Tennis Conditioning Blueprint 2021

Tennis Match KPIs

Journey to the Top 100

Having worked in elite Tennis since 2004 I've been fascinated with the physical determinants of Elite tennis performance. I have always felt that there must be something 'physical' that separates the elite players from the rest.

In recent years I've come to believe that *physical prowess is a prerequisite* to reach the top level of performance; therefore, all the top players will need to have similar physical attributes in terms of strength, power and speed. I think it was Dana Aga-Newman who described this as the ''price of entry'' you pay to get a ticket to the dance, but it doesn't tell us if you can dance- the top players can dance!

In Pacey Performance Podcast Episode 373, Dana goes on to say, ''You should always take your testing and try and compare it to the KPIs of your sport. So, start with that, and then with the metrics that are reliable then you want to be comparing them to the key actions and KPIs within the game, <u>so when this metric moves, that metric moves in the game as well.</u>

You can look at different levels of athlete, that would be your basic level of analysis, so are these metrics different in <u>lower-level athletes compared to say higher level</u> athletes? Then you could look at a regression approach where you are predicting 'performance' on the y axis and the (force plate) metric on the x axis; if the force plate metric moves, I know that I can expect to see a certain movement in this performance metric. And probably a more advanced way of doing it is to look at the <u>individual level</u> so you're saying with this individual athlete, when this metric moves, I expect to see this metric to move over here in this KPI."

Up until now, I have been unable to identify with confidence what the KPIs are of the sport of elite Tennis. Yes, I can tell you how fit, fast and strong an elite player is in a general sense, but I'm talking about *specific* metrics we can measure from competitive play.

There are emerging studies that have been published since the introduction of Hawk-Eye player and ball tracking technology that first entered the professional game in 2007. Observed tennis performance indicators related to serve and return of serve are sufficiently sensitive to discriminate between top 300 ATP players with variable number of win- loss matches (Filipcic et al., 2015).

Could it be that there are physical performance indicators that are also sufficiently sensitive to discriminate between top 100 players? This Ebook will take a closer look at some of the emerging research that may help us explore this in further detail.

But first, for those interested in the rise to the Top 100 a little background for you.

How Is Your Player Ranking Calculated?

Men’s ATP Tour

Your best 19 results of the year count towards your ranking. In an ideal scenario, a player/pair (especially top 30 ranked ones) is expected to score their ranking points from the four Grand Slams, eight mandatory ATP Masters 1000 events and seven ‘Best Other’ results from the ATP Cup, ATP Tour 500, 250, ATP Challenger Tour or ITF WTT men’s events.

However, for every Grand Slam or mandatory ATP Tour Masters 1000 tournament a player is not in the main draw owing to valid reasons (either not qualified or injured), the number of results from other eligible tournaments within the 52-week period that count towards rankings is increased by one.

For example, if a player misses one of the Grand Slams or eight-mandatory ATP Masters 1000 events, the seven ‘Best Other’ results that count towards their ranking goes up to eight to ensure the total number is 19.

Towards the end of the year, the ATP Finals are played with the top eight ranked singles players and doubles pairs preceding the tournament. For qualified players, the ATP Finals is considered as a bonus 20th tournament and the points earned counts in their ranking

Grand Slams: The four Grand Slams (Australian Open, French Open, Wimbledon and US Open) are the highest graded tournaments in the ATP tennis calendar. Here's the Grand Slam points system:

Winners: 2000 points

ATP Finals: If a player/pair, who qualified for the ATP Finals, wins the tournament undefeated, they can earn a maximum of 1500 points

ATP Masters 1000: There are a total of nine ATP Masters 1000 tournaments in a year – Indian Wells, Miami Open, Madrid Open, Italian Open, Canadian Open, Cincinnati Masters, Shanghai Masters, Paris Masters and Monte-Carlo Masters.

Winners: 1000 points

ATP Tour 500: The next level features the ATP Tour 500 tournaments.

Winners: 500 points

ATP Tour 250: The next grade of tournaments includes the ATP Tour 250 tournaments.

Winners: 250 points

Following these, we have the ATP Challenger 125, 110, 100, 90, 80, 50 tournaments followed by various levels of lower-ranked International Tennis Federation (ITF) events ($25k and $15k), known as *Futures events*, with descending number of points on offer (to get your first '1 ATP point' you need to win a round of main draw). Currently you need 668 points to break into the ATP Tour Top 100.

The first (of many) challenging part of playing professionally is being able to play futures events without having ATP points.

When players sign up for futures, the acceptance list is based on the ATP Ranking. There are 20 main draw spots and 48 qualifying spots. If players do not have ATP points, they will often find themselves deep on the alternates page on the acceptance list.

Alternates are the players waiting to get into qualifying. In futures, the players in the qualifying and alternate lists need to sign in to the tournament on-site the day before the qualifying starts.

The problem when players are starting to play futures (and have no ranking) is that there are often many players in front of them on the list, which can be deflating. It is hard to justify traveling to a tournament without knowing for a fact if that player will be able to compete.

That is not to say the qualifying draw will always fill up and you won't be able to play. In fact, most lower-level tournaments do end up having multiple spots not filled in the qualifying after sign-in. Regardless, starting your professional career can feel overwhelming from the get-go. Some people can rely on wild cards but that is a luxury most players do not have.

Earning that first ATP point is super important. Not only is it a great personal achievement, but it means a player will often be able to compete in any futures qualifying draw.

After you earn enough points at playing futures, you can graduate to the ATP Challenger Tour.

The cut-off will largely depend on the availability of other tournaments at any given week. Weeks that only have one or two challengers will have cut-offs in the three hundreds, where weeks where there are 4 plus challengers will see the cut-offs dropping to the five, six hundreds.

The challenger level is where we see a lot of the current stars break through. It is where the great get separated from the good. If you ever have the chance to go watch a challenger, do it. Entrance will most likely be free and you will watch high quality tennis all around. Most challenger events include one, if not a couple of current top 100 players.

Aside from Grand Slams, the ATP Tour events are the most well-known tournaments. As a player, the ATP Tour is where you want to be. The tournaments are bigger, there is more money and points involved and the atmosphere is awesome. The ATP Tour is the NBA of the tennis world. To consistently play ATP Tour events, a player will have to be ranked inside the top 100.

Women's WTA

A player's WTA ranking is determined by her best results at a maximum of 16 tournaments for singles and 11 for doubles. These must include points from the four Grand Slams and four mandatory WTA 1000 tournaments (Indian Wells, Miami, Madrid, Beijing), wherever possible.

Grand Slams: The four Grand Slams (Australian Open, French Open, Wimbledon and US Open) are the highest graded tournaments in the WTA tennis calendar. Here's the Grand Slam points system:

Winners: 2000 points

WTA Finals: If a player/pair, who qualified for the WTA Finals, wins the tournament undefeated, they can earn a maximum of 1500 points

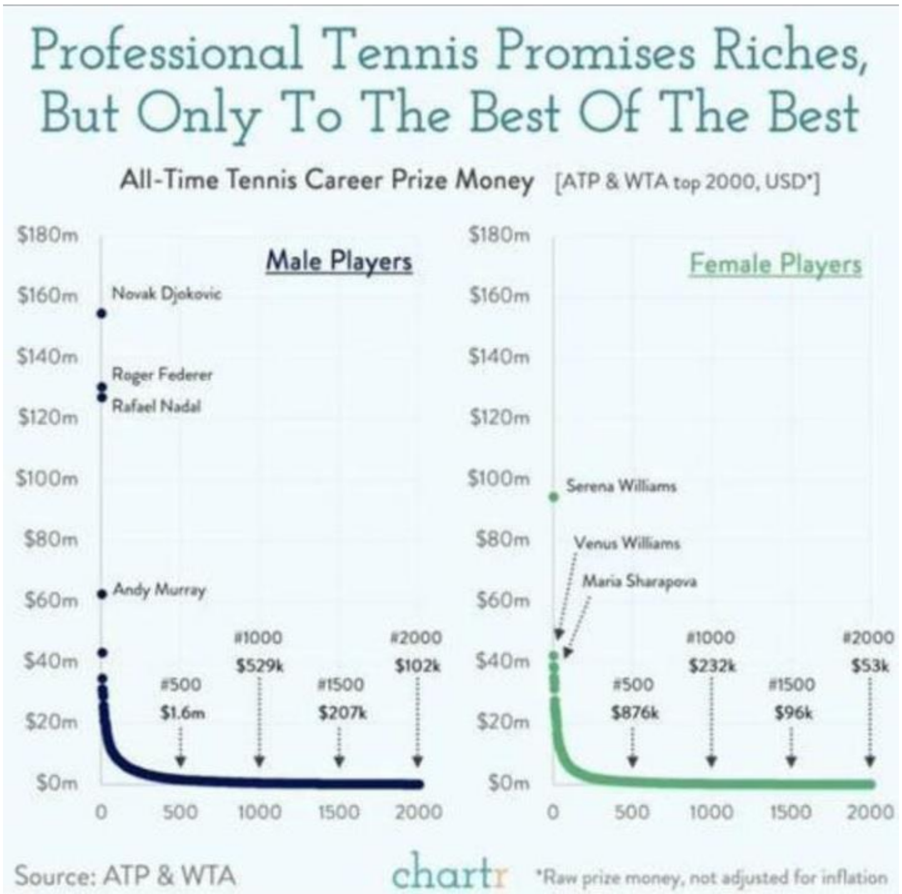
WTA 1000: (Beijing, Indian Wells, Madrid, Miami). These tournaments are mandatory.

Winners: 1000 points

WTA 1000: (Cincinnati, Doha/Dubai, Rome, Montreal/Toronto, Wuhan). These tournaments are not mandatory.

Winners: 900 points

There are the WTA 500, WTA 250, WTA 125 and various ITF tournaments ($15,000, $25,000, $60,000, $80,000 and $100,000) where players can score WTA ranking points. Currently you need 653 points to break into the WTA Top 100.



We can see in the diagram above **players need to break into the Top 100 otherwise they are just breaking even**- even if you had the fortune to have a 20-year career, $500k career prize money amounts to $25,000 per year which is not even enough to cover the costs of travel. A top 500 player might be earning $80,000 a year, which might cover travel costs but leaves no money for coaching.

The British Lawn Tennis Association estimates it costs about £250,000 ($385,000) to develop a player from age 5 to 18 (around £19,000 per year). Staying pro doesn't come cheap, either. The U.S. Tennis Association estimated in 2010 that the annual average cost to be a "highly competitive" professional tennis player was $143,000—including $70,000 for coaching and $60,000 for travel—and that only the 164 highest-ranked players on the men's tour would have broken even with such costs.

But if you break into the Top 100 the prize money skyrockets. And that's why players and coaches alike are obsessed with investigating the success metrics of Top 100 players.

A recent review of professional men's tennis revealed that 60% of the total prize money available is won by the top 1% (i.e., top 50) of players (ITF, 2015). Moreover, it was estimated that only players ranked higher than 336 earned enough money to cover their basic playing expenses.

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Tennis #1

Performance Indicators of Elite Competitive Tennis

Reid et al (2010). The relationship between match statistics and top 100 ranking in professional men's tennis.

A stepwise regression analysis showed that second-serve points won and second-serve return points were the most relevant match statistics, explaining 52% of the ranking variance in the men's game.

Predicted men's professional ranking = 548.5 + -666.6 * second serve points won + -319.9 * second serve return points won

Filipcic et al (2015). Differences in performance indicators of elite tennis players in the period 1991-2010

The aim of this study was to compare differences in 15 tennis match variables between two groups of top 300 male ATP players. Group 1 had a positive win-loss ratio (1991- 64%, 2000 – 62% and 2010 – 65%), and corresponded with an average player ranking of 45.2, 44.4 and 33.4 respectively. Group 2 had a negative win-loss ranking (1991- 39%, 2000 – 39% and 2010 – 40%), and corresponded with an average player ranking of 96.6, 103.4 and 98.4 respectively.

Group 1 achieved a significantly better statistical performance in selected aspects of the serve, return and in general matchplay, independent of the year. In 2010 significant differences between Group 1 and 2 existed in all but three of the 15 performance indicators. These included variables such as first and second serve points won, first and second serve return points won, and total points won.

On average, Group 1 players had more effective first serves (more aces) and second serves (fewer double faults), made more effective first- and second serve returns, and won more service games than the Group 2 players.

In professional tennis, research has shown that it is not only the effectiveness of the first serve that is important: the quality of the second serve and the return of the second serve are even more important. The present findings suggest that the observed performance indicators are sufficiently sensitive to discriminate between top 300 ATP players with variable number of win-loss matches.

Reid et al (2017). Differentiating top-ranked male tennis players from lower-ranked players using hawk-eye data: an investigation of the 2012-2014 Australian open tournaments.

Eighty players were assigned to either a top-ranked (n=40) or lower ranked (n=40) group, based on their ATP ranking.

Top ranked players achieved more success on serve (with respect to aces, accuracy and points won) and possessed a faster first serve return, compared with lower ranked players.

Top ranked players also played more groundstrokes from behind the baseline, delivered the ball deeper into their opponent's court, and covered greater distance during matches. Average speed and maximum speed did not differ between groups.

The Hawk-Eye system recorded ball and player movement data. The summary report of the data contained a total of twenty-eight performance metrics pertaining to serving, returning serve, groundstrokes and on-court movement that were analysed in this study.

Players aiming to infiltrate the top 50 in professional tennis should possess a proficient serve. Top-ranked players achieved more aces, which may relate to their capability of achieving faster maximal serve speeds. Accuracy was also foremost in top-ranked players, who possessed a greater first serve percentage.

These factors might explain why top-ranked players won a greater percentage of points on their first and second serve and underlines the importance of being able to win points on serve in professional tennis.

Interestingly however, average serve speed did not differ between groups and implies that velocity generation was similar in this cohort of professionals. For this reason – and based on first serve percentage data in this study – developing serve accuracy and/or direction should be at the forefront of coaches' intentions.

Top-ranked players executed a greater number of shots from behind the baseline, which is consistent with a *counter-punching strategy* where the player aims to return as many balls as possible (standing deeper permits greater court coverage). Top-ranked players also delivered 5% more of these groundstrokes to a deeper location in their opponent's court. This speaks to their offensive ability, as deeper balls are generally considered more difficult to play since they arrive faster and may afford top-ranked players an advantage during rallies.

Logically, these findings imply that practice drills should afford players ample opportunities to develop their groundstroke play from behind the baseline. However, it should be noted that average groundstroke speed, shot flatness (i.e., net clearance) and contact height did not significantly differentiate groups.

Thus, for groundstrokes – as appeared to be the case with the serve – accuracy may be more pivotal a differentiator of top- and lower-ranked players than speed.

Interestingly, top-ranked players covered greater distances during (1) entire matches and (2) points where they were receiving. This is seemingly consistent with the counter-punching strategy noted previously but could also indicate that top-ranked players: (1) recovered to centre court after each shot, and/or (2) took extra steps to execute strokes from more favourable positions. These data underlie the importance of movement and endurance capabilities in professional men's tennis.

In contrast, average and maximum movement speed data did not differentiate top- and lower-ranked players and – when considered alongside the stroke speed findings – presents the possibility that explosiveness is not a critical discriminator of ATP ranking.

Tennis #2

Workload Profiles of Junior and Professional Tennis Players

Reid & Kovalchik (2017). Comparing Matchplay Characteristics and Physical Demands of Junior and Professional Tennis Athletes in the Era of Big data.

Some basic differences in the serve and return characteristics of juniors and professionals have been highlighted. On serve, professionals hit fewer double faults and won relatively more first serve points than younger players. On return, professionals won more second serve return points, a likely product of a more aggressive approach to play.

Between 2000 and 2015 the median age of the top 1000 ranked junior boys was between 17.1 and 17.5 years. Among top 1000 professional men, the range was 23.0 to 24.2 years. Top 1000 junior girls were younger than junior boys, with median range between 16.8 and 16.9 years. Professional women in the top 1000 were also younger, having a median age of 20.8 to 22.9 years (lowest to highest ranked women). This implies a much smaller age gap among the junior and professional females (4 years) and a gap more comparable to the male players among higher ranked players (6 years).

Focusing on the top 1000 players in each circuit, we found that the highest ranked players, whether junior or professionals, competed in more events per year than lower ranked players. The median events for the top 250 boys was 21 and for professional men was 24, which was 11 and 13 events more than the median for players ranked 751-1000, respectively.

Top 250 boys competed in a median of 56 matches and top 250 professionals 60 matches, which were 33 and 41 more matches than players ranked 751-1000. Junior boys tended to have a higher match win percentage per rank group than professionals. These differences reduce as player ranking increased from less than 1% (1-250 junior and professionals, 64.2 - and 63.5% - win percentage per season, respectively) to 10% (751-1000 1-250 junior and professionals, 51.5 - and 41.2% - win percentage per season, respectively).

Event activity patterns between junior girls and professional women followed a similar pattern as the boys and men. However, differences in win percentage were large between girls and women ranging from 5% (1-250 junior and professionals, 65.1 - and 60.8% - win percentage per season, respectively) to 10% (751-1000 1-250 junior and professionals, 50 - and 40% - win percentage per season, respectively).

Match data from the 2017 Australian Open revealed a number of differences in the match characteristics of juniors and professionals. For both male and female players, professionals had a higher frequency of aces, a higher percentage of points won at net, and a higher percentage of winners relative to unforced errors (junior boys vs professional men; 39:61 and 49.7:50.3, and junior girls vs professional women; 34.0:65.8 and 42.9:57.1).

Professional men were found to perform significantly better than juniors across several service statistics, including service points won (overall), first service points won (boys 66.7% vs men 72.1%), and second service points won (boys 47.3% vs men 50.4%). However, the same difference was not observed for female players (first service points won girls 64.1% vs women 64.2%; and second service points won girls 44.3% vs women 45.6%).

Stroke production, measured as the number of shots played in a match, was generally greater for professional players compared to junior players. The differences were largest for male players, where the average production difference in a Grand Slam match was +62 on the serve (boys 72 vs men 134), on forehand was +97 (boys 140 vs men 237), and on backhand was +100 (boys 119 vs men 219) compared to the typical production in a junior Grand Slam match. For female players, the differences were +11 on the serve (girls 64 vs women 75), on forehand was +2 (girls 118 vs women 120), and on backhand was +21 (girls 89 vs women 110). We can attribute most of these differences in match format at men's Grand Slams which is best of 5 match format compared to the best of 3 match format for junior boys and all junior girls and professional women's matches.

Both male and female professional players show higher impact speeds compared to juniors, with the largest differences found on serve (median for men was 179 kph vs 158 for boys; median for women was 153 vs 146 for girls). Forehand shot speed was a median of 6 kph faster for men (119 for men vs 113 for boys) and 1 kph faster for women professional (111 for women vs 110 for girls). Similar differences were found in backhand shot speed for male and female players (108 for men vs 105 for boys; and 106 for women vs 103 for girls).

While professional men hit to the body on only 7% of first serves, junior boys hit to that region 19% of the time. A similar gap was found for female players, with junior girls hitting to the body on first serves 12 percentage points more often than professionals (28% girls vs 16% women). On second serves the differences persisted. Junior boys hit 48% of second serves to the body compared to just 31% for professional men. Junior girls hit an even higher percentage to the body on second serves (57%) which was 22% more than professional women (35%).

Professional men travelled greater distances per point (7.4m vs 6.9m). However, the average peak foot speed (12.0 kph boys vs 10.5 kph men) and changes of direction per point (6 boys vs 5 men) tended to be greater for junior boys compared to professionals. These factors contributed to a work rate per point that was a median of 27% higher for junior boys.

Junior girls also showed higher foot speeds (11.9 kph girls vs 9.1 kph women) and changes of direction per point (6 girls vs 4.5 women) compared to professional women.

As junior players rise in the professional ranks, they can expect to be competing in more events, matches, sets and games throughout the year. Even talented junior players can expect to have fewer wins as a professional and players will have to prepare psychologically for this change.

The margins differentiating winners and losers of matches at the professional level are significantly narrower than in junior matches. At the same, the average junior boy player might expect to experience a greater serve advantage as a professional, to find it more difficult to get break point opportunities (7.5% men vs 8.8% boys), winning less (37.5% men vs 42.9% boys), and play more tiebreaks.

Some of the largest differences we found between juniors and professionals were in the observed physical demands of play. Professional players play with more power and accuracy.

The largest difference in power was observed on serve where the men's serve was an average 20 kph faster than the boy's serve and the women's serve was 10 kph faster than the girl's serve, accounting for an increased serve advantage at the professional level. Serve placement also showed considerably fewer deliveries hit near to the lines at the junior level, which might be explained by technical and strategic skill as well as stature.

These differences highlight a considerable adjustment for junior players in the transition to the professional game where they can expect to play at higher speeds and closer to the margins of the court. It is also notable that the speed and changes of direction were actually higher for junior players, both boys and girls, compared to professionals.

Thus, while juniors have the potential to play at the same intensity as professionals, the sustainability of that effort is put to the test in the professional game, especially for transitioning male players.

Tennis #3

Sex-based differences of Matchplay Characteristics of Grand Slam tennis

Reid et al (2016). Matchplay characteristics of Grand Slam tennis: implications for training and conditioning.

Sex-based differences in the stroke and movement dynamics of Grand slam hard-court tennis were investigated through collection of player and ball tracking data for 102 male and 95 female players during the 2012-2014 Australian Open tournaments.

Serve statistics were the subject of the largest differences, with males achieving significantly faster speeds (first serve 184 vs 156 kph; and second serve 152 vs 131 kph), aces and unreturned serves while also winning a greater percentage of service points (first serve points won percentage men 69 vs 61 women; second serve points won percentage 49 vs 42). When returning serve, women contacted the ball closer to the net, lower to the ground and achieved flatter ball trajectories than males. Women return of first serve speed (97 vs 95 kph) and return of second serve speed (112 vs 110 kph) was faster than men.

Groundstroke frequencies were similar between sexes, although males hit with greater speed (111 vs 106 kph), flatter trajectories and impacted more shots inside the baseline.

Distance covered per set (572m men vs 553m women), or during points won or lost (mean metres covered: won point – men 10.24m vs 10.55m men; lost point – men 8.07m vs 7.57 women) was not sex dependent yet men exhibited faster average movement speeds (men 3.68 vs 3.43 ms).

Sex differences in explosive power – whose expression has been reported as 25-65% lower in females – may help to explain some of the disparity in service speeds. Logically, sex-based differences in the internal rotation strength about the shoulder of tennis players may also contribute. From a technical perspective, sex differences in *lower limb drive mechanics* and shoulder internal rotation have been presented as contributory factors.

The data depict that the typical groundstroke is a shot that is impacted considerably closer to waist height (contact height men 0.96m vs women 0.94m) and hit flatter (i.e., with lower net clearance), than both serve returns (contact height return of first serve men 1.27m vs women 1.17m; return of second serve men 1.50m vs women 1.37m).

In direct opposition to our hypotheses, female players were found to impact a significantly lower percentage of groundstrokes inside the baseline, as well as, more generally, produce groundstrokes with greater clearance over the net (net clearance men 0.69m vs women 0.77m women). Impact height and shot depth (the percentage of balls landing beyond the service line) were comparable between sexes.

In the context of training load management and overuse injury, it also raises the interesting prospect of whether players should prepare for what routinely happens, what *could* happen or both.

It would seem that either the accumulation of work or the intermittent nature of the sport – therein allowing for prolonged, sustained physical performance and adequate recovery between points – lessens the need for training session durations to specifically replicate the demands of matchplay.

Indeed, the expectation that players accumulate ''miles in their legs'' features predominantly in the narratives of former tennis professionals. It may be that the games combatants are simply reminding all stakeholders that tennis is a running game. This notion of training prescription provides an obvious avenue for future research.

Tennis #4

Training versus Matches

Murphy et al (2016). A Comparison of the Perceptual and Technical Demands of Tennis Training, Simulated Match-Play and Competitive Tournaments.

Data were collected from 18 high-performance junior tennis players (10 males and 8 females, age 16+/- 1.1 y) during 6 +/- 2 drill-based training sessions, 5 +/- 2 simulated match-play sessions, and 5 +/- 3 tournament matches from each participant. Tournament matches were further distinguished by win or loss and against seeded or nonseeded opponents.

Notational analysis of stroke and error rates, winners and serves, along with rating of perceived physical exertion (RPE) and mental exertion was measured post session.

Sessions were significantly shorter in duration than tournament matches. RPEs during training and simulated match-play sessions were lower than in tournaments. Mental exertion in training was lower than in both simulated match-play and tournaments.

Stroke rates during tournaments exceeded those observed in training and simulated match-play sessions. Furthermore, the serve was used more during tournaments than during simulated match-play, while errors and winners were similar independent of setting.

Training in the form of drills or simulated match-play appeared to inadequately replicate tournament demands in this cohort of players.

Ideally, training drills and simulated match play should mimic conventional or worst-case scenario tournament scenarios [Daz comment- but should they? What is the job of training? Isn't it also to help build knowledge and experience around game-based scenarios, which is a form of slow thinking problem solving, so that they have a clearer picture of what to 'perceive' and respond to using 'fast thinking' during match play?]

In other sports a primary objective of training is to replicate certain patterns of play, enabling players to cope with the highest demands placed on them during competitions.

Previous research (Murphy et al 2014) investigated internal (i.e., heart rate (HR) and ratings of perceived exertion (RPE), and mental exertion) and external (i.e., stroke rate) measures.

- Recovery/defensive drills were of greatest internal training load
- More open drills were characterized by higher peak and mean HR
- Matchplay and more closed or technical drills presented with lower peak and mean HR.

Note than external load can be measured using stroke rate but also ball velocity and distance covered via GPS.

Training-drill sessions were selected for drills that were of open nature only (in accordance with our previously reported data), as these drill types have the greatest physical and mental demands of typical elite-oriented tennis drills. Specifically, these types of drills consisted only of recovery/defensive, open-pattern, and 2-on-1 open drill categories. These drills were each typified by high strokes rates (>0.9 strokes/6 s), RPE (>5.5 AU), mental exertion (>5.8 AU), and % HRmax (>89%). Sessions were excluded from analysis post hoc if the aforementioned criteria were not met.

Matches within tournaments that were won were perceived to be of significantly greater exertion than matches lost. Furthermore, large effect sizes suggest that a greater mental exertion was perceived during simulated match play and tournaments than during training drills.

Tournament stroke rates (14/min) were also significantly greater than in simulated match play (10/min). This compared to a shot rate of 7/min in training. Within tournaments, stroke rates were similar in both matches won (13 ± 3.4 strokes/min) and matches lost (16 ± 6.2 strokes/min), as well as when playing a seeded opponent (17 ± 8.2 strokes/min) compared with nonseeded opponents (13 ± 4.2 strokes/min). 14/min represents a stroke rate of 0.23/s which compares to a peak of 0.81/s and 0.76/s for men and women at the Australian Open between 1997 and 1999.

Keeping in mind that the current investigation controlled for intensity of training drills, it can be interpreted that in order for mental exertion to approximate tournament match play, simulated competition or pressures (i.e., targets, time pressure) must be incorporated in training. Given that drills were selected due to their prominent physical intensity rather than technical focus, the current findings identify a somewhat perplexing disparity between stroke rates of training sessions (7 ± 1.0 strokes/min), simulated match play (10 ± 5.1 strokes/ min), and tournament matches (14 ± 3.6 strokes/min).

Such disparity may be due to the technical/tactical focus or development during simulated match play (i.e., tactical patterns, or stroke technique) in the corresponding training block

The work-rest durations of simulated match play demonstrated large effects for less work (i.e., time in play- 20 min) compared with tournament matches (29 min) and significantly less rest (i.e., stoppages) in simulated match play (30min) than in tournaments (51 min). Therefore, the work-rest durations revealed simulated match play to be less intensive (i.e., less work, less recovery).

Absolute and relative serve counts (serves/min) of simulated match play (46 ± 12.5 total, 2.6 ± 1.3 serves/min) and tournament play (90 ± 16.6 total, 3.4 ± 0.8 serves/ min) was higher during tournament matches than during simulated match play.

In addition, coaches should be mindful that even the most physically demanding training sessions and simulated match play were of lower RPE than tournament matches. With mental exertion in training also lower than both simulated match play and tournaments, it appears that tournament match play is currently difficult to replicate during training.

To effectively prepare athletes for the mental demands of competition, there appear to be limited alternatives other than through tournament matches.

Moreira et al (2016). Training intensity distribution in young tennis players.

Twelve professional tennis players participated in this study. Heart rate and session rating of perceived exertion were collected in 384 tennis training sessions, 23 simulated matches, and 17 official matches. The total training time spent in the heart rate zone-1 (52.00%) and zone-2 (37.10%) was greater than the time spent in zone-3 (10.90%) during the 5-week training period. (Zone-1 = <70%; zone 2 = 70–85%; zone-3 = >85% Heart Rate Maximum).

Similarly, the total training time spent in the session rating of perceived exertion zone-1 (42.00%) and zone-2 (47.50%) was also greater than the time in zone-3 (10.50%). (Zone-1 = low intensity RPE 4 or less; zone 2 = RPE 5-6 and zone-3 = 7 or more).

There was a discrepancy in the intensity distribution between training session (zone-1 = 42.00%; zone-2 = 47.50%; and zone-3 = 10.5%) and official tennis matches (zone-1 = 0%; zone-2 = 10.80%; and zone-3 = 89.20%).

A possible for this outcome might be related to specific demands imposed by real competition. For instance, the sports competition related stress could potentiate physiological (e.g., heart rate) and perceptual (e.g., RPE) responses.

The data of the present study suggest that the majority of the training sessions of these young tennis players were performed at low-to-moderate intensity zone and, therefore, under the intensity performed during actual tennis match play.

Twelve elite young tennis players (age: 18.5 +/- 0.4 years; height: 178 +/- 4.0 cm; mass: 72.4 +/- 6.0 kg) with a minimum experience of 5 years in tennis training, ranked between positions 242 and 1400 in the association of tennis professionals (ATP), participated in this study.

In the present study, there was a deliberate increase in training load during weeks 3 and 4; however, the pattern of training intensity distribution was not different between the 5-week period of the preparation phase. These results suggest that coaches manipulated the training load mainly due to the increment in training duration rather than intensity. The findings, therefore, suggest that the training session intensity was maintained at the same level across the entire preparation phase.

One could argue that this approach could be attributed to the tradition inherent to the training practices of tennis coaches, rather than to deliberate decision making, based on scientific evidence. However, as these athletes often are involved in a twice-daily training schedule, a greater number of high-intensity sessions could lead to the down-regulation of the sympathetic nervous system that has been demonstrated after severe and more prolonged training.

As the young athletes assessed in the current study typically train twice a day, the resting interval between training sessions varies between 4 and 6 h and, thus, appropriate management of the training intensity taking this frequency into account seems to be fundamental to avoid excessive training strain and sub-optimal adaptation. It is also important to consider that the coaches could deliberately choose to prescribe training intensity in the low-to-moderate zone in order to develop technical components. For technical development, it has been proposed that the training sessions should be conducted at a low level of fatigue, maintaining low lactate concentration, so that the major focus (technical training) can be achieved effectively.

The results of the present study do not guarantee that a greater amount of high-intensity training sessions is a better approach to achieve a higher performance level, due to more specific adaptations.

Future studies, including the manipulation of intensity distribution across the periodization phases, need to be developed. For example, periods with a greater amount of high-intensity training sessions could be compared with periods in an alternating high-low fashion, and with periods in which the low-to-moderate training intensity are maintained constant.

Tennis #5

Male Junior Elite vs sub-elite players

Fett et al (2017). Athletic performance, training characteristics, and orthopedic indications in junior tennis Davis Cup players

Twelve junior Davis Cup (DC) males (15.6 yrs) and two samples of regional squad (RS) players (RS1 60 males, 14.9 yrs and 47 females 14.6 yrs; RS2 59 males 15.2 yrs) participated in physical testing, an interview for data evaluation on training characteristics, and a questionnaire survey of injury frequency.

Results indicate higher physical performance levels and training volumes in DC (total hours including physical training; 22.7 hrs (15.1 + 7.6) vs 14.4 hrs (9.8 + 4.5 hrs). Effect sizes were greatest for grip strength, medicine ball forehand and serve velocity.

The qualities of the upper body strength and power related characteristics (i.e., Medicine ball and serve velocity) especially have to be highlighted with percentile values up to 85%.

It is reasonable to assume that the qualities of upper body power and strength are one of the determining factors in tennis performance as supported by the previous research.

Greater upper body power allows for the chance to improve tennis performance with higher stroke velocities. Since the modern game becomes faster, with the tennis serve being the most powerful and potentially dominant shot that influences the match result in the game of tennis, the implementation of high-serve velocities where 210 km/h serves are common, has led to an advantage in winning the rally either through an ace or indirectly due to a defensive situation of the opponent because of the given time pressure.

There was no difference in Injury frequency between groups, but there was a tendency toward higher rates in DC. The knee and shoulder are the areas where injuries occurred most frequently for both groups, and in the last 12-month, prevalence of upper extremities revealed highest scores for the shoulder (RS 32%, DC 44%), followed by wrist (RS 25%, DC 33%).

There is no consensus in the literature whether there is an increased or decreased risk of injury with increasing skill level. We suppose that the tendency of higher injury rates in DC could occur due to the evidently higher demands in DC, particularly in training volume and match participations (75.6 vs 57.2 singles matches).

Kramer et al (2017). Prediction of Tennis Performance in Junior Elite Tennis Players.

A total of 86 junior elite tennis players (boys, 44, and girls, 42) U13 (aged 12.5) and followed to U16 took part in this study. All the players were top-30 ranked on the Dutch national ranking list at U13, and top-50 at U16.

In boys U13, positive correlations were found between upper body power and tennis performance (R2 is 25%). This means the higher the upper body power, the higher the ranking.

In girls U13, positive correlations were found between maturation (age at PHV) and tennis performance (R2 is 15%). This means the earlier a girl has her APHV the higher the ranking.

In girls U16, only maturation correlated with tennis performance (R2 is 13%). This means the later a girl has her APHV the higher the ranking. No correlations were found between the variables and ranking at U16 for boys.

In terms of predicting future tennis performance, later maturing girls at U13 had better tennis performance at U16. For boys, none of the physical tests at U13 were a predictor for tennis performance at U16.

The mean APHV for both boys and girls was around the expected mean age of 14 and 11.8, respectively. Maturation did not vary much among players; the players measured in the current study were quite a homogenous group. This could affect the insignificant contribution that APHV played in tennis performance for boys.

A possible explanation for better tennis performance for later-maturing girls at U16 could be that later-maturing girls have to fight harder to reach the top than earlier-maturing girls, who have the advantage of their physical growth at U13.

This may raise the question of the best age for coaches to select their players for talent development programmes. Maturation and relative age should be assessed when selecting players for talent-development programmes. Lower body power, speed and agility did not predict tennis performance at U13. Not one physical fitness component measured at U13 was a predictor for tennis performance at U16. However, the players measured in the current study were all highly ranked (top-30 at U13) and therefore more homogenous in tennis performance.

It might be concluded that speed does discriminate between elite and sub elite youth players, but not within a group of elite youth players.

Tennis #6

Coach Approaches to Practice Design

Murphy et al (2014). A Descriptive Analysis of Internal and External Loads for Elite-Level Tennis Drills.

Fourteen elite-level junior tennis players (8 male, 6 female; age 15+/- 1.2yr with ITF junior ranking 91 +/- 72) completed 259 individual drills. Six coaches helped devise classifications for all drills: recovery/defensive, open pattern, accuracy, 2-on-1 open, 2-on-1 net play, closed technical, point play and match play.

Previous literature reveals that tennis matches (3 sets) typically comprise 300-500 high-intensity efforts over 1.5 to 4 hours. Stroke rates have been reported between 2.5 and 4.7 shots per rally (7.5 and 6.7 s rally, respectively), depending on gender and surface. During competitive matches, mean heart rate (HR) is between 130 to 170 beats/min, with peak HR reaching 190 to 200 beats/min. Ratings of perceived exertion (RPE) has been reported as ranging from 5 to 7 AU (arbitrary units on a scale of 1 to 10), with service games of higher intensity.

In this study notational analysis on stroke and error rates was performed post session. Drill RPE and mental exertion were collected post drill, while heart rate (HR) was recorded continuously.

Recovery/defensive drills had the highest RPE (6.5 AU), % maximum heart rate (MHR); 90%, peak heart rate (HR); 181, and mean heart rate (HR); 154. However, no significant HR differences were observed between categories.

Shot rate varied between 4/min (match play) to 12/min (open-pattern drills), with error rates varying from 11.8% (2-on-1 net play) and 11.9% (match play) to 19.2% (closed-technical drills). These compared to previous data for star (20/min) and box (23/min) drills, which were characterised by considerably higher stroke rates than the current drill categories in this study.

The discrete hand-fed nature of these drills (1 set, 6 repetitions), combined with high metabolic demand, suggest that star and box drills may not be sustainable if they make up the bulk of a 90- to

120-minute session. However, suicide (7/min) and big-X (8/min) were comparable to many of the drills in this study.

Recovery/defensive drills had a high error rate (17.3%) and a shot rate of 9/min making them highest in physiological stress and ideal for maximising physicality.

In this study, it appears that drill stroke rates during point play and match play are generally below the stroke rates reported from tournament data.

Therefore, stroke frequency during drills aimed at skill development is below that considered optimal to simulate tournament intensity, although it should be acknowledged that drills designed to achieve technical outcomes are usually not completed at tournament intensity. In any case, the current data show that while below tournament intensity, stroke rate was greatest in open-pattern drills, making these drills ideal for instilling 'match-like' stroke frequencies into training.

Currently there is limited literature reporting the error rates associated with tennis tournaments and training. In an analysis of seven hard-court men's singles matches of Association of Tennis Professionals (ATP) players ranked 1 to 63, error ratios described low, medium and high time-pressure situations on hard courts with respective error rates of 13.7%, 21.0% and 26.4% on the forehand with 13.5%, 16.8% and 25.6% on the backhand. [This equates to being able to make 5/6, 4/5 and 3/4 shots as time pressure increases from low to medium to high].

In this study the closed technical drills which were the least physically demanding (low stroke rates), produced the greatest error rates (19.2%). This is likely due to technical adjustments and changes in stroke mechanics during these drills, whereby errors are tolerated in the optimisation of technical outcomes.

However, the higher-intensity recovery/defensive drills (17.3%) also had high error rates, likely due to the heightened physical load. Coaches should take caution in prescribing drills of increased physical intensity when the focus is to alter stroke mechanics or specific movement patterns, as excessive loads may affect stroke performance.

Krause et al (2019). Assessment of elite junior tennis serve and return practice: A cross-sectional observation.

Practice tasks that more closely represent the demands of competition are thought to augment skill learning and transfer. This study observed the serve and return performances of junior grand slam tennis and used this benchmark to evaluate the representativeness of serve and return practice among elite junior tennis players.

The serve and return behaviour of 26 junior tennis players competing in junior Australian Open grand slam matches were observed and compared with the serve and return practice behaviours of 12 elite junior tennis players over an 8-week period.

The variables measured included the number of serves/returns landing in, serve/return type, serve direction and the variability of practised skills. Serve and return practice contributed to <13% of total practice time, with each skill predominately practised in isolation. Compared to the matchplay benchmark, players typically had less success (i.e., fewer serves/returns landing in the court), were less variable in shot selection and hit fewer serves to the extremities of the service box. As task representativeness increased fewer differences between practice and matchplay were observed. Tennis serve and return practice could be improved by better simulating specific competition affordances, providing greater opportunities to practice serve/return tactics and/or increasing the variability of practised skills.

Anderson et al (2021). Coach approaches to practice design in performance tennis.

Research demonstrates the benefits of a more contemporary, ecological-dynamics led approach in sport coaching; however, traditional methods of practice design persist.

Interviews took place with ten high performance coaches who worked within a national tennis performance network, of which six coaches had played professionally. Three common beliefs regarding player development emerged between participants: repeatable players, performing under pressure and individualised practice.

Repeatable players

A traditional approach to practice design refers to one based on a reproductive style of teaching; where athlete learning is perceived to take place via structured practice that includes demonstration of 'optimal' technique, extensive verbal feedback, and tasks that often isolate the learner from their performance environment.

The theory of 'deliberate practice' is one traditional approach to practice design, resulting in an overemphasis of practice volume over quality or type, resulting in athlete expertise being quantified or predicted according to practice volume.

This approach to practice and expertise has been criticised for its linear representation of learning, particularly as research suggests that learning is an intrinsically nonlinear process.

In an ecologically-led, nonlinear approach, learning takes place as a performer interacts with their environment. Athlete behaviour emerges under a variety of environmental, performer and task constraints.

Traditional approaches emphasis the belief that players need to be 'repeatable,' and defined this as players needing to be able to repeat shots or patterns of play in large volumes.

All coaches mentioned that they included 'drills' within practice sessions – describing blocked, repeated tasks which include a <u>high volume of shots hit and serial repetitions of the same actions or patterns of play.</u>

Although a wide variety of intentions were highlighted, technical and physical skills were identified as the key attributes that coaches intended for players to develop through drilling. Coaches rationalised drill-based tasks by stating that they felt repetition was necessary to embed and retain technical competence in players.

Technical skills

By including and repeating drills in practice, coaches intended to reinforce players' stored technical models of skill through high volumes of repetition. This demonstrates an understanding of skill as internal, cognitive and separated from perceptual information. Referring to the amount of time it takes to achieve technical competence also indicates coaches may focus on quantity of practice when considering player development, which is a feature of information-processing approaches to practice design.

Physical skills

Coaches also intended to develop player physical development through drilling. Coaches justified this approach to practice design by suggesting that players needed to be fit and physically robust in order to be 'repeatable.'

Coaches aimed to stimulate player physical development by prescribing high volume, high intensity tasks. Previous research demonstrates that these types of tasks require players to work together (cooperate) to keep the ball in play and focus primarily on quantity of balls hit, rather than shot quality or variation. This may be unhelpful within the competitive context of match play, resulting in player behaviour that was detrimental to player creativity and the perception of information from their environment.

Individualised Practice

Coaches believed that practice design should be different for each individual and to help coaches achieve individual development goals, coaches referred to ‘layering’ or progressing an action from ‘closed’ to ‘open’ by introducing one new variable at a time.

‘We’d show them the final skill in terms of a demo, or we’ve got a video of them doing it well or someone else doing it well. Then we would develop that skill by changing the feeds.’

- Make it really closed (hand feeds)
- Slowly build it up (feeding from further back or having to run onto the ball as opposed to being static
- Contrast it so if it’s a backhand, could they hit a forehand then hit the backhand?
- Then building it so it’s cooperative rather than basket feeds
- Then trading in neutral
- Then open it a little bit
- Then add decision making so almost layer it in one by one

Another example of layering from a coach:

- Challenge to receive a more difficult shot through a feed (or a live feed to make it tougher)
- Ask to send a more demanding shot, for example, with more pace or higher accuracy
- Request more movement to deal with the same shot
- Make the score more demanding, for example first 5 out of 10, then 8 out of 10 then 5 out of 5.
- I personally would only modify one of these four variables at a time.

These descriptions of practice demonstrate that coaches perceive ‘skill’ as an action to be achieved and embedded, contradicting the notion of a skill as a functional behaviour situated within the environment.

The method described here of demonstrating or showing the ‘correct’ action, followed by slowly adding layers of complexity and finally adding ‘decision making’ demonstrates an information-processing approach, where information and movement are decoupled, and performer and environment are considered separately.

This approach to skill as an action isolated from the environment and perceptual information may promote organismic asymmetry – a focus on the performer and their own structures and processes, rather than on the environment in which the performer resides.

Player Reflection

Organismic asymmetry might also occur through coach conceptualisations of problem solving. For example, the second approach that coaches used to individualise practice was to adjust their coaching style to facilitate player reflection. In adjusting their delivery, coaches intended to encourage players to find their own solutions to on-court problems.

Coaches intended their practice design to be athlete led (by asking them clarification questions- for example, what would you do differently?). However, as players describe the problem, they use cognition and reasoning, which mediates perception and encourages players to develop *knowledge about* the problem. This means that although players may be able to describe what they want to do, they may be less able to find a functional solution for themselves.

Instead, designing a variety of sport-specific practice environments and contexts within which learners interact may help coaches to develop players' knowledge of the problem, by enabling them to become more attuned to the information sources that constrain functional behaviour.

Tennis #7

APA Research into Distribution of Training in British Junior Elite Tennis Players

Statement #1

Training drills and simulated match play should mimic conventional or worst-case tournament scenarios (i.e., highest demands required during competition) depending on developmental stage of the involved players).

Statement #2

A day-to-day variation in training loads could maximize positive adaptations related to athletes' performance, whilst decreasing the likelihood for negative outcomes such as overuse injury, illness (i.e., upper respiratory tract infections), signs and symptoms of non-functional overreaching, suboptimal performance, or even the syndrome of overtraining.

Statement #3

Distribution of training sessions should be performed equally below, at, and above match intensities.

Statement #4

In order to be competitive, players must devote a great amount of time to improving their tennis skills and high demands of training workloads must be tolerated. A training workload of 15-20 hours per week of technical and tactical training is recommended to achieve high competitive levels, not including a further conditioning programme.

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