ball. Top level returners can intuitively return to the right side and accurately regulate their body movements until the time to make contact (Ruiz, 2012). After qualitative observation, Nick Saviano (2000) stated that top level players unconsciously produce functional behaviour to adapt to demanding strokes in different game situations. Saviano (2000) states that top level players are able to regulate the landing phase of the split-step, instead of landing with both feet simultaneously, they touch the ground first with the foot that is further away from the direction of the ball, so as to start the stroke with an explosive movement towards that side. Saviano concluded from his observations that when the players are in the air, they are able to perceive the direction of the ball. It is from these ideas that a chronometric study was performed in order to increase, by means of quantifiable data, the knowledge about specific footwork when returning, to prove that experienced returners are able to adjust or adapt the landing of their feet during the flight before contacting the ground. Another objective of the analysis was to find out if the different phases of the split-step (take off, flight and landing) were relative to the response times of returners.

METHOD

Participants

Two male players and three female players voluntarily participated in this study. The average age of the participants was 15.4 years with 5.6 years of intensive practice. The participants were selected by the Castilla-La Mancha Tennis Federation and each trained between 12 and 15 hours a week. The players participating in the research competed regularly in their respective categories and had a high national ranking in the RFET competition qualification system.

Material and Procedure

The players were filmed with a TroubleShooter TS250MS camera, Fastec Imaging (250 fps). The camera was placed behind the returning player to capture the moment of impact of the server, and the return shot from the deuce side and from the advantage side. Two additional JVC GY-301E and Cannon MV950 (25 fps) cameras recorded the service landing area and the accuracy of the return shots. A Sports Radar SR-3600 was used to record the service speed. The average speed for the male service was 162 km/h and for the females was 133 km/h.

Each player was recorded both as a server and as a returner. When serving, they were asked to serve a powerful and flat first serve in a certain sequence and the returner had the open court. The returner then had to direct the return shots to cones in each corner of the court. The return was scored between zero and four points depending on the accuracy. 13 attempts were recorded per player and the image after image analysis occured every four milliseconds (ms) (Figure 1). A Quick Time 7 Player, was used in addition to a portable MacBook and an auxiliary monitor .

Figure 1. The player´s left foot touches the ground 32 milliseconds before his right foot helping to increase the dynamism of the return towards his right in the direction of the ball.

Findings and discussion

Table 1., Figure 2. and Figure 3. show the main results in time, percentage and score. Correlating to previous research, participants M1, M2 & F2 showed that they took off almost at the time of impact of the server (Avilés, Benguigui, Beaudoin, & Godard, 2002; Avilés, Ruiz, & Benguigui, 2006). Female players F1 & F3 took off late, +72 ms and +76 ms, after hitting. In reference to the time in the air, important individual differences were detected among participants. Player M2 remained in the air 172 ms while female player F1 was in the air only 60 ms.

Participants	Take-off Time	Flight Time	Landing time	Response time	% landing opposite foot	Scoring to return 0-4
Male player 1 (M1)	33 (27)	106 (30)	138 (27)	161 (30)	66.7	1.4
Male player 2 (M2)	-33 (45)	172 (41)	133 (29)	190 (26)	36.4	0.9
Female player 1 (F1)	72 (22)	60 (22)	132 (34)	169 (30)	78.6	1.2
Female player 2 (F2)	24 (54)	134 (37)	159 (29)	234 (32)	75.0	1.5
Female player 3 (F3)	76 (40)	119 (37)	195 (19)	237 (32)	83.3	1.0

Table 1. The three phases of the split-step in milliseconds and the response time. Typical deviations are between brackets. Percentages of landing with the opposite foot and the score when returning are on the right. Participants are ranked from the best to the worst, males (M) and females (F).

In relation to the adjustment of the feet just before touching the ground, Saviano´s (2000) observations were confirmed, although four participants passed the random level (50%), only three players (F1, F2 & F3) surpassed 70%. The best player (M1) landed with his opposite foot 66.7% of the times, so it showed a tendency to adaptive adjustments just before landing (Table 1. & Figure 2.).

It is possible that the frequency of landing with the opposite foot benefited some participants because of a late take off. Taking off later (after impact and initial flight of the ball), the players can get more reliable information about the direction of the ball. On the other hand, anticipating take off makes it more difficult to obtain and use the information about the direction of the shot, and as a consequence, it is more complicated to adjust the feet when landing. For example, players F1 & F3 adjust landing on the opposite foot on 78 and 83% of the services, while player M2, who started take off prior to the stroke, did so 36% of the times.

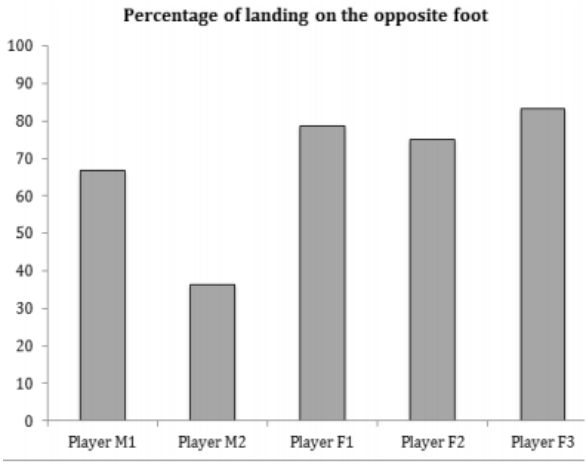

Figure 2. Percentage of landing on the opposite foot for each participant. (Surpassing 70% is evidence that this behaviour has a purpose and it is not just by chance).

The great adaptability of the best player is worth mentioning. She took off late and to make up for this she remained in the air for an extremely short time of 60ms. so that she could gain time to land, touching the ground in just 132ms. Besides, she landed with the opposite foot 78.6% of the time, only to react in just 169ms.

If all five participants had landed in a high percentage (over 70%) with the opposite foot, it would have been possible to consider the instant of landing as the true reaction, but this level was surpassed by all three female (F1, F2 & F3) but not by the two male players (M1 & M2). It is still uncertain what really happens when the returner is in the air, if the muscular pre-activation of the gastrocnemio regulates the visio-motor function before landing (Nieminen, Piirainen, Salmi, & Linnamo, 2013).

Landing is a crucial moment that illustrates the quickness of the returner and it could be considered strongly connected to reaction. If this is to be true, the following question could arise: Is there a relationship between the landing time and the response time? The response to this question is affirmative since the best players (M1 & F1) fell rapidly in 138ms and 132ms, and were the fastest in reaction with relatively short response times (see Gillet, Leroy, Thouvarecq, Mégrot, & Stein, 2010). The two female players who landed later (F2 & F3), reacted with slower times closer to 230 ms and similar to those in previous studies (Uzu, Shinya, & Oda, 2009; Vaverka,

Stromsik, & Zhanel, 2003; Williams, Singer, & Weigelt, 1998) (see Figure 3.).

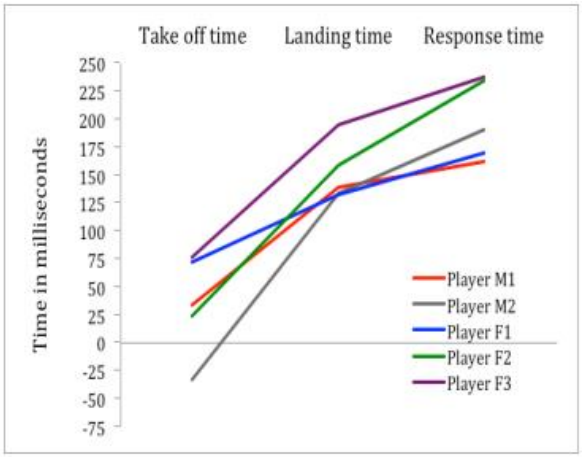

Figure 3. Time to take off, time to land and response time for each player. Returners who landed earlier (M1 y F1) also reacted faster.

In consideration that the response times of all five returners were over 160ms, and the accuracy of their responses (98.4%), it is possible to infer that the players responses were more adaptive and reactive than anticipatory (see Triolet, Benguigui, Le Runigo, & Williams, 2013). It is worth mentioning that the players who were fast, as well as those players who were slow, in landing and reacting have the chance to adjust their movement when hitting a return, in order to have accuracy when directing their shots to targets. For example, the fastest M1 player won 1.4 points and F2 with a long 234ms response time was the best performer with 1.5 points. The score of F2 indicates that even though she reacted much slower she still had a margin to adjust her movement until making contact with the ball.

CONCLUSIONS

In view of the results and the constraints of the size of the sample, we can state that there were important individual differences among experienced players. Returners showed adaptive skills to regulate the time of landing and the hitting movement.

Given the importance of a good return in todays game, the coach should evaluate and develop the player´s action and reaction capabilities. Thus, he should examine the different phases of the split-step (take off/ flight/ landing), detect if he takes off early, within time or late, or even if he is fast or slow to land and react. The development of this area is an important aspect of the progression of a player and to improve their returning game, just 30ms can make a difference.

Acknowledgements

This project benefited from a research subsidy granted by the ITF Development Department. We would like to thank Conrado López, Ramón Guzmán, Virginia García, Ana Martín, Miriam Palomo, Juan Ángel Simón and Guillermo Viguria for their collaboration and for the help provided by the RFET Research and Teaching Area of Castilla-La Mancha Tennis Federation.

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