CAN ELITE TENNIS PLAYERS JUDGE THEIR SERVICE SPEED?

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The purpose of this study was to examine if elite tennis players could accurately determine whether successive serves were faster or slower than the preceding serve. Eleven national standard junior tennis players completed 10 acceptable maximum effort serves, aiming to land the ball with-in a 1m square area adjacent to the service box T. A Wilcoxen signed rank non-parametric test was employed ($\alpha = 0.05$). Results indicated players were no more likely to correctly differentiate serves (4.9 ± 1.5) than that which would be expected by chance (5 out of 10) [$p = 0.92$]. The average speed of serve was 46.9 ± 4.5 $m.s^{-1}$ and the variation in each player's service was 1.1 ± 0.5 $m.s^{-1}$ (approximately 2.3%). The implications of these findings is that it is not possible for elite junior tennis players to use service speed (knowledge of results) as a means of guiding and fine-tuning their technique when they rely on gaining this information from purely internal physiological systems (e.g. vision).

KEY WORDS: augmented feedback, tennis, service speed

INTRODUCTION: The serve in tennis is commonly considered the most important stroke in the game (Roetert and Groppel, 2001), with a high service speed being of paramount importance. In many sports, including tennis, players attempt to use knowledge of results (outcome measures) to guide positive changes in technique (Adams, 1987; Newell, 1991). In essence, if a serve is faster than previous attempts then the player will aim to more perminantly adopt the technique that produced it. This requires tennis players to be able to judge whether one serve attempt results in a faster or slower serve than a previous attempt. At the very least they should be able to judge from consecutive attempts which is faster or slower. However, as no previous studies could be found that examined this; the present study aims to do so. It was hypothesised that they would be able to coorectly identify whether consecutive attempts were faster or slower.

METHODS: Participants: Eleven national standard junior tennis players, 7 male and 4 female, between the age of thirteen and eighteen (15.7 ± 1.6 years) volunteered for the study. Players were free from any injury that would have prevented them from using maximum effort. All participants were training between 20 and 26 hours per week as part of the Tennis Ireland national squad. Ethical approval was received by Dublin City University.

Data Collection: Following a warm-up, players served fifteen acceptable serves to the T of the deuce service box. Attempts were deemed acceptable if they were (i) within a 1m x 1m area of the T in the service box (Figure 1), and (ii) judged by the player to be maximum effort. Players were shown by means of a large digital display the speed of the first five serves and were asked to state whether each of the subsequent 10 serves were faster or slower than the immediately preceding one. Players were allowed up to 20 seconds between serves in accordance with ITF guidelines (ITF, 2009).

The warm-up consisted of: 3 minutes jogging at a self-selected 'slow' pace and 2 minutes at a 'fast' pace; 8 minutes of whole body dynamic stretching; 10 minutes of rallying increasing in intensity and 3 minutes service practice.

Service speed was measured using a StalkerPro speed gun (Stalker, USA) placed 4m behind the end base-line and in line with the intended direction of serve. Reported absolute errors for the speed gun are very small (± 0.04 $m.s^{-1}$). It is acknowledged however that serves to either side of the sensor of the speed gun would contain inaccuracies; these were estimated to be up to 0.25%.

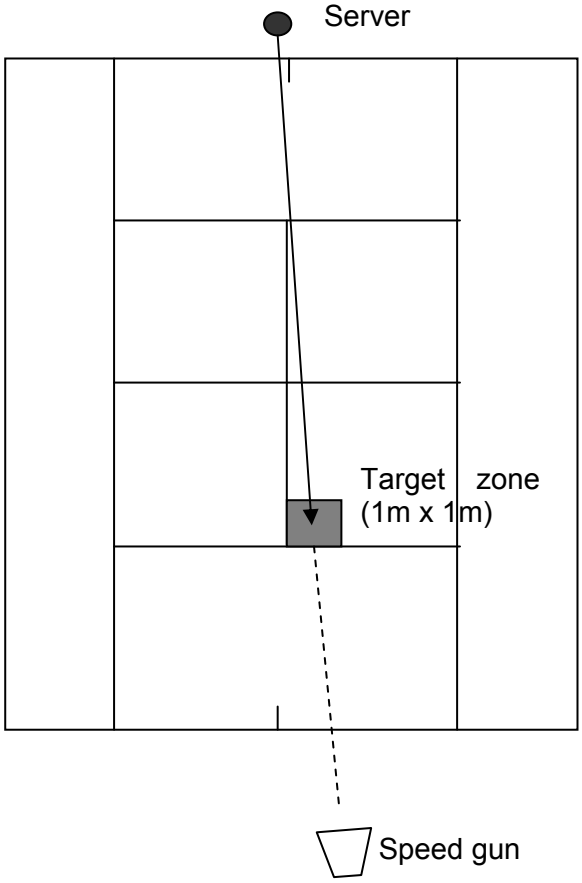

Figure1: Experimental set-up

Data Analysis: A Wilcoxen signed rank non-parametric test was employed (α = 0.05). The two variables used were (i) the number of correct differentiation (faster/slower) out of 10 and (ii) the number of correct differentiations expected due to chance (5).

RESULTS: No significant difference was evident between the number of correctly differentiated serves (4.9 ± 1.5) and the number of serves expected to be differentiated correctly due to chance (5) [p = 0.92]. This indicates that tennis players could not correctly determine if consecutive serves were faster or slower than each other. The average speed of serve was 46.9 ± 4.5 $m.s^{-1}$, and the average difference between serves was 1.1 ± 0.5 $m.s^{-1}$ (Table 1).

DISCUSSION: Newell (1991) suggests that knowledge of the service speed in tennis is extremley important in technique enhancement, as it provides information by which an individual can judge whether a particular movement action was more or less appropriate than previous attempts. The present study indicates that players can not accurately differentiate service speed between consecutive serves. If they can not do this between consecutive serves, it is very unlikely that they can differentiate between non-consecutive serves. The consequence of this is that tennis players can not use knowledge of results, based on their own perception of service speed, as a means of guiding and fine-tuning their technique. From the available data it is not possible explain why two subjects (participant 1 and 2, Table 1] had a higher number of correct identifications, but this could clearly be by chance only.

Table 1. **Participant ability to identify if their service speed was faster or slower than their preceding serve**

Participant	Correct out of 10	Ball Speed ($m.s^{-1}$)	Difference in speed ($m.s^{-1}$)
1	7	41.5	1.3 (0.7)
2	8	43.6	2.4 (1.1)
3	4	53.3	1.5 (1.0)
4	5	51.6	0.8 (0.6)
5	4	44.3	1.1 (0.9)
6	3	46.3	1.0 (0.8)
7	5	53.7	0.8 (0.7)
8	5	45.4	0.7 (0.6)
9	5	47.3	0.8 (0.9)
10	5	48.2	1.2 (0.8)
11	3	40.6	0.8 (0.7)
Mean ± SD	4.9 ± 1.5	46.9 ± 4.5	1.1 ± 0.5

Unfortunately, no previous studies appear to have investigated the ability of elite standard tennis players (or any standard) to differentiate between the speeds of consecutive serves hit as fast as possible. Similarly, no studies could be found that investigated this ability in other high speed ball-projection based sports where the full flight path of the ball is impeded (e.g. by a wall, net etc).

For novel (non-sporting) tasks Magill (1998) suggests that in performing a movement as quickly as possible a person can initially differentiate whether the movement was faster or slower than the previous one and subsequently utilise enahnced techniques; however, such enhancements seem to stop at a certain level of performance due to a person's inexperience and therefore decreased capability to discriminate small movement-speed differences (Magill, 1998). It is unclear from the present study if the inability to differentiate between serves in terms of speed is related to either, or both, the relatively high speed of serve (46.9 ± 4.5 $m.s^{-1}$) or the small variation in each player's service speed (1.1 ± 0.5 $m.s^{-1}$, which is approximately 2.3% of the ball speed); however, given the level of expertise and prior training of the participants, it is unlikely due to inexperience.

The findings from the present study would suggest that if speed of serve is to be used to optimise service technique, it may be necessary to use an appropriate measuring device (such as a speed gun), but this needs investigating.

Finally, it is worth noting that a number of sports/sports actions make it diificult to identify ball projection speed (e.g. pitching in baseball, penalty kicks in soccer, forehand drive in tennis) bacause a playes can not see how far the ball would travel without interference from an another player or the environment. It would be worthwhile to determine if athletes from these sports could accurately differentiate ball projection speeds and whether this is dependent on the skill level or experience of the player.

CONCLUSION: Elite junior tennis players are unable to accuractely judge whether their tennis serves are faster or slower than their preceding serves. It is therefore unlikely that without the help of external augmented feedback (e.g. from the coach or a measuring device) they would be able to use this information to effectively guide the development of a more optimal technique.

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