Cardiff School of Sport
DISSERTATION ASSESSMENT PROFORMA:
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Dissertation title:	How the Importance of the Serve Varies between Gender and Different Court Surfaces
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Comments	Section
	Title and Abstract (5%) Title to include: A concise indication of the research question/problem. Abstract to include: A concise summary of the empirical study undertaken.
	Introduction and literature review (25%) To include: outline of context (theoretical/conceptual/applied) for the question; analysis of findings of previous related research including gaps in the literature and relevant contributions; logical flow to, and clear presentation of the research problem/ question; an indication of any research expectations, (i.e., hypotheses if applicable).
	Methods and Research Design (15%) To include: details of the research design and justification for the methods applied; participant details; comprehensive replicable protocol.
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	description of critical findings.
	Discussion and Conclusions (30%) [2] To include: collation of information and ideas and evaluation of those ideas relative to the extant literature/concept/theory and research question/problem; adoption of a personal position on the study by linking and combining different elements of the data reported; discussion of the real-life impact of your research findings for coaches and/or practitioners (i.e. practical implications); discussion of the limitations and a critical reflection of the approach/process adopted; and indication of potential improvements and future developments building on the study; and a conclusion which summarises the relationship between the research question and the major findings.
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CARDIFF SCHOOL OF SPORT

DEGREE OF BACHELOR OF SCIENCE (HONOURS)

SPORT AND EXERCISE SCIENCE

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How the Importance of the Serve Varies Between Gender and Different Court Surfaces

(Dissertation submitted under the discipline of Performance Analysis)

Ben Gauna

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HOW THE IMPORTANCE OF THE SERVE VARIES BETWEEN GENDER AND DIFFERENT COURT SURFACES

Cardiff Metropolitan University

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Firstly I would like to express my appreciation to friends and family for their generous support and help in keeping my motivation levels high. In addition, I would like extend special thanks to my dissertation tutor, Peter O'Donoghue for being there from the beginning to the end. Throughout this study he was very approachable and his knowledge helped provide advice and guidance in how this study should be carried out which was gratefully received.

ABSTRACT

The aim of this study was to see how the importance of the serve varies between different Grand Slam court surfaces and gender using up to date information. The study analysed male and female matches taking place at the 2013 Grand Slams; Australian Open (N=88 male, N=91 female), French Open (N=88 male, N=86 female), Wimbledon (N=69 male, N=69 female) and the US Open (N=88 male, N=78 female). The data regarding the key performance indicators being analysed were collected through IBM Pointstream. Matches were excluded from the study, if a match was not complete due to an injury or any other reason. Sometimes IBM Pointstream did not have all the service data and these matches were also excluded from the analysis. The data gathered was put into the SPSS statistical package to allow for analysis. A Mann-Whitney U test was carried out to see if there were any significant differences (p<0.05) between genders at the found Grand Slams. A series of Kruskal-Wallis H tests followed between the four Grand Slams, one for males and another for females. Finally if a significant difference was observed (p<0.05), a series of Mann Whitney-U tests were carried out between each tournament where a performance indicator was significant. P values of less than 0.008 were considered as significant. This study found that the likelihood of winning a point whilst serving was influenced by both gender and tournament. It showed that the importance of the serve is greater for males than females as significantly less breaks of serves or occur (p=0.000). The serve is also the most important for both males and females at Wimbledon with serves reaching their highest velocities (Male = 184.4kmh, Female = 158.5kmh) and more aces (Male = 10, Female = 5) occurring on this surface. A consistent finding was that players win more points on serve than when receiving making it a pivotal shot within tennis. This study has laid a base for future research and It can help coaches and players in there preparation and tactics for each Grand Slam tournament.

CHAPTER I

INTRODUCTION

Introduction

1.1 Background

Tennis is a dynamic and intricate game which involves using a hand-held racket that is used to propel a ball between two or four players with a purpose of placing the ball in such a position that a player is unable to return it successfully (Lees, 2003). To enable for this to occur player's repeatedly make decisions on positioning and placement of shots (O'Donoghue and Ingram, 2001).

There are various tactics a player could utilise to win a point during a tennis match including the serve and service return. These are a standardized couple of actions that within the modern era have an essential role on deciding an outcome to a match. The serve in tennis is considered by many to be the most important stroke and is the only closed skill within the game (Sweeney *et al.*, 2012).

Men's Grand Slam matches are the best of five sets and females are the best of three sets, therefore strategies could vary throughout a match. Glam Slam tournaments take place on different surfaces, which affect player's strategies right through the season and their preparation going into the tournaments.

Within the game of tennis, the serve has such a crucial role and it is imperative to understand how. Previous studies have looked at the importance of the serve (Furlong, 1995; O'Donoghue and Brown, 2008), the effectiveness of the serve (O'Donoghue and Ingram, 2001), how the serve velocity affects the serve (O'Donoghue and Ballantyne, 2004) and the probability of winning break points at Grand Slam tournaments (Knight and O'Donoghue, 2012).

1.2 Rationale

Research has stressed the importance of the serve, but has not taken into consideration how this changes between the playing surfaces and genders. Especially the court surfaces at the US open (DecoTurf) and Australian Open (Plexicushion).

No previous studies have combined all the service performance indicators associated with the importance of the serve. Coaches and players preparation for competitions can be influenced and enhanced with a greater understanding of the importance of the serve. Statistical information about the problem solving of game situations is objective and comparable as it can be expressed numerically or in percentages. Subsequently, Filipčič

et al. (2011) stated that players and coaches must control training effects and monitor development during tennis matches through various notation analysis tools.

1.3 Aim

The aim of the study is provide up to date information concerning how the importance of the serve varies between court surfaces and gender using the 2013 Grand Slam tournaments to gather data for the relevant performance indicators.

1.4 Hypothesis

The null hypothesis is:

- Surface and gender did not have an influence on the importance of the serve of elite tennis players at Grand Slam tournaments

The alternative hypotheses are that:

- The importance of the serve of elite tennis players at Grand Slam tournaments were significantly influenced by the surface, with service breaks being less frequent on the faster surfaces such as grass.

- The importance of the serve of elite tennis players at Grand Slam tournaments were significantly influenced by gender.

1.5 Scope of the Study (De-Limitations)

Matches where a player was forced to retire for any reason was not included in the study, due to the possibility of the injured player having differing service statistics before and after the injury occurred.

Regardless of the number of points that were played in a match, all completed matches were included in the study as long as they met the criteria outlined by the study.

The study only looked at key serving statistics to determine how important the serve is; therefore other aspects of a player's performance were ignored.

1.6 Limitations

Only matches with all serve statistics provided by IBM Pointstream for each Grand Slam tournament were included in the study.

The study is dependent on the reliability of the data gathered from IBM Pointstream.

The physical and mental states of the players were not taken into consideration as the number of matches each player has played during the tournament was not considered.

The study didn't take into account matches that may have been suspended due to bad light or rain, giving the players an opportunity to improve their physical condition as well an opportunity to alter their strategies before resumption of play.

CHAPTER II

LITERATURE REVIEW

Literature Review

2.1 Serve Strategy in Tennis

Tennis is a dynamic and complex game which at the elite level has become one of the most lucrative sports. The serve starts off every point within a tennis match, consequently it is the one shot a player has full control over. Sweeney *et al.* (2012) stated that many consider the serve to be the most important stroke in tennis because it is the only closed skill within the game. The serve can facilitate winning the point either indirectly through the advantage gained in the rally after a great serve, or directly through a service winner or an ace (Gillet *et al.*, 2009).

A player can gain an advantage within a point through a variety of ways, with the serve being one of them. Being able to win points on serve is an essential skill for tennis success (Brody, 2004). O'Donoghue and Ingram (2001) established that both male and female serving players won more points than the receiver at all of the Grand Slam tournaments. In the modern era, the serve has an essential role on determining the result of a match despite being a standardised action. The serve has been considered a critical event within a rally, because the server can gain an instant advantage (O'Donoghue and Brown, 2008). In contrast, the receiver needs to overcome the server's advantage by gradually recovering the deficit from the return. A receiver will have more opportunities to take control of the point taking the advantage away from the server if an opponent has a poor first serve or second serve. Due to the nature of elite level sport, any weakness will be exposed and exploited. The margin between players is marginal; therefore the outcome of a match can be decided by how a player serves throughout.

A significant difference existed between the French Open and other Grand Slam tournaments when Takahashi *et al.* (2009) analysed time factors in elite male tennis player. The study involved a different number of matches at three of the four Grand Slams and took into consideration matches in different rounds at the Grand Slams. Second round matches were analysed in the French Open whereas fourth round matches were used for Wimbledon and US Open. In spite of this Takhashi *et al.* (2009) recognised that a different service strategy is needed depending on the speed of the surface. This was due to the average time duration of first and second serve being longer at the French Open than Wimbledon and the US Open.

Players can vary many aspects of the serve to help them become more effective. O'Donoghue and Ballantyne (2004) looked into service speed whereas Unierzyski and Wieczorek (2004) investigated the service placement. Gale (1971) used a mathematical model which demonstrated serve dominance and effectiveness from first and second serves. O'Donoghue and Ingram (2001) added additional support to the importance of the serve as they found that at all four Grand Slam tournaments the serving players won the majority of points in both men's and women's singles. Gillet *et al.* (2009) underlined the influence the serve and service return have on the outcome of a match, even on clay, which is widely known as the slowest court surface within tennis.

2.2 Performance Indicators

It is worth considering the differences between performance indicators and variables, as all performance indicators are variables but not all variables are performance indicators (O'Donoghue, 2010). A performance indicator is an objectively measured performance variable (Hughes and Bartlett, 2002). They represent a valid measure of performance and a valid means of interpretation (O'Donoghue, 2010). Choi (2008) showed that the selection of key performance indicators is a critical decision. An essential step for analysing performance is making a selection of valid performance indicators (Hughes and Bartlett, 2002). O'Donoghue (2008) stated that it is necessary to have an optimal set of performance indicators, but these must be small enough in number so the related variables can be entered reliably especially if the data is being recorded in real time.

Principal component analysis identifies broad dimensions within a set of variables where some variables are correlated (Manly, 2005). The key motivation for the use of principal component analysis was the concern about related performance indicators being selected and others being omitted (Csataljay *et al.,* 2008). Choi (2008) described how principal component analysis should be used along with other techniques to identify key performance indicators. However, a final set of key performance indicators should include the opinion of an expert coach (O'Donoghue, 2008). The identification of key performance indicators confines the data collected and produces an optimal set of performance indicators (O'Donoghue, 2008; Choi, 2013). The opinion of the expert coach helps to establish which performance indicator is more important than the others. Nonetheless, the final set of key performance indicators will be a compromise between what the coach needs and what can feasibly be entered into the system (O'Donoghue, 2008).

Frequencies or relative frequencies of behavioural occurrences are usually the way performance indicators are reported (Hughes and Bartlett, 2004). They fail to offer sequential data but provide statistics that can help summarise a performance. However, Choi (2013) stated that the purpose of the performance indicators used needed to be taken into consideration as some indicators may favour technical or tactical evaluation. Problems can occur with the reliability of performance indicators especially if there are no clear operational definitions. For example, one observer may define an unforced error differently to different observer therefore different statistics would be recorded from the same match between the observers. If a clear operational definition is provided the chances of getting the same data would vastly increase.

In tennis, players are more successful when serving than receiving (Furlong, 1995). The analysis of serving performance can include many different aspects, mechanical aspects (Drianovski and Otcheva, 2002), tactical effectiveness (Croucher, 1998) as well as service strategy (King and Baker, 1979). O'Donghue (2013) used numerous service performance indicators (percentage of first serve in, percentage of points won when first serve was in, percentage of point won on second serve, percentage of aces, percentage of doubles, mean first and second serve speed) when comparing typical profiles of Novak Djokovic and Roger Federer for their matches in the 2010 and 2011 Australian and US Open. In addition, Knight and O'Donoghue (2012) looked at the probability of winning break points in Grand Slam men's singles tennis. Some of the performance indicators they used within this study were break points per game and service breaks per game. All the performance indicators mentioned can be directly and indirectly influenced by the serve. Key performance indicators are used on all Grand Slam websites with professional players and coaches taking a genuine interest. An example of this is Alexandr Dolgopolov after a Quarter-Final victory in the BNP Paribas Open, Indian Wells, 2014, he was interviewed about how he served and replied:

"I don't think I served quite as well as I did the whole tournament because the ball is a little bit fast here and I couldn't get my percentage high."

This is clear reference to his first serve percentage and something he would like to improve as he goes further on in the tournament.

2.3 Tournament/Surface Effect

Throughout the year, tennis players compete on a variety of different surfaces. The International Tennis Federation (2007) court surface classification states that there are three different categories (slow, medium and fast) concerning surface speed. The French Open played on the clay courts at Roland Garros is categorised as a slow surface. Grand Slam tournaments such as the Australian Open and the US Open are played on medium paced surfaces. Fast surface speeds are found on grass courts at venues such as Wimbledon. In Grand Slam tournaments, O'Donoghue and Ballantyne (2004) found that the service speed on both first and second serve is positively correlated with the proportion of points won when the serve is in. In contrast, the proportion of serves that landed in was negatively correlated with the service speed. The serve will hold greater importance on faster surfaces as the server will win a greater percentage of points on serve than slower surfaces. In addition they would serve with greater velocities therefore expecting to have a lower first serve percentage.

An analysis of strategies on the four different court surfaces using the Grand Slam tournaments was carried out by O'Donoghue and Ingram (2001). A key finding from the study was that the lengths of rallies produced were longer on the clay courts at the French Open and shorter on the grass courts at Wimbledon, therefore concluding the length of rallies is influenced by the court. An explanation for these findings could be that at the French Open, significantly less service winners and aces were served than at Wimbledon. The receiver has a greater opportunity to return the serve and regain equilibrium within a point at the French Open compared to other surfaces due to the slower and higher bouncing nature of the courts (Filipčič *et* al., 2011).

Previous studies (Ferjan, 2001; Šantl, 2006) have shown that the winner of a match won more points in total and more points in succession than defeated players. Therefore the ability to win consecutive points will be easier on faster surfaces especially if a player can utilise their serve. Winning points in succession will be more difficult for the returners on the fast surfaces therefore it will have greater significance if they can win a sequence of points. On the other hand slower surfaces put the onus on the servers to prevent the returners from winning a series of points.

Furlong (1995) looked at how important the serve is within tennis; however his study had flaws as it assumed that all sets did not contain any breaks of serve if it went to a tiebreak. Despite this, he concluded that the serve held greater importance in men's singles than

female singles and on grass courts than clay courts. Filipčič *et al.* (2011) stated an opportunity to take the opponent's serve or an opportunity to win the game served by the opponent signifies a break opportunity. When a player is serving during a match, they win the majority of the points therefore making a break of serve crucial in the outcome of a match. On faster surfaces, opportunities to break someone's serve occur a lot less frequent therefore if a player was to get broken they may struggle to break the serve of their opponent (Filipčič *et al.*, 2011).

Schonborn (1999) found that the number of points won when returning serve is higher on fast surfaces than on clay courts. In spite of this, it is far more difficult to return a serve on faster surfaces (Hughes and Clarke, 1995). This could be because, if the receiver can get the service return over and in on a fast surface, it will be travelling a lot faster than a return of serve on a slower surface. Consequently service effectiveness depends directly on opponent's serve-return skills (Gillet *et al.*, 2009). If the opponent's serve-return skills are of a very high quality, they will be able to make a lot more returns on the faster courts and a lot more effective returns on the slower courts. As a result, no matter what surface a tennis match is being played on, the beginning of each point in a modern tennis game seems particularly essential and even decisive for increasing the chances of winning the point.

2.4 Gender Effect

The tennis tactics implemented during a tennis match, seem to vary depending on the gender of the tennis player, especially on the serve. Over 30 years ago King and Baker (1979) concluded that women benefited from hitting a 1st serve aggressively compared to a conservative 2nd serve. McMahon and de Mestre (2002) challenged this and found that women should have a conservative approach on both serves; whereas male players should have an aggressive approach on both serves. O'Donoghue and Ballantyne (2004) findings coincide with these findings because on the first serve, male players won a greater percentage of points when the serve was in, whilst serving faster and getting a lower percentage of serves in. Although male players served faster on the second serve, served significantly more aces and got a greater proportion of their serves in than female players. Paserman (2007) found that as the stakes become higher in women tennis matches, for example a break point, the likelihood of a return winner by the opponent increases as significantly slower first serves are hit. This could also explain why there are greater numbers of service winner returns in women's singles than in men's singles. Holm

(1987) explained the reason for this maybe that female players concentrate on the sufficiency, positioning and anticipation of service return.

The serve was the predominant shot for male tennis players accounting for 45%-60% of strokes during service games (Johnson and McHugh, 2006). Significantly more aces and service winners were hit by men than women therefore adding substance to previous research that claims the importance of the serve is far greater in the men's game than women's. Cross and Pollard (2009) revealed that male tennis professional serve one ace for every eight serves. Venderlin *et al.* (2004) attributed the greater number of aces per match in men's matches than female matches due to the disparity in the physical strength, stature and service speed between the genders. In comparison, Furlong (1995) stated that the service in women's singles is simply a means of putting the ball into play. O'Donoghue and Ingram (2001) found that at Wimbledon and the US Open, both men and women won over 70% of points when the first serve went in, whereas at the French Open and Australian Open, men won over 65% and women won over 60%. The ability to serve aces, serve winner and to hit winners on the third shot of the rally is a big advantage within men's singles (O'Donoghue and Brown, 2008). In contrast, the server has lost all the advantage gained by serving if a rally reaches three shots within women's singles.

CHAPTER III

METHODLOLGY

Methodology

3.1 Participants

This study analysed the matches at the 2013 Grand Slam tournaments as each were played on a different surface; Plexicushion (Australian Open), Clay (French Open), Grass (Wimbledon) and DecoTurf (US Open). The matches analysed were all matches from the opening round at each Grand Slam tournament. The players have had to earn the right to play in the tournament through their performances during the year, resulting in a group of very high standard players. Grand Slam tennis matches consist of a best of three set match for women and best of five set match for men. If for any reason, such as an injury to a player, a match was not completed, the match was excluded from the analysis. Some of the matches did not have all the serving data, such as serve speed and other data appropriate for the performance indicators being analysed, therefore these matches were also excluded from the analysis. Over the four grand slams in 2013 a total of 333 male and 324 female matches fell within this criteria and were analysed (Table 1).

Table 1. Number of matches analysed in the study

	Male	Female
Australian Open	88	91
French Open	88	86
Wimbledon	69	69
US Open	88	78
Total	**333**	**324**

3.2 Instruments

There is an internet database which consists of statistics for all tennis matches played at each Grand Slam venue called "IBM Pointstream". The data regarding the key performance indicators in question was collated using IBM Pointstream. The data was collected from the Grand Slam tournament websites, Australian Open (Australian Open, 2013), French Open (French Open, 2013), Wimbledon (Wimbledon, 2013) and US Open (US Open, 2013). These websites of the Grand Slam tournaments all contain IBM Pointstream allowing for data to be gathered in relation to the appropriate performance indicators.

3.3 Procedure

The data gathered from each match within each grand slam was compiled into a spreadsheet manually in Microsoft Excel. For each match recorded, two sets of data were obtained, one for each player within the match. The data gathered consisted of:

- Gender
- Tournament
- Round
- Outcome of the match
- Players current world ranking
- Name
- Opponents current world ranking
- Opponents name
- Number of 1st serves in
- Total number of serves
- Points won on 1st and 2nd serves
- Number of 1st and 2nd serves
- Number of aces
- Number of double faults
- Number of break points saved
- Number of break points faces
- Average 1st and 2nd serve speeds

Once the data was gathered, percentages of key performance indicators were established prior to uploading into Statistical Package for the Social Sciences (SPSS) for statistical analysis. These were percentages of first serves in, points won on 1st and 2nd serve, aces, double faults, break points faced and saved.

3.4 Reliability

For each Grand Slam tournament, one men's and one women's singles match was analysed using a hand notation system (Table 2) for a quasi-estimation of the reliability of data. As a couple of Grand Slams had been completed by the time this investigation got underway, full match highlights were obtained and observed from YouTube

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(http://www.youtube.com/ accessed 09/01/14). The matches observed were completed and did not stop short for any reason such as an injury or disqualification.

Table 2. The hand notation used during the reliability testing

Performance Indicators	Player A	Player B
No of 1st serves in		
No of 2nd serves in		
Points won on 1st serve		
Points won on 2nd serve		
Aces		
Double Faults		
No. BP faces		
No. BP saved		

A simple hand notation system (Table 1) was devised and used during the observation of the singles matches. The data recorded were those used from IBM Pointstream online in the data collection process. When a specific event occurred it was recorded using a tallying chart process. Once completed, each variable was counted and then compared to the statistics gathered from the relevant sources. Some data was missing, for example the total number of 2nd serves, so to work this out the double faults and number of 2nd serves in had to be added together.

Brown (2004) defined an ace as a winning serve that a receiver cannot touch with the racket and a double fault as a failure on both attempts to serve into the proper court. If either of these two events occurred it was noted in the hand notation system. When a serve was successful, meaning the serve landed in the correct box and the receiver could get his racket to it, it was noted as either a 1st or 2nd serve in. When the server won a point, it was recorded with particular attention placed on whether they won the point on their first or second serve. A break point is when a receiver has a chance to win the game with the next point. Finally, if a server faced a break point or even saved a break point it was recorded.

Percentage error testing revealed 100% agreement between the observer and the IBM Pointstream data across all eight matches for all performance indicators. This is due to each performance indicator having a very common and simple operational definition. In

addition during the reliability process the umpire and line judge's decisions aid the observer, especially if they cannot clearly see if the ball has landed in or out.

3.5 Data Analysis

The data gathered was put into descriptive statistics using the SPSS statistical package to analyse the data. Initially, to see if there were any significant differences between genders at the four Grand Slam tournaments, a Mann Whitney-U test was conducted. Within each Grand Slam tournament there were two sets of data as the data acquired was divided into male and female. A series of Kruskal-Wallis H tests were carried out between the four grand slams, one for males and another for females where P values below 0.05 were deemed significant. Where there was a significant difference observed, a series of Mann Whitney-U tests were carried out between each tournament, meaning 6 were carried out. As there are a series of 6 Mann Whitney-U tests done for each performance indicator that is significant, p values of less than 0.008 are considered significant. This restricts the family wise error rate to 0.05 and avoids type I error inflation.

CHAPTER IV

RESULTS

4.1 Results

Table 3. Mean (2dp), standard deviations (2dp) and Kruskal Wallis Test (KW) results of some service performance indicators.

Gender	Tournament	%1In	%W1	%W2
Male	Australian Open	62.05±6.69$^{£\$}$	71.77±9.49	50.60±11.16
	French Open	62.53±7.57$^{£\$}$	69.16±9.79$^{£}$	51.35±11.23
	Wimbledon	65.23±6.19$^{\$}$	74.87±9.39$^{\$}$	52.58±11.35
	US Open	59.79±7.39	71.14±10.07	49.61±10.61
	All	62.20±7.24	71.56±9.88	50.95±11.10
	KW	0.000	0.000	0.161
Female	Australian Open	62.33±8.13	62.10±15.28	43.53±13.33
	French Open	63.97±9.21$^{\$}$	62.02±11.52	45.41±13.14
	Wimbledon	63.44±7.03$^{\$}$	64.17±12.31	46.45±11.40
	US Open	60.99±9.55	63.11±12.69	44.77±14.03
	All	62.68±8.63	62.79±13.10	44.95±13.08
	KW	0.019	0.203	0.198
Mann Whitney U Between Genders		0.550	0.000	0.000

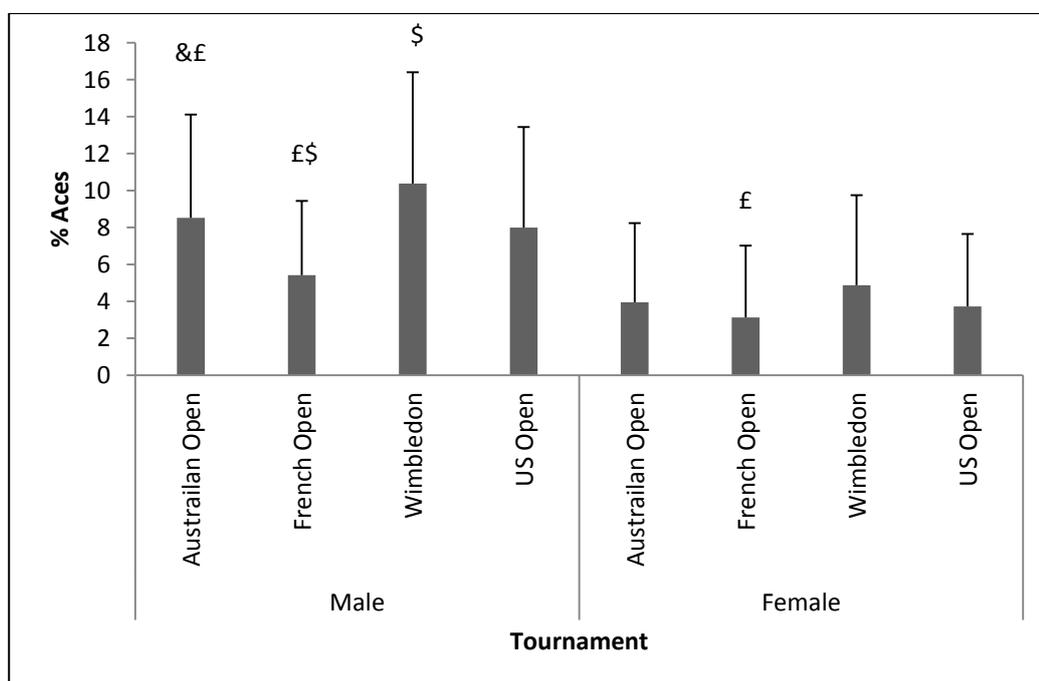$^{\&}$ Mann Whitney U test reveals a significant difference to the French Open

$^{£}$ Mann Whitney U test reveals a significant difference to Wimbledon

$^{\$}$ Mann Whitney U test reveals a significant difference to the US Open

A significant surface effect was observed for percentage of first serves for both males ($p < 0.05$) and females ($p < 0.05$). Males had the greatest percentage of first serves in at Wimbledon in comparison to the US Open where the lowest percentage of first serves in was observed. This means that a male player is more likely to get a first serve in at Wimbledon in contrast to the other Grand Slam tournaments. Females were more likely to get a first serve in at the French Open as a higher percentage of first serves in was obtained. Similar to males, females were less likely to get a first serve in at the US Open as that is where the lowest percentage of first serves in occurs (See Table 3).

The chances of winning the point on a first serve was more likely to occur at Wimbledon as this is where the highest percentage of points won on first serve was attained for both males and females. In particular compared to the French Open and the US Open for males a significant difference was observed. Both males and females won the least amount of points at the French Open due to the playing surface. The standard deviations were greater for females than males at each Grand Slam tournament meaning there was a greater variation of data. A significant surface effect occurred for males ($p<0.05$) on percentage of points won on first serve unlike females ($p<0.05$) where no significant surface effect was observed (See Table 3).

Once more, the chances of winning the point on a second serve were at its highest at Wimbledon for both genders. In contrast at the US Open males had the lowest percentage of points won on second serve whereas this occurred for females at the Australian Open. No significant surface effect was observed for both males and females. A significant percentage of points were won on 1st ($p<0.05$) and 2nd ($p<0.05$) serve by male players than female players. In addition there was no significant gender effect on percentage of first serves.

[&] Mann Whitney U text reveals a significant difference to the French Open

[£] Mann Whitney U test reveals a significant difference to Wimbledon

[$] Mann Whitney U test reveals a significant difference to the US Open

Figure 1. A graph to show the mean percentages and standard deviations of aces per match per Grand Slam

A Mann Whitney U test between genders showed that overall there was a much greater chance of a male player hitting an ace than a female player as there was a significant gender effect on the percentage of aces hit (p=0.000). Furthermore a Kruskal Wallis Test showed a significant surface effect for both males (p<0.05) and females (p<0.05). Figure 1 shows the chances of hitting an ace for males were significantly higher at Wimbledon than at any other Grand Slam tournament. In addition, females hit a greater percentage of aces at Wimbledon (4.87%). In comparison the chances of a female hitting an ace at the French Open was less likely than at the other Grand Slam tournaments as the percentage of aces hit was the lowest (3.13%).
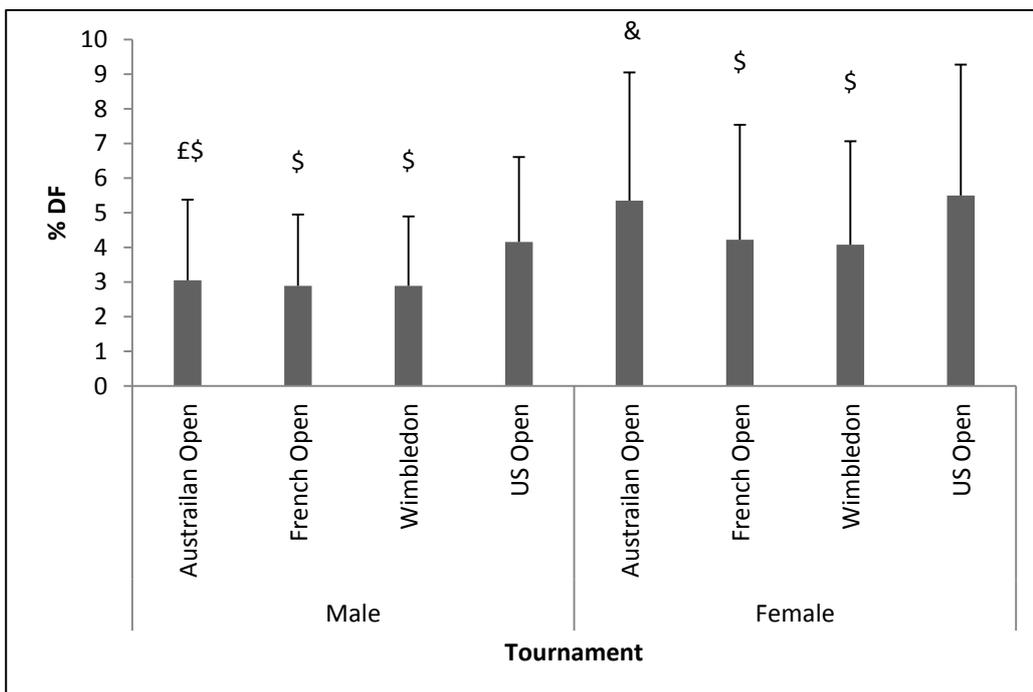

& Mann Whitney U text reveals a significant difference to the French Open

£ Mann Whitney U test reveals a significant difference to Wimbledon

$ Mann Whitney U test reveals a significant difference to the US Open

Figure 2. A graph to show the mean percentage and standard deviations of doubles faults per match per Grand Slam

A significant percentage of doubles faults were hit by females as opposed to males (p <0.05) therefore females were more likely to hit a double fault than males. Figure 2 shows that at the US Open, males (4.16%) and females (5.5%) had significantly greater percentages of double faults than the rest of the Grand Slam tournaments except the Australian Open for females. Double faults were the least frequent at the French Open (2.89%) and Wimbledon (2.89%) for males and at Wimbledon (4.08%) for females. There

was a significant surface effect between tournaments for both males ($p < 0.05$) and females ($p < 0.05$) for the percentage of double faults hit per match.

Table 4. Mean (2dp), standard deviations (2dp) and Kruskal Wallis Test (KW) results of the Break Points statistics

Gender	Tournament	BP Faced	% BP Saved
Male	Australian Open	8.35±4.57	61.77±19.96
	French Open	8.76±4.56$^£$	57.31±22.50$^£$
	Wimbledon	7.13±4.36$^\$$	65.48±23.63$^\$$
	US Open	9.03±4.80	59.92±21.50
	All	8.35±4.63	60.81±21.98
	KW	0.004	0.003
Female	Australian Open	12.52±5.77$^£$	51.15±24.10
	French Open	11.62±5.62	51.56±21.85
	Wimbledon	10.74±4.86	54.35±24.09
	US Open	12.09±6.05	53.40±24.04
	All	11.80±5.64	52.48±23.50
	KW	0.045	0.506
Mann Whitney U between Genders		0.000	0.000

$^\&$ Mann Whitney U text reveals a significant difference to the French Open

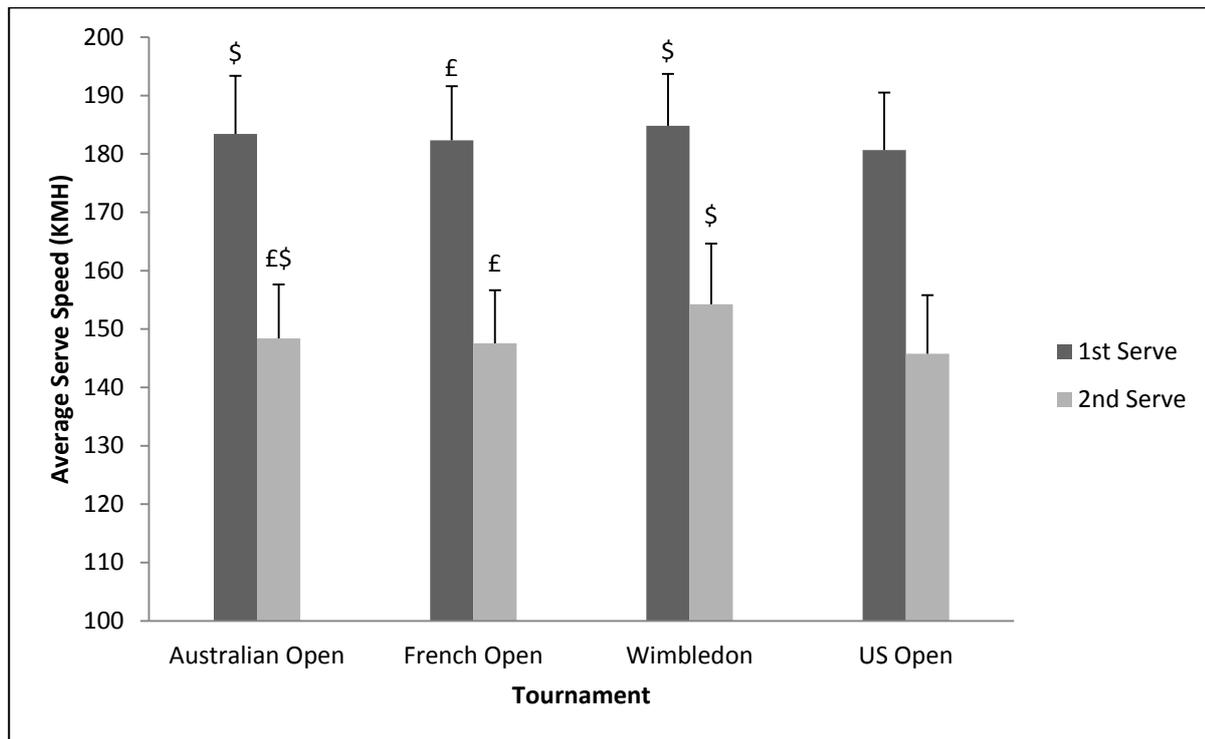$^£$ Mann Whitney U test reveals a significant difference to Wimbledon

$^\$$ Mann Whitney U test reveals a significant difference to the US Open

When serving, male players faced a greater number of break points at the US Open and faced the least amount of break points at Wimbledon. Whereas females faced the least number of break points at Wimbledon but faced more break points at the Australian Open. The standard deviation was greater at all the Grand Slam tournaments for females than males showing greater variation in the data. At Wimbledon males saved a higher number of break points whereas at the French Open, the male servers saved the least number of break points. Similarly females saved the most amounts of break points at Wimbledon but unlike male servers, they saved the least break points at the Australian Open (See Table 4).

A significant number of break points faced and percentage of break points not saved by males ($p < 0.05$) than females ($p < 0.05$). In addition both genders ($p < 0.05$) had a significant

gender effect on break points faced and percentage of break points not saved (see Table 4).
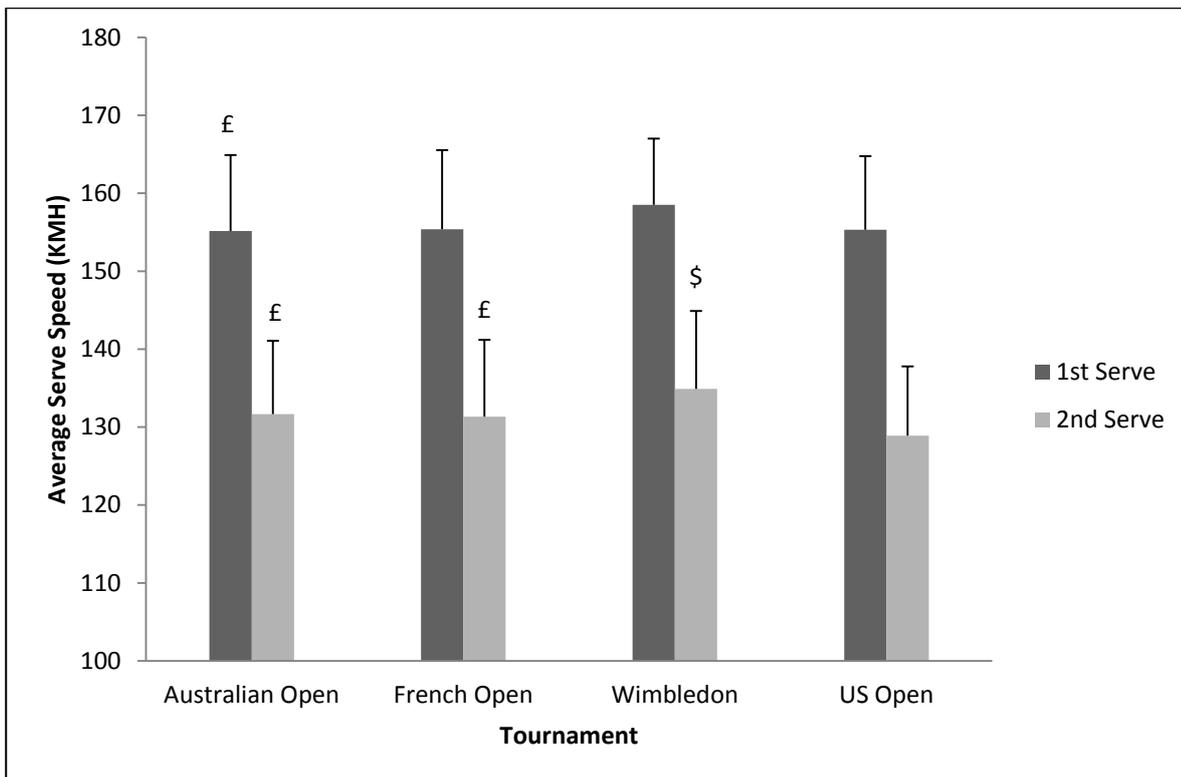
Figure 3. A graph to show the male average 1st and 2nd serve with the standard deviations for each Grand Slam

The Kruskal Wallis Test showed that there was a significant surface effect for both the average speed of the first ($p<0.05$) and second ($p<0.05$) services. Figure 3 shows males hit their first serves quicker than the second serves at the Grand Slam tournaments. The average speed of the first serve at Wimbledon (184.83KMH) is significantly greater than the average first serve speed at the French Open (182.34KMH) and US Open (180.66KMH). Similarly, the average second serve speed is significantly higher at Wimbledon (154.24KMH) than all of the other Grand Slam tournaments. Therefore males serve quickest at Wimbledon in contrast to the US Open where they serve the slowest for both first and second services.

Figure 4. A graph to show the female average 1st and 2nd serve with the standard deviations for each Grand Slam

Figure 4 shows the average first and second serve speeds were significantly quickest at Wimbledon. The Australian (155.15KMH), French (155.38KMH) and US (155.31KMH) Open had very similar average first serve speeds. The slowest average second serve speed occurred at the US Open (128.9KMH). Parallel to the males, a Kruskal Wallis Test showed that there was a significant surface effect for both first ($p < 0.05$) and second ($p < 0.05$) average serve speeds. The Mann Whitney U test showed a significant gender effect on both first ($p < 0.05$) and second ($p < 0.05$) services.

CHAPTER V

DISCUSSION

Discussion

5.1 General Serve

Many have described the serve to be the most important shot in tennis (Bollettieri, 1995; Schonborn, 1999; Kleinoder, 2001). More often than not players have a first serve percentage greater than 50% and when the first serve goes in, they win the majority of points. If a player misses a first serve they win around 50% of the points. As a result the probability of a player saving a break point varies depending if they get their first serve in or not. This supports O'Donoghue and Ingram's (2001) findings that male and female players win more points when serving than the receiver during a match. Throughout a Grand Slam tournament a server is very unlikely to go through a tournament without facing a break point. On average the males face 8.35 and females 11.80 break points per match. Therefore having the ability to get a first serve in on these crucial points increases chances of success.

First serves are also faster than second serves. A reason for this could be the fact the player knows they have two chances but if they miss the first serve they have to get the second one in or they will give away the point. Slowing down the serve will help make the serve more accurate and therefore increases the chances of the ball going into court. Taking this into consideration, if a player hits a very high percentage of first serves in they are more than likely not going to lose the game when serving which gives them a greater chance of success within the match.

5.2 Gender Effect on Serve

A significant gender effect was identified for all performance indicators except the percentage of first serves. This is contrary to O'Donoghue and Ballantyne (2004) findings, as they found that male players got a lower percentage of first serves in than females. Furthermore, Furlong (1995) suggested in women's singles, they focus on getting their first serves in and achieving a high percentage of first serves. Therefore during this investigation, women were expected to hit significantly more first serves in than males.

Males hit first and second serves, significantly faster than females. A difference in physical strength of approximately 20% exists between males and females (Van Aken, 2002). Therefore males are expected to hit their serves faster than females which supports previous literature (O'Donoghue and Ballantyne, 2004; Venderlin *et al*., 2004). Males hit significantly more aces than females, which supports O'Donoghue and Ingram (2001)

findings who indicated the serve in the men's tennis is more of a weapon than in women's tennis. The greater number of aces hit by males and females could also be attributed to the extra physical strength male's possess (Venderlin *et al.*, 2004). In addition, females have a technically different serve to males, where greater emphasis is placed on slice serves (Van Aken, 2002). Slice serves do not create as much speed as flat serves, therefore limiting the speed at which a woman can serve.

Significantly greater percentages of points were won on serve in the males matches compared to the females. Males hit significantly faster serves than females therefore they were expected to win significantly more points whilst serving. O'Donoghue and Ballantyne (2004) findings support this as they found that the proportion of points won when the serve is in has been positively correlated with the serve speed on both first and second serves in all Grand Slam tournaments. Males serve more aces and yet less double faults than women. The greater number of aces males hit also help increase the amount of points won on serve, therefore increasing the percentages of points won on each serve. In addition, females have a significantly higher percentage of double faults per match, which could be one of the reasons why they win significantly fewer points on their second serves.

The game score within a set can influence performance in tennis, as well as the point score within a game (Croucher, 1986; Morris, 1977). Therefore a break point is a very important point within a game and has the potential to influence performance. Females faced significantly more break points than males throughout the Grand Slam tournaments. Males win more points on serve, which means the receiver has significantly fewer chances of gaining a break point compared to females. Females tend to have differing intentions on their serve compared to males therefore impacting the thought process of the returners. Furthermore, this study showed that men have significantly faster serves than females therefore male returners have less time to react than females. The accumulation of these factors, makes returning easier for females. Therefore females have a greater opportunity of winning points on the return of serve and increasing their chances of earning a break point.

5.3 Tournament/Surface Effect on Serve

The surface of a tennis court has an effect on serve and therefore a player has a different intention on their serve depending on the surface (O'Donoghue and Ingram, 2001). This study found that the males and females hit their first and second serves the fastest at Wimbledon. This supports the International Tennis Federation's (2007) court

classifications stating Wimbledon as a fast surface therefore faster serves were expected on this surface.

Males hit significantly faster first serves at Wimbledon compared to the other Grand Slam tournaments except the Australian Open. In addition they hit significantly faster serves at the Australian Open compared to the US Open. In comparison females only hit significantly faster serves at Wimbledon compared to the Australian Open. This is contrary to previous literature (O'Donoghue and Ingram, 2001; O'Donoghue and Ballantyne, 2004) which states that the slower serves occur at the French Open. Similar results were found for the second serve, where both males and females hit significantly faster serves at Wimbledon than at any other Grand Slam tournament and males hitting significantly faster serves at the Australian Open compared to the US Open. A reason for these unexpected results could be that in 2006, new balls were introduced into the professional game by the International Tennis Federation.

One of the main reasons the International Tennis Federation changed the balls, was to decrease the variation in game characteristics between different surfaces. Three variations of balls were introduced, type 1, type 2 and type 3. The type 1 ball is a slightly harder, fast-speed ball which is intended for use on slower court surfaces such as the French Open. The type 2 ball is the standard ball used on medium paced court surfaces whereas the type 3 ball is a larger, slow-speed ball for faster courts such as the grass courts at Wimbledon. Some of the findings conflict with the research prior to 2006 so it suggests that the introduction of new tennis balls by the International Tennis Federation may have been successful (O'Donoghue and Brown, 2008).

A significant tournament effect was found for the percentage of first serves in for males. At Wimbledon they hit significantly more first serves in than any other tournaments and at the Australian and French Open they hit significantly more in than the US Open. In addition males hit significantly greater percentages of double faults at the US Open. This study has proved that Wimbledon is the fastest surface; therefore male players can focus more on getting their serves in rather than generating pace. In comparison, the US Open has been proven to be the slowest surface so the players have to focus more on generating pace therefore losing accuracy and getting less first serves in and hitting more double faults.

There was a slight difference for females with them getting the highest percentage of first serves in at the French Open. In addition, hitting significantly more first serves in at the French Open and Wimbledon compared to the US Open. Furthermore, females hit a

significantly greater percentage of double faults at the US Open than at the French Open and Wimbledon. This supports the reasoning that they may also be trying to generate greater speeds on serve at the US Open like males therefore losing some accuracy.

Filipčič *et al.* (2011) defined serving effectiveness as points won on second serve. No significant tournament effect was found for both genders on percentage of points won on second serve. Consequently, the serve effectiveness for both males and females is the same at all tournaments. There is more pressure to get the second serve in than the first meaning the intention of the server is different.

Males hit a significantly greater percentage of aces at Wimbledon than at any other Grand Slam tournament. These results add further contradiction to Hughes and Clark's (1995) findings as they found no significant difference between the number of aces and service winners at the French and Australian Open. In contrast, these findings support O'Donoghue and Ingram (2001) who found that significantly more aces were served at Wimbledon than at the French Open and significantly more serve winners at Wimbledon than at the Australian and French Open. Both genders hit the lowest percentage of aces at the French Open. Females hit significantly less aces at the French Open than at Wimbledon. There is a higher coefficient of friction and a higher coefficient of restitution on the clay courts at the French Open than the other surfaces, resulting in a higher and slower bounce allowing the receiver more time to play shots than on faster surfaces (O'Donoghue and Ingram, 2001). In addition the ball bounces higher giving the opponents more time to get a racket to the serve therefore making an ace difficult to hit (Brody, Cross and Lindsey, 2002). An example of this in the current professional game is Rafael Nadal. He returns further back at the French open than any other Grand Slam due to the high bouncing nature of the surface. He knows he will get far greater time and therefore knows he doesn't have to be as aggressive on his return as at the other Grand Slam tournaments.

Both genders face the least amount of break points at Wimbledon. Males faced significantly less than the French and US Open and females faced significantly less than the Australian Open. Players generate a greater number of break points than expected and break serve more frequently than is expected based on the proportion of points won when receiving serve (Knight and O'Donoghue, 2012). Servers win more points on serve at Wimbledon therefore they are less likely to face a break point.

5.4 Combination of Tournament/Surface and Gender Effect on Serve

There were two performance indicators where a significant court surface effect was found for males but not females. These were the percentage of points won on first serve and the percentage of break points saved. A significant gender effect was found between genders with males winning a significantly greater percentage of points on first serves than females. However no court surface affect was found for females unlike males where a significant surface affect was found.

The serving efficiency of the first serve is defined by the percentage of points won when the first serve lands in (Filipčič *et al.*, 2011). The results help provide support to the statement made by Furlong (1995) that a women's main intention when serving is simply to get the ball into play to start off the point. This means, that they are less likely to hit fast speeds on their first serve and aim for fine margins. These tactical intentions from women means they don't look for the surface to have an effect on the serve and do not look to gain an upper hand at the start of the point. Taking this into consideration the chances of a women hitting an ace or setting up the point from a serve is less than when a male serves.

No significant tournament effect was found for females on the percentage of points won on the first serve. In comparison males won significantly more points on first serve at Wimbledon than the French and US Open. Greater service speeds are reached at Wimbledon therefore increasing the chances of hitting an ace or winning the point on serve meaning the highest percentage of points won on first serve should be at Wimbledon. These results help support O'Donoghue and Ingram's (2001) findings that more serve winners and aces were hit at Wimbledon. Males have advantages when serving as they have the ability to serve aces and serve winners as well as play winners on the third shot of the rally (O'Donoghue and Brown, 2008). Consequently, a significance court surface effect was expected for males as they can utilise the differences in the court surfaces but not females, due to the differing tactical intentions of both genders.

Males saved a significantly greater percentage of break points than females. A reason for this could be that males win significantly more points on first and second serve than females therefore giving them greater chance of winning the point when a break point occurs. In addition it could be due to the fact they faced significantly fewer break points so if they saved the same number of break points as a female player the percentages for each player would be different. Knight and O'Donoghue (2012) investigation suggested the probability of winning a point in men's singles at Grand Slam tournaments is dependent on

whether or not the point is a break point. The investigation showed that players break serve more frequently than is expected based on the proportion of points won when receiving serve.

The serve effectiveness depends directly on the opponent's serve-return skills (Gillet *et al.*, 2009). No previous studies have analysed the percentage of break points saved for females and there was no significant difference between the tournaments. This is in comparison to the males where there was a significant difference between the tournaments. This suggests that the court surface affects a male's match more than a female's match. A significant court surface effect for females was expected as, the serve is more difficult to return on faster surfaces such as Wimbledon but studies (Hughes and Clarke, 1995; Schonborn, 1999) have shown the number of points won when returning on faster surfaces is higher. A reason for this could be a female's inability to get as many cheap points, such as an ace or a service winner, than a male. The ability to execute a powerful serve with good placement increases the chances of winning the point therefore becoming an invaluable skill if a competitor can do this on a break point.

Males save a significant greater percentage of break points at Wimbledon than at the French and US Open. This is contrary to the findings of Schonborn (1999) where a greater number of returning points would be expected on the fast surfaces therefore fewer break points being saved. A reason for this could be the ability of male tennis players to hit faster serves which increases the chances of hitting an ace and gaining control of a point. In contrast no significant difference was found for females, as they do save a greater percentage of break points on the faster surfaces at Wimbledon.

5.5 Coaching Aspect

Coaches at an elite level place greater importance on tactics rather than technique (Unierzyski and Crespo, 2006). Gaining a greater understanding on strategies and how points are won on differing court surfaces and how males win points differently to females will help progress the coaching process.

At the Bollettieri academy, they teach their students that a strategy will vary depending on the court surface. Taking this into consideration, professional players will implement different strategies on different surfaces therefore leading to different service statistics and placing a differing emphasis on the importance of the serve.

All court players have more success on hard courts (Bollettieri, 2001). Coach's look to implement variety into a player's game as on a hard court surface a distinct style of play is not as obvious as on a grass or clay court. This supports the results of this study as for the majority of the performance indicators, both the US and Australian Open seems to fall in between Wimbledon and French Open

Grass courts strategies involve coming forwards and standing closer to the baseline with flat and slice shots being hit (Bollettieri, 2001). Players and coaches have knowledge of this, therefore putting great emphasis on the serve on the faster surfaces as breaks of serve happen less often. Coaches are willing to sacrifice first serve percentage as they know it's a balancing act because a returner has a greater chance of winning a point when returning a second serve, as this study shows. Therefore as the preparations for Wimbledon begins, coaches tell players to take a few more risks as they will get significantly more aces and therefore win significantly more points on serve, as this study proves.

The principles for effective clay court play are movement, stand close to the baseline, physical shape, patience, attacking the opponents movement and mental toughness (Jaramillo, 2012). A successful clay court player usually has the following characteristics; a more consistent game, with very strong groundstrokes, patience and good physical endurance. However, clay court specialists often have their disadvantages, which mainly include being less focussed on the development of their serve and net game (Martinez, 2002). These principles do not consist of being aggressive with the serve but instead placing greater emphasis on setting up the points with the serve. Bearing this in mind, it is no surprise that this study found players win the least amount of points on serve at the French Open.

CHAPTER VI

CONCLUSION

Conclusion

6.1 Summary of Findings

The current investigation has described the advantage of serving in elite male tennis compared to elite female tennis. The serve within a males match at a Grand Slam tournament is greater than the importance of the serve within a females match. Break of serves happen a lot less frequent within men's tennis therefore making a break of serve even more crucial. If a male was to break an opponent's serve, the chances are that the set is over due to regularity of break serves that don't occur. Breaks of serves happen more frequent within female's elite tennis meaning a break of serve does not play as crucial part within a tennis match. Male's also have an advantage over females due to the ability to serve aces and hit serves with greater velocities, which has been put down the greater physical strength they possess. In addition, males and females hit a similar percentage of first serves in, meaning they are even more likely to win a greater number of points serving than receiving.

The greatest velocity of service speeds occurred on the grass courts at Wimbledon but the slowest serves did not occur on clay courts at the French Open but on the DecoTurf hard courts at the US Open. These results suggest that the introduction of new tennis balls by the International Tennis Federation in 2006 may have been successful. This investigation results, showed that the importance of the serve is at its highest on grass courts at Wimbledon. At Wimbledon, the least amount of break points are faced and a higher percentage of break points are saved, meaning if a break occurs, the chances of the player breaking serve to get back on level terms is less likely to occur than on any other surface and at any other Grand Slam tournament.

6.2 Practical Implications of the Study

This study found that the likelihood of winning a point whilst serving was influenced by both surface and gender. It will be beneficial for coaches and players in there preparation and tactics at a tournament. Coaches can use these findings to look at relevant serving tactics depending if their player is male or female and what tournament they are playing. Players can also use these findings very similarly to coaches; they can work out serving tactics and pattern of plays during a match where a coach cannot have an influence.

6.3 Potential Improvements

This study has laid a base for future research and It can help coaches and players in there preparation and tactics for each Grand Slam tournament. The performance indicators analysed throughout this study alone do not provide enough information on the importance of the serve. Combining service direction and service spin especially on the more important points such as break points is a recommended study for the future. Tennis is not only played on surfaces at Grand Slam tournaments therefore a look into other surfaces, such as indoor like the London O2 arena which hosts the Barclays ATP World Tour Finals would be beneficial. This study only looked at the importance of the serve in singles and at an elitist level, a look into doubles and juniors could help further knowledge in the future.

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APPENDICIES

Appendix A

When undertaking a research or enterprise project, Cardiff Met staff and students are obliged to complete this form in order that the ethics implications of that project may be considered.

If the project requires ethics approval from an external agency such as the NHS or MoD, you will not need to seek additional ethics approval from Cardiff Met. You should however complete Part One of this form and attach a copy of your NHS application in order that your School is aware of the project.

The document *Guidelines for obtaining ethics approval* will help you complete this form. It is available from the Cardiff Met website.

Once you have completed the form, sign the declaration and forward to your School Research Ethics Committee.

PLEASE NOTE:
Participant recruitment or data collection must not commence until ethics approval has been obtained.

PART ONE

Name of applicant:	Ben Gauna
Supervisor (if student project):	Peter O'Donoghue
School:	School of Sport
Student number (if applicable):	St20001697
Programme enrolled on (if applicable):	SES
Project Title:	Gender and tournament effect on Grand Slam tennis singles performance.
Expected Start Date:	23/09/2013
Approximate Duration:	7 Months
Funding Body (if applicable):	Click here to enter text.
Other researcher(s) working on the project:	If your collaborators are external to Cardiff Met, include details of the organisation they
Will the study involve NHS patients or staff?	No
Will the study involve taking samples of human origin from participants?	No

In no more than 150 words, give a non technical summary of the project
Observational analysis of movement of tennis from public domain footage.

Does your project fall entirely within one of the following categories:	
Paper based, involving only documents in the public domain	No
Laboratory based, not involving human participants or human tissue samples	No
Practice based not involving human participants (eg curatorial, practice audit)	No
Compulsory projects in professional practice (eg Initial Teacher Education)	No
If you have answered YES to any of these questions, no further information regarding your project is required.	
If you have answered NO to all of these questions, you must complete Part 2 of this form	

DECLARATION:	
I confirm that this project conforms with the Cardiff Met Research Governance Framework	
Signature of the applicant: Ben Gauna	Date: 21/03/14
FOR STUDENT PROJECTS ONLY	
Name of supervisor: Pete O'Donoghue	Date: 31/10/13
Signature of supervisor: *Peter O'Donoghue*	

Research Ethics Committee use only	
Decision reached: A-3	Project approved ☑
	Project approved in ☐
	principle
	Decision deferred ☐
	Project not approved ☐
	Project rejected ☐

Project reference number: 13/05/128U	
Name: Peter O'Donoghue	Date: 01/10/2013

Signature: *Peter O'Donoghue*

Details of any conditions upon which approval is dependant:

Click here to enter text.