

How Our Player DNA Scores Work

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No two tennis players are exactly the same. Even the best players distinguish themselves in unique ways. Federer's textbook technique, Nadal's intensity, Serena Williams' power, or Halep's doggedness are all examples.

When we talk about the attributes we most identify with some players, we are talking about what gets to the core of a player—what, in other words, makes up a player's DNA.

But how do you put scores to a concept as complex as Player DNA? Such an intricate problem can't be taken up lightly.

Our GIG team went through a lot of careful deliberation to arrive at our method for measuring Player DNA. Our process raised a number of common difficulties in the analysis of performance data that we think makes our method of scoring as interesting as the scores themselves! So we decided to take some space to summarise our process.

The Four Dimensions of Tennis

In Major League Baseball, the sport that launched the field of sports analytics, there is a concept of the 'five tool player'. The *five tools* refer to a player's ability to hit for power, get on base, to run, to throw and to field. A player who can excel in all of these areas is considered a *complete* player.

To say a tennis player has a 'complete' game, what essential tools would he or she need to possess? This was the first question we had to tackle in developing the Player DNA. From our studies of tennis performance and our own observation of the game, we landed on four essential 'dimensions' of performance: **Technical, Tactical, Physical** and **Mental**.

Breaking Down the Dimensions

To rate a player's ability in any one of the dimensions, we needed to identify performance statistics that are strong markers of skill in that area. For some dimensions, the statistics required were fairly clear. Technical DNA, for example, wouldn't be complete without some measure of the speed and accuracy of the major strokes in the game.

The measures that should go into the scores for other dimensions were less obvious. In those cases, we brainstormed a broad list of possible stats and then selected a subset among these that had good discriminatory properties (high player-to-player variance) and minimal correlation with other measures (high information added).

A complete description of the set of performance statistics that went into each of our four tools of tennis are detailed below.

Rating Excellence

Using the data that is available to us — specifically, point level data from Grand Slams and shot-level tracking data from the Australian Open — raises a number of challenges to rating a player's performance on any particular skill.

Suppose you wanted to rate the power of a player's forehand with observations of forehands played at the past three years at the Australian Open. You might first consider ranking players based on their average forehand speed. But this approach would have multiple shortcomings.

First, if two players had the same average but one had played ten matches at the AO and the other had played only two, we should be more certain about the performance of the first player and weigh their performance more heavily. Second, average speed (like many other simple summaries of observed performance) is going to be biased by a player's playing style. An aggressive player like Lukas Rosol will have a higher average forehand speed than Rafael Nadal, because Nadal is more choosy about unleashing his most powerful forehand.

Another major source of bias for performance statistics in tennis is the opponent effect. Would it be fair to compare Marin Cilic's average forehand speed at the 2018 Australian Open to Alex De Minaur's? No, because Cilic faced multiple opponents, including the No. 1 and No. 2 players in the world, in his AO journey, while De Minaur only faced Tomas Berdych.

The above example illustrates the three major challenges that we faced when rating player skill in each area of the Player DNA:

1. Sample size
2. Playing style
3. Opponent effect

Our main strategy for dealing with these issues was to setup a statistical model for each measure that would help us to estimate a *player's how much better or worse a player's expected* performance is compare with an average player controlling for contextual factors and opponent strength. To account for differences in sample size, each player effect was measured with 'shrinkage': shrinking values towards an effect size of zero in proportion to our uncertainty about a player's performance.

To give a concrete example of the modeling approach, consider the *Court Control* measure of the Tactical DNA. To assess each player's Court Control, we took all instances in our AO tracking

data when the impact player had a spatial advantage, which we defined as playing a rally shot from a central location while their opponent was out wide. The outcome of interest was a player's ability to win the point within two shots from this situation controlling for each of the following factors: exact player positions, incoming shot characteristics, opponent's ranking group, and opponent's general rally ability. Using random effects for player, the model yields a shrinkage estimate of how much better or worse a player's Court Control is than the average player, accounting for differences in sample size.

The final part of our rating methodology is the transformation of the player effect sizes into more interpretable scores. The transformation is chosen to put scores on a 0-to-100 scale, and such that a positive 'six sigma' performance (being six standard deviations above the population mean) gives the best possible score of 100, a negative 'six-sigma' performance (six standard deviations below) gives 0, and an exactly average performance gives a score of 50. For example, Nadal is approximately 3 standard deviations above the average player in Court Control, which corresponds to a score of 97.

For consistency, the same standardization and transformation process is applied to each individual measure and each overall area. This is important because it allows like-for-like comparison, so that a score of 95 for one measure has the same statistical meaning as a 95 on any other measure. One consequence of this is that a player's overall score for a dimension is not simply the average of their component scores. For example, Andy Murray scores well across all five areas of his Tactical DNA: Rally Craft 86, Attacking Balance 95, Court Control 84, Time Control 81 and Wide Defence 88. This is uncommon amongst his peers, as only 5 male players score above 80 in all five components. Hence he is a top player tactically and rates very highly at 94.

There are many more interesting takeaways like these that can find below where we have tabulated the Player DNA scores for 56 male players and 59 female players. These scores are based on point-level data from Grand Slam matches and tracking data from the Australian Open matches played from 2016 to 2018. The subset of players shown are the group who had sufficient match data during those years that they could be reliably scored on each dimension.

Summing Up

We think the rating method we have used to create Player DNA scores has a lot going for it. It looks at a number of dimensions of performance we rarely see analysed in tennis. And for each measure we have attempted to make a statistical comparison that is robust and doesn't cherry pick to favour popular players just because they are popular. Still, our approach isn't without limitations. We hope that by sharing our method with readers, we can get more of the tennis community thinking about how we can improve the number and usefulness of advanced stats in our sport.

Technical DNA Measures

We look across the following strokes to rate how well each player is technically:

- Serve (First and Second)
- Return
- Forehand
- Backhand.

Each stroke is broken down into subcomponents depending on the nature of the stroke and data sources:

- Speed,
- Potency
- Accuracy, Placement and/or Reliability.

1. Serve

- **First and Second Serve**
 - **Speed:** rates a player's average serve speed from AO ball tracking data.
 - **Placement:** rates how much closer to or further from the lines a player hits their serve compared with the average player.
 - **Reliability:** rates how often a player gets their serve in-play in all Grand Slam matches, accounting for the quality of their opponent.
 - **Potency:** rates how often a player is able to use their serve to win quick points. We use AO point by point data and model how often they win service points within their first two shots, accounting for their opponent's return ability.

2. Return

- **Speed:** rates a player's average return speed. We account for the opponent's serve ability and the characteristics of the incoming serve.
- **Reliability:** rates how often a player gets their return in-play. We account for the opponent's serve ability and the characteristics of the incoming serve.
- **Potency:** rates how often a player is able to use their return to win points. We model how often they win return points within their first two shots, accounting for the opponent's serve ability and the characteristics of the incoming serve.

3. Forehand

- **Speed:** rates a player's top forehand speed. To minimize the effect of anomalous speed readings, we model a player's 99th percentile forehand speed within each match. We include opponent strength variables in the model, as we would expect playing a stronger opponent gives a player fewer opportunities to hit their forehand at top speed.

- **Potency:** rates how often a player is able to win points in which the last shot they play is their forehand: a winner or error, or directly followed by an opponent winner or error. We model whether the player wins or loses the point with that shot, accounting for player positions, incoming shot characteristics, opponent's ranking group [A categorical variable to measure player strength], and opponent's general rally ability.
- **Accuracy:** It is difficult to judge accuracy directly for rally shots, as it is impossible to know exactly where a player was aiming and what tactical decisions played a role. So we adapt the Potency measure above by including the speed of the outgoing forehand as a control variable. The logic behind this change is to see if a player wins more at equal speed than the average player. If a speed-accuracy tradeoff exists, a higher win rate controlled for speed should get at a player's accuracy.

4. Backhand

- **Speed:** as in Forehand Speed above.
- **Potency:** as in Forehand Potency above.
- **Accuracy:** as in Forehand Accuracy above.

PLAYER	SERVE	RETURN	FOREHAND	BACKHAND	TECHNICAL DNA
Roger Federer	93.1	88.5	94.0	92.1	95.7
Novak Djokovic	85.7	95.4	84.3	82.0	94.4
Gael Monfils	82.4	73.5	86.7	91.4	93.2
Kyle Edmund	78.4	84.3	87.3	74.4	92.2
Rafael Nadal	39.1	95.1	94.5	93.9	92.0
Dominic Thiem	88.2	53.1	87.3	93.3	91.9
Andy Murray	74.1	88.7	75.0	80.0	91.4
Tomas Berdych	82.5	94.8	84.3	55.6	91.3
Alexander Zverev	56.4	78.1	93.3	87.8	91.1
Kei Nishikori	52.5	81.9	86.3	88.5	90.2
Diego Sebastian Schwartzman	53.9	94.3	68.8	88.5	89.6
Marin Cilic	90.5	84.2	94.0	34.4	89.2
Stan Wawrinka	90.3	79.1	71.4	56.2	88.1
Hyeon Chung	18.1	94.0	90.6	92.5	87.8
Fernando Verdasco	63.7	81.9	60.9	84.5	86.9
David Goffin	50.2	93.6	70.0	72.1	85.8
Richard Gasquet	72.6	70.4	40.9	94.9	84.1
Grigor Dimitrov	49.7	40.7	94.3	93.8	84.1
Andreas Seppi	73.9	50.9	69.5	78.1	82.4
Ryan Harrison	61.1	85.8	75.4	46.2	81.3
Albert Ramos-Vinolas	34.2	65.4	81.5	85.8	80.8

Andrey Kuznetsov	41.7	72.6	72.3	78.7	80.3
Fabio Fognini	8.5	80.5	88.0	85.5	79.4
Jo-Wilfried Tsonga	84.3	52.0	85.9	40.1	79.3
Roberto Bautista Agut	61.8	61.2	74.7	62.4	78.6
Jack Sock	55.9	66.1	91.2	44.7	77.9
Nick Kyrgios	92.9	33.6	39.1	84.1	74.8
Mischa Zverev	64.8	39.1	57.6	86.0	73.9
Juan Martin Del Potro	84.4	53.2	86.7	22.9	73.9
Milos Raonic	92.0	87.6	50.1	15.9	73.2
Gilles Simon	12.1	63.1	80.3	82.7	70.1
Philipp Kohlschreiber	45.1	47.7	86.8	50.1	66.1
Guido Pella	36.7	53.4	81.5	55.3	64.7
Julien Benneteau	49.5	85.4	22.2	66.1	62.9
Sam Querrey	89.9	17.2	24.5	84.0	58.9
Denis Istomin	63.0	84.2	8.9	58.1	58.2
David Ferrer	11.0	38.3	76.3	70.0	47.9
Jordan Thompson	15.2	23.0	88.1	68.6	47.6
Marcos Baghdatis	49.5	49.2	70.1	24.3	46.6
Damir Dzumhur	10.7	45.0	55.2	82.0	46.5
Andrey Rublev	9.3	84.8	59.9	35.3	44.5
John Isner	93.5	43.7	37.5	10.5	42.3
Pablo Carreno-Busta	49.6	42.0	55.3	38.1	42.1
Benoit Paire	54.0	89.4	7.8	31.9	41.1
Paolo Lorenzi	12.6	15.3	69.4	84.9	40.7
Guillermo Garcia-Lopez	10.7	48.0	89.7	27.7	37.5
Pablo Cuevas	67.7	43.7	21.9	31.8	32.1
Bernard Tomic	85.1	33.0	11.6	13.2	22.9
Viktor Troicki	27.0	52.4	17.3	43.4	21.9
John Millman	20.1	14.9	40.3	57.6	19.6
Daniel Evans	14.3	36.1	28.1	49.7	18.2
Alex De Minaur	9.0	34.1	6.9	75.3	17.3
Gilles Muller	88.3	15.7	9.2	8.7	16.4
Ivo Karlovic	92.2	3.9	11.4	4.7	14.1
Joao Sousa	22.4	18.8	41.1	7.2	9.8
Yoshihito Nishioka	8.8	26.8	18.2	30.3	9.1

PLAYER	SERVE	RETURN	FOREHAND	BACKHAND	TECHNICAL DNA
Madison Keys	91.6	86.8	95.7	91.0	95.9

Serena Williams	92.9	94.1	88.8	68.1	94.4
Elina Svitolina	57.3	92.6	94.2	90.5	93.6
Kaia Kanepi	90.5	79.6	91.0	63.1	92.6
Coco Vandeweghe	89.8	56.4	88.6	78.6	91.3
Simona Halep	69.1	91.8	81.2	54.4	88.6
Ashleigh Barty	89.0	30.2	86.3	90.9	88.6
Camila Giorgi	73.9	49.1	84.2	87.9	88.3
Caroline Wozniacki	70.8	56.5	75.0	91.0	88.0
Aliaksandra Sasnovich	55.3	75.2	76.4	81.9	87.1
Barbora Strycova	73.0	55.4	79.7	80.0	86.9
Daria Gavrilova	62.9	81.5	82.6	60.0	86.7
Karolina Pliskova	90.3	92.6	74.7	20.4	84.7
Jelena Ostapenko	12.2	83.7	87.7	94.3	84.6
Timea Babos	78.4	25.6	84.0	89.0	84.4
Ana Bogdan	34.7	75.7	77.4	87.9	84.0
Angelique Kerber	33.1	65.2	84.2	84.3	81.5
Belinda Bencic	90.8	79.2	84.4	11.5	81.3
Petra Martic	90.4	64.0	49.1	62.5	81.3
Jelena Jankovic	85.4	85.2	12.0	82.6	81.1
Venus Williams	37.4	88.2	93.1	45.1	80.7
Shuai Zhang	34.1	78.1	55.2	90.4	78.6
Mirjana Lucic-Baroni	63.3	85.8	90.3	17.8	78.4
Garbine Muguruza	84.6	72.5	11.3	88.2	78.2
Elise Mertens	73.5	74.6	22.9	82.5	77.1
Dominika Cibulkova	56.5	37.5	87.7	71.0	76.8
Ekaterina Makarova	62.2	90.6	11.5	80.6	73.8
Lauren Davis	10.4	47.1	94.2	92.2	73.4
Annika Beck	16.6	63.8	75.9	86.2	72.8
Kristyna Pliskova	89.7	44.3	43.0	63.7	72.0
Maria Sharapova	92.0	94.8	12.0	41.0	71.7
Samantha Stosur	84.5	27.2	40.6	85.7	70.8
Johanna Konta	92.3	60.0	43.4	42.0	70.7
Julia Goerges	88.8	43.6	87.5	14.6	69.2
Anna-Lena Friedsam	57.8	28.2	65.9	78.0	67.1
Qiang Wang	73.5	64.4	20.3	67.9	65.2
Anett Kontaveit	88.6	88.9	27.9	11.3	60.3
Lucie Safarova	91.4	30.7	86.6	6.2	59.3
Naomi Osaka	47.1	57.9	42.2	66.3	58.6
Su-Wei Hsieh	56.5	52.1	68.9	34.6	57.8

Carla Suarez Navarro	15.3	47.7	88.1	59.8	57.2
Petra Kvitova	89.4	76.3	29.7	9.3	53.7
Anastasija Sevastova	64.3	35.5	13.9	84.2	49.9
Agnieszka Radwanska	39.1	53.5	78.5	19.2	45.6
Monica Puig	87.0	27.2	45.5	27.2	43.7
Maria Sakkari	44.1	68.7	41.1	31.2	42.7
Luksika Kumkhum	57.5	15.7	41.5	70.0	42.5
Mona Barthel	80.1	32.8	22.8	46.6	41.2
Denisa Allertova	54.3	44.4	15.5	55.0	34.3
Caroline Garcia	91.2	46.8	14.9	9.7	31.1
Eugenie Bouchard	77.3	53.2	9.9	17.6	29.1
Saisai Zheng	12.8	43.2	23.3	77.5	28.5
Laura Siegemund	30.4	28.9	41.1	46.6	24.5
Carina Witthoeft	62.5	47.0	12.2	19.7	22.4
Donna Vekic	30.9	77.7	19.3	9.7	21.1
Kirsten Flipkens	20.9	32.8	74.4	9.4	21.1
Magdalena Rybarikova	68.8	17.5	7.1	31.5	17.1
Nicole Gibbs	28.9	9.4	22.0	38.5	11.2
Roberta Vinci	16.3	24.9	14.9	28.9	9.0

Tactical DNA Measures

We look at five components to rate how well each player is tactically: Rallying Craft, Attacking Balance, Court Control, Time Control and Wide Defence.

1. Rallying Craft

This measures how successful a player is at rally exchanges. We model the win rate across all rallies of 4 or more shots in AO matches, accounting for opponent ability and whether the point was on serve or return.

2. Attacking Balance

This measures how well a player balances risk and reward when looking to attack. A good balance would result in more winners than unforced errors. We model the ratio between winners and unforced errors in Grand Slam matches, accounting for opponent ability and removing the effect of service winners.

3. Court Control

This measures how successful a player is when they have a spatial advantage. A player has the spatial advantage when they can play their shot from a central location and their opponent is out wide. We use AO tracking data to model whether the player wins or loses the point within their next two shots, accounting for player positions, incoming shot characteristics, opponent's ranking group, and opponent's general rally ability.

4. Time Control

This measures how successful a player is when they have the time advantage. A player has the time advantage when they have significantly more time to play their shot than their opponent just had. This is more time for decision-making, positioning and shot execution. Again, we use AO tracking data to model whether the player wins or loses the point within their next two shots, accounting for the same variables as in Court Control.

5. Wide Defence

This measures how well a player is at defending from a wide position when their opponent is central. We use AO tracking data to model whether the defender is able to overturn their opponent's space advantage and win the point, accounting for the same variables as in Court Control.

PLAYER	RALLY CRAFT	ATTACKING BALANCE	COURT CONTROL	TIME CONTROL	WIDE DEFENCE	TACTICAL DNA
Rafael Nadal	95.4	97.3	97.3	94.2	94.0	96.3
Roger Federer	95.4	97.8	91.4	92.0	93.5	96.0
Novak Djokovic	97.6	94.1	85.2	93.0	95.1	95.8
Kei Nishikori	91.0	84.7	80.1	93.8	89.0	94.4
Andy Murray	86.4	94.9	83.8	80.5	88.5	94.2
Tomas Berdych	90.9	89.5	78.7	84.5	67.0	92.4
David Ferrer	94.8	51.1	64.4	97.1	94.0	91.5
Mischa Zverev	82.2	89.0	79.6	59.7	79.8	90.4
Dominic Thiem	86.7	87.9	59.7	55.8	97.0	90.0
Richard Gasquet	90.0	94.9	79.3	91.1	20.0	88.4
Roberto Bautista Agut	85.1	84.3	63.9	52.1	89.2	88.3
Kyle Edmund	48.0	75.9	91.8	65.5	92.8	88.3
Grigor Dimitrov	92.2	62.8	63.8	97.1	57.9	88.2
Jo-Wilfried Tsonga	80.1	76.9	94.7	35.0	84.5	87.9
Fabio Fognini	72.3	21.0	91.0	86.7	97.2	87.4
Philipp Kohlschreiber	58.5	77.0	50.6	87.8	89.2	86.6
Gilles Simon	86.0	35.8	59.3	90.2	91.1	86.4
Gael Monfils	75.3	74.9	88.0	29.8	91.4	85.9
Marin Cilic	93.5	31.6	76.4	88.1	65.0	85.1
Albert Ramos-Vinolas	87.4	82.7	56.7	79.6	35.1	82.4
Hyeon Chung	72.4	68.1	98.1	59.9	32.8	80.1
Fernando Verdasco	71.4	46.0	91.2	59.5	47.4	75.8
David Goffin	71.9	67.0	85.0	34.6	53.1	74.6
Pablo Carreno-Busta	73.9	96.1	29.5	90.8	16.1	73.0
Stan Wawrinka	54.0	61.2	83.4	40.7	62.7	71.6
Bernard Tomic	67.1	45.1	60.2	61.1	59.4	68.3
Juan Martin Del Potro	44.1	68.3	75.8	74.1	29.1	67.8
Damir Dzumhur	76.9	22.4	72.3	23.9	91.3	66.1
John Millman	69.2	18.8	77.1	39.5	81.8	65.9
Guillermo Garcia-Lopez	72.9	40.3	75.2	77.9	19.2	65.6
Guido Pella	48.2	87.0	61.7	37.3	47.5	64.2
Nick Kyrgios	74.6	58.7	35.2	24.6	87.5	63.7
Paolo Lorenzi	52.5	61.0	49.3	50.2	65.0	62.7
Andreas Seppi	71.3	34.9	64.3	44.6	58.2	60.8
Daniel Evans	71.5	22.9	91.6	48.2	38.7	60.7

Jack Sock	51.2	70.8	70.0	65.1	4.8	56.1
Andrey Kuznetsov	81.0	80.2	21.0	53.4	25.6	55.8
Andrey Rublev	61.1	37.0	58.2	77.0	11.9	48.9
Milos Raonic	72.7	76.2	24.9	44.9	24.8	48.2
Denis Istomin	24.9	82.2	25.5	19.3	87.9	46.6
Alex De Minaur	23.6	37.7	39.4	40.6	93.6	44.5
Julien Benneteau	57.0	42.5	36.7	51.1	41.4	41.9
Sam Querrey	71.0	53.6	5.3	66.6	31.9	41.8
Yoshihito Nishioka	40.1	19.2	61.8	41.6	56.1	37.8
Marcos Baghdatis	25.4	45.0	77.1	49.8	17.3	36.2
Alexander Zverev	58.6	15.1	19.6	72.4	47.2	35.6
Diego Sebastian Schwartzman	67.3	16.1	68.3	31.4	13.9	29.7
Gilles Muller	21.0	82.2	8.1	47.1	23.7	24.9
Jordan Thompson	29.4	11.5	45.9	53.9	28.6	21.3
Viktor Troicki	48.0	38.5	14.1	5.4	49.5	17.9
Ivo Karlovic	20.8	80.7	27.7	12.8	6.7	16.5
Pablo Cuevas	44.5	28.9	20.3	19.3	17.4	13.1
John Isner	24.6	31.2	25.7	4.5	42.6	12.8
Joao Sousa	16.2	55.7	15.2	21.0	6.6	10.8
Ryan Harrison	15.2	14.9	29.2	3.5	29.4	8.3
Benoit Paire	19.0	45.8	6.0	1.9	12.6	7.6

PLAYER	RALLY CRAFT	ATTACKING BALANCE	COURT CONTROL	TIME CONTROL	WIDE DEFENCE	TACTICAL DNA
Angelique Kerber	96.9	97.1	98.0	92.4	98.3	97.8
Caroline Wozniacki	96.4	89.0	79.4	97.1	93.2	97.0
Shuai Zhang	90.2	75.0	92.1	97.4	99.0	97.0
Johanna Konta	86.9	79.1	93.7	86.4	75.3	95.5
Serena Williams	96.1	83.8	87.6	62.9	66.0	93.8
Barbora Strycova	74.7	37.5	88.7	95.6	95.2	93.4
Su-Wei Hsieh	79.3	75.9	93.8	95.2	40.2	92.7
Dominika Cibulkova	68.2	87.9	79.8	60.4	76.6	91.4
Madison Keys	93.4	74.9	78.8	26.1	88.8	90.0
Agnieszka Radwanska	42.8	98.4	45.2	82.8	85.0	88.7
Simona Halep	44.9	89.9	74.0	87.6	54.8	88.2
Belinda Bencic	80.8	89.9	58.6	85.9	29.3	87.0
Carla Suarez Navarro	79.4	58.8	82.1	94.3	18.0	84.5
Jelena Ostapenko	83.4	72.5	24.7	58.1	93.7	84.4

Kirsten Flipkens	60.8	91.4	45.5	44.8	86.9	83.7
Venus Williams	76.4	79.0	91.8	19.5	46.4	79.2
Ekaterina Makarova	84.3	88.5	42.9	59.1	35.6	78.3
Lucie Safarova	62.2	91.4	58.3	61.1	36.6	78.1
Elina Svitolina	66.3	86.6	21.3	41.7	93.5	78.0
Qiang Wang	48.2	74.6	14.6	77.2	86.8	75.2
Maria Sharapova	86.8	57.9	52.1	29.8	70.8	73.7
Aliaksandra Sasnovich	78.4	26.8	33.1	71.8	84.1	72.5
Karolina Pliskova	82.0	60.9	24.3	60.2	63.1	71.0
Petra Martic	35.9	77.8	46.6	61.1	68.7	70.8
Naomi Osaka	31.3	62.3	90.1	73.2	21.0	65.5
Laura Siegemund	48.6	55.0	86.0	28.2	59.8	65.4
Garbine Muguruza	79.7	89.9	11.0	6.8	89.5	65.1
Ashleigh Barty	74.1	40.5	88.5	31.9	37.5	62.9
Mirjana Lucic-Baroni	51.8	49.3	22.6	81.1	63.7	61.1
Daria Gavrilova	69.0	41.7	21.2	93.9	37.9	58.6
Petra Kvitova	52.6	73.7	57.7	38.5	37.4	56.7
Anna-Lena Friedsam	70.8	33.7	14.6	52.6	86.7	56.0
Eugenie Bouchard	64.9	74.8	26.1	87.1	4.4	55.4
Annika Beck	77.6	21.2	49.8	86.2	21.7	55.0
Elise Mertens	72.8	59.4	3.0	77.6	36.8	51.4
Luksika Kumkhum	60.1	30.1	33.8	56.3	63.6	48.4
Kaia Kanepi	80.7	24.9	66.8	44.1	22.8	46.0
Camila Giorgi	73.6	24.5	61.8	61.8	15.4	44.9
Monica Puig	4.6	63.9	77.8	15.4	73.9	44.1
Timea Babos	44.4	22.4	84.1	64.7	18.9	43.6
Jelena Jankovic	67.2	45.8	36.8	76.2	6.2	42.4
Roberta Vinci	36.7	61.8	12.3	34.4	82.8	40.3
Mona Barthel	58.4	28.3	6.8	79.1	51.6	38.4
Julia Goerges	13.8	93.4	85.4	16.5	15.0	38.4
Ana Bogdan	40.6	37.5	35.9	26.2	80.3	36.6
Coco Vandeweghe	78.5	53.4	48.9	19.2	17.7	35.3
Maria Sakkari	16.0	64.9	13.2	49.7	61.3	29.7
Denisa Allertova	41.0	21.9	58.6	21.1	57.6	27.7
Lauren Davis	85.5	6.4	24.0	51.1	29.5	26.3
Saisai Zheng	50.4	19.2	30.7	41.1	53.7	25.7
Samantha Stosur	26.5	64.8	13.3	30.9	45.8	21.0
Nicole Gibbs	18.9	8.8	75.2	34.4	42.4	20.5
Anett Kontaveit	25.5	79.1	12.5	24.3	38.2	20.4

Kristyna Pliskova	12.2	59.7	7.1	33.7	65.1	19.9
Caroline Garcia	28.6	81.1	5.5	4.3	41.5	15.4
Anastasija Sevastova	12.1	45.5	38.3	24.3	25.9	12.4
Magdalena Rybarikova	14.6	52.9	46.7	7.9	20.2	11.7
Carina Witthoeft	18.9	40.9	3.8	8.6	61.3	10.3
Donna Vekic	12.4	68.9	18.7	5.0	6.1	7.5

Physical DNA Measures

We look at five stats to rate a player's Physical DNA: Foot Speed, Acceleration, Repeat Sprints, Agility, and Match Endurance.

1. Foot speed

This stat looks at players who are able to hit the highest running speeds in a rally and still be in control enough to win the point. Specifically, we look at the top speed reached during sprints in points a player won in a match, using the 95th percentile as a robust measure of a player's peak speed.

2. Acceleration

This stat looks at a player's explosive acceleration power when they are in control enough to win the point. As with foot speed, we only measure acceleration during sprints on points won and use the 95th percentile over these situations to robustly assess a player's power capacity.

3. Repeat Sprints

The Repeat Sprints stat measures how well a player can perform multiple high speed efforts and still be in control enough of their movement to win the point. Because the rating is based on a player's win rate in points with multiple sprints, the expected win rate controls for opponent ranking group.

4. Agility

This measure assesses how well a player is able to change direction quickly during points and still be in control enough to win the point. A 'quick change' is a high-intensity change of direction. Because the rating is based on a player's win rate in points with a quick change, the expected win rate controls for opponent ranking group.

5. Match Endurance

A player's Match Endurance is measured by their win rate in Grand Slam matches 3 hours in length or more for men, and 2 hours in length or more for women. The expected win rate in long matches controls for surface and opponent ranking group.

PLAYER	FOOT SPEED	ACCELERATION	REPEAT SPRINTS	AGILITY	MATCH ENDURANCE	PHYSICAL DNA
Rafael Nadal	86.9	94.1	93.7	88.1	94.5	95.1
Novak Djokovic	64.0	83.0	94.2	92.7	97.7	93.7
Dominic Thiem	92.2	82.5	61.2	91.5	81.2	91.9
Marin Cilic	56.9	87.6	92.3	86.3	82.7	91.7
Jo-Wilfried Tsonga	71.7	89.4	77.3	79.9	81.0	91.1
Hyeon Chung	36.1	85.7	86.8	92.1	89.9	90.2
Viktor Troicki	78.5	86.6	68.2	64.0	93.1	90.1
Damir Dzumhur	78.6	75.4	82.3	83.9	67.6	89.8
Andy Murray	81.0	59.6	81.9	66.3	98.5	89.8
Tomas Berdych	79.3	57.0	87.1	85.6	76.1	89.5
Richard Gasquet	83.0	78.7	84.3	75.2	62.7	89.4
Grigor Dimitrov	28.9	76.8	82.8	89.7	93.4	87.8
Andreas Seppi	92.2	36.0	80.2	71.6	89.9	87.6
Mischa Zverev	48.7	36.8	89.7	93.7	88.9	85.7
Kyle Edmund	87.1	84.8	79.0	79.6	25.2	85.4
Albert Ramos-Vinolas	53.8	53.3	79.5	73.4	93.0	84.9
Fabio Fognini	49.8	81.8	93.7	94.7	22.7	83.0
Roger Federer	21.2	34.8	92.7	98.5	92.5	82.4
Philipp Kohlschreiber	66.2	45.2	55.3	76.1	88.7	80.7
Diego Sebastian Schwartzman	91.1	91.5	45.2	33.1	69.5	80.5
Juan Martin Del Potro	77.9	75.9	52.6	30.1	92.6	80.2
Kei Nishikori	42.1	57.8	90.2	82.4	54.2	79.6
Gael Monfils	98.2	93.1	55.0	50.9	18.4	76.9
Yoshihito Nishioka	75.7	75.1	48.3	81.7	33.9	76.7
David Ferrer	53.4	54.6	96.1	97.6	12.5	76.5
Stan Wawrinka	82.1	35.8	65.0	34.6	96.3	76.4
Daniel Evans	35.5	49.6	87.5	68.5	69.1	75.4
David Goffin	75.0	70.1	72.0	25.9	67.0	75.3
Guido Pella	52.8	57.5	88.8	73.8	32.2	74.0
Gilles Simon	64.2	49.5	92.9	64.7	21.2	70.1
Alex De Minaur	89.3	74.8	30.8	17.3	79.3	69.8
John Millman	89.7	29.6	61.0	46.0	53.4	65.8
Paolo Lorenzi	46.9	58.2	67.9	20.3	72.1	60.7
Andrey Kuznetsov	45.1	46.5	80.3	55.9	32.4	58.7

Jack Sock	85.8	46.9	56.1	66.5	3.4	58.1
Pablo Carreno-Busta	52.3	43.7	64.6	18.3	73.1	55.5
Roberto Bautista Agut	49.0	30.4	83.9	41.1	39.2	52.2
Benoit Paire	78.0	27.6	22.6	23.1	90.9	51.6
Guillermo Garcia-Lopez	21.3	62.2	70.6	41.6	44.3	50.7
Alexander Zverev	79.3	85.0	41.6	5.8	23.4	48.8
Andrey Rublev	35.6	63.8	63.9	19.2	45.5	46.0
Julien Benneteau	18.5	83.7	27.9	61.4	34.3	45.1
Ryan Harrison	77.6	47.5	21.0	11.4	67.2	44.7
Pablo Cuevas	41.1	42.7	32.0	33.4	74.0	44.1
Denis Istomin	22.1	45.3	33.3	42.2	74.8	42.0
Fernando Verdasco	15.8	27.4	74.6	29.8	69.4	41.7
Bernard Tomic	9.2	30.1	64.1	39.2	73.7	41.4
Milos Raonic	25.4	21.3	71.2	76.7	17.9	40.0
Nick Kyrgios	14.9	43.1	73.6	48.4	19.0	35.0
Sam Querrey	14.5	14.3	65.2	57.6	47.5	35.0
Gilles Muller	9.5	54.0	42.2	26.7	59.7	32.6
Joao Sousa	21.0	43.0	22.0	46.0	53.1	30.3
Jordan Thompson	76.4	35.4	53.9	7.1	7.8	28.9
Marcos Baghdatis	72.4	80.9	16.2	3.7	4.5	27.9
Ivo Karlovic	22.6	6.5	8.9	51.5	33.8	15.1
John Isner	16.6	21.7	15.1	22.0	20.1	11.0

PLAYER	FOOT SPEED	ACCELERATION	REPEAT SPRINTS	AGILITY	MATCH ENDURANCE	PHYSICAL DNA
Angelique Kerber	84.3	90.1	91.9	92.9	97.1	94.4
Caroline Wozniacki	91.9	87.5	95.0	80.1	95.2	94.1
Lauren Davis	92.9	79.5	91.9	94.0	67.7	92.5
Ashleigh Barty	84.5	84.6	70.1	93.9	91.1	92.3
Simona Halep	91.8	94.7	44.6	95.3	95.0	92.1
Barbora Strycova	95.1	91.4	85.7	52.3	93.2	91.8
Carla Suarez Navarro	91.4	85.8	85.4	69.7	64.7	89.8
Kirsten Flipkens	74.2	79.3	76.2	69.9	82.2	88.0

Daria Gavrilova	62.2	72.7	86.3	82.0	75.9	87.7
Petra Martic	78.6	84.9	50.5	73.2	89.2	87.3
Laura Siegemund	61.3	82.0	70.0	95.8	60.4	86.3
Caroline Garcia	53.0	76.1	65.2	79.8	92.8	85.9
Elina Svitolina	76.4	63.6	64.7	77.1	84.3	85.8
Madison Keys	95.3	71.8	74.0	66.0	57.8	85.6
Anna-Lena Friedsam	92.3	54.6	80.7	81.8	53.9	85.4
Jelena Ostapenko	26.6	85.1	88.9	88.5	63.7	83.6
Denisa Allertova	74.2	67.9	80.7	68.6	60.3	83.4
Elise Mertens	80.9	82.8	68.8	34.9	83.3	83.2
Julia Goerges	54.3	85.9	35.1	76.8	91.0	81.7
Venus Williams	64.3	76.1	85.0	79.0	37.2	81.5
Camila Giorgi	74.7	68.4	62.9	74.9	59.0	81.1
Karolina Pliskova	37.7	80.8	80.7	42.5	96.1	80.7
Serena Williams	69.7	40.2	94.3	62.9	67.8	80.0
Su-Wei Hsieh	50.9	63.1	72.1	89.5	59.1	80.0
Agnieszka Radwanska	90.5	88.0	80.1	1.9	69.0	78.8
Roberta Vinci	60.2	73.3	44.4	59.4	90.5	78.4
Dominika Cibulkova	56.8	86.7	65.4	31.4	83.8	77.5
Monica Puig	74.0	50.8	83.0	30.2	83.0	76.8
Shuai Zhang	69.7	30.4	80.7	96.0	38.5	75.3
Aliaksandra Sasnovich	64.9	44.3	88.0	70.2	44.7	74.5
Garbine Muguruza	43.6	36.0	84.7	87.7	57.0	73.6
Ana Bogdan	88.0	74.3	61.0	28.7	53.3	72.6
Kaia Kanepi	74.0	64.1	54.8	74.4	36.9	72.2
Samantha Stosur	53.9	65.5	48.5	87.2	49.0	72.2
Carina Witthoeft	65.4	80.3	55.3	53.3	49.5	72.1
Annika Beck	83.1	77.0	75.7	24.2	36.5	69.9
Saisai Zheng	55.9	55.0	69.0	73.2	33.8	66.9
Maria Sharapova	12.8	21.6	86.1	92.5	63.5	63.4
Anett Kontaveit	32.8	67.4	48.9	58.7	63.7	61.6
Lucie Safarova	53.4	65.0	46.1	60.9	43.1	60.6
Timea Babos	74.1	49.5	58.6	77.5	7.5	60.1

Coco Vandeweghe	19.9	50.7	88.1	56.8	39.9	55.7
Luksika Kumkhum	24.4	86.4	56.0	28.0	60.1	55.6
Naomi Osaka	66.4	46.2	35.9	35.7	70.2	55.4
Belinda Bencic	27.8	21.4	59.5	88.4	52.9	53.7
Johanna Konta	42.7	32.7	88.3	22.0	54.9	50.1
Nicole Gibbs	80.2	48.9	31.4	35.4	31.2	45.1
Magdalena Rybarikova	66.2	87.5	20.7	20.2	31.2	44.6
Petra Kvitova	41.1	33.7	40.2	16.4	93.7	44.3
Ekaterina Makarova	10.5	18.7	70.6	26.3	84.2	38.9
Jelena Jankovic	68.2	47.8	73.8	8.1	4.6	36.1
Mona Barthel	64.5	53.6	33.8	10.6	38.5	35.6
Qiang Wang	62.4	47.2	46.3	8.4	35.7	35.3
Maria Sakkari	84.6	59.5	14.8	3.0	22.0	30.1
Anastasija Sevastova	16.2	56.7	8.2	5.1	82.1	25.6
Mirjana Lucic-Baroni	21.3	11.8	90.0	21.3	22.9	25.3
Eugenie Bouchard	42.1	42.3	44.0	13.7	17.1	23.2
Donna Vekic	69.1	27.2	9.1	16.2	35.9	22.8
Kristyna Pliskova	18.3	24.0	17.1	51.4	4.0	14.3

Mental DNA Measures

Winning the mental game is all about handling pressure. We break down a player's ability to handle scoreboard pressure into four components: Killer Instinct, Grit, Clutch and Winning Edge. Because each measure is ultimately tied to a player's ability to win, all of the component measures are adjusted for the strength of opponent using a categorical variable based on the opponent's rank at the time of the match. We obtain an effect size for each player and category of opponent, and combine them using a weighted average that weighs performance against stronger opponents more heavily.

1. Killer Instinct

This measure gets at a player's ability to be clinical when they are in control of the match. The specific stat looks at how well a player is able to close out matches at Grand Slams with minimal pressure faced.

2. Grit

The Grit measure of mental performance focuses on a player's doggedness. To evaluate player Grit we look at Grand Slam matches when a player's back was against the wall and see how well they were able to raise the pressure of the match, keeping the match close even if it was ultimately a loss.

3. Clutch

A player who can raise their level in key moments is considered 'clutch': they bring their best game when it matters most. To evaluate Clutch we look at a player's pressure win rate (PWR) on serve and return and compare these rates with their overall win rate on serve and return. The higher the differentials, the more clutch a player is.

4. Winning Edge

Most matches are won by the player who wins more of the key points than their opponent. Being able to maintain that edge in big moments takes more than talent, it takes mental strength. The Winning Edge gets at this ability by looking at a player's PWR on serve relative to their opponent's in Grand Slams matches.

PLAYER	KILLER INSTINCT	GRIT	CLUTCH	WINNING EDGE	MENTAL DNA
Rafael Nadal	97.5	96.2	97.1	97.5	95.7
Roger Federer	98.8	92.4	98.5	98.2	95.7
Novak Djokovic	97.6	91.4	98.8	98.2	95.6
Andy Murray	94.8	94.6	97.6	96.4	95.5
Juan Martin Del Potro	88.6	84.6	96.0	95.7	94.4

Jo Wilfried Tsonga	88.0	87.1	90.9	92.2	94.0
Milos Raonic	91.5	74.3	95.7	92.3	93.7
Marin Cilic	91.1	71.5	92.1	90.4	93.0
Stan Wawrinka	51.3	94.0	96.6	94.5	92.2
John Isner	66.7	98.3	75.2	84.0	90.9
Dominic Thiem	63.1	87.0	85.3	85.3	90.5
Gael Monfils	64.2	80.9	84.2	88.5	90.1
Roberto Bautista Agut	77.2	72.7	83.5	81.0	89.6
Grigor Dimitrov	85.5	67.6	77.1	84.0	89.6
Richard Gasquet	94.0	33.1	86.9	87.2	87.7
Nick Kyrgios	86.1	55.6	76.0	82.6	87.6
David Ferrer	63.3	65.7	78.0	89.3	86.9
David Goffin	82.4	47.9	81.2	83.9	86.7
Kei Nishikori	59.5	49.3	94.4	91.2	86.6
Sam Querrey	69.0	61.9	79.4	76.2	85.1
Tomas Berdych	81.0	17.4	93.0	91.0	84.2
Gilles Simon	44.9	61.5	75.3	82.6	80.0
Alexander Zverev	60.9	91.3	42.9	68.4	79.7
Andreas Seppi	39.5	77.0	66.9	77.9	79.1
Fabio Fognini	62.1	84.6	40.2	65.4	76.5
Jack Sock	54.0	75.9	45.0	70.3	74.2
Pablo Carreno Busta	60.9	72.6	47.9	52.0	70.1
Philipp Kohlschreiber	86.1	37.3	46.7	58.2	68.2
Fernando Verdasco	4.5	91.3	64.1	67.8	67.9
Bernard Tomic	34.9	88.8	41.9	58.3	66.5
Marcos Baghdatis	77.6	47.0	41.4	56.9	66.1
Albert Ramos Vinolas	55.2	14.8	72.0	79.0	65.3
John Millman	32.0	57.5	62.1	60.1	61.3
Andrey Kuznetsov	41.7	58.2	52.2	58.7	61.0
Julien Benneteau	47.2	82.3	40.7	35.8	58.8
Kyle Edmund	71.7	36.3	41.1	55.0	58.0
Ryan Harrison	67.0	30.1	55.3	47.6	56.2
Mischa Zverev	67.1	9.1	67.8	53.7	55.2
Guido Pella	48.8	65.5	53.5	28.9	54.7
Paolo Lorenzi	38.6	72.0	38.3	45.3	53.5
Pablo Cuevas	70.9	46.9	38.8	35.2	52.4
Alex De Minaur	42.4	21.7	59.7	57.4	47.6
Damir Dzumhur	60.3	55.6	24.2	36.2	45.3
Diego Schwartzman	17.1	52.8	50.3	55.2	44.9

Andrey Rublev	8.3	72.6	43.4	48.1	43.6
Gilles Muller	4.9	57.6	56.0	47.8	40.8
Daniel Evans	19.7	42.1	50.4	50.0	39.0
Guillermo Garcia Lopez	51.5	26.7	44.2	36.7	37.7
Benoit Paire	7.9	49.8	45.9	53.8	37.0
Viktor Troicki	30.8	22.1	60.3	43.8	36.8
Hyeon Chung	39.3	25.5	30.9	23.3	23.0
Ivo Karlovic	9.8	18.6	50.6	40.0	23.0
Jordan Thompson	39.8	39.6	21.6	16.3	22.5
Denis Istomin	25.5	13.8	44.4	28.1	20.9
Joao Sousa	37.5	13.2	23.4	29.5	18.8
Yoshihito Nishioka	42.9	5.2	9.6	8.4	11.4

PLAYER	KILLER INSTINCT	GRIT	CLUTCH	WINNING EDGE	MENTAL DNA
Garbine Muguruza	74.6	93.5	95.1	95.4	95.9
Serena Williams	99.0	44.9	99.4	98.6	94.9
Simona Halep	86.8	84.8	86.9	81.7	94.8
Maria Sharapova	94.1	53.2	92.5	95.6	94.4
Karolina Pliskova	82.4	63.5	93.3	92.7	94.2
Johanna Konta	81.9	63.3	91.9	90.2	93.8
Ekaterina Makarova	98.6	32.5	91.2	90.1	92.2
Venus Williams	69.0	60.3	88.2	90.1	91.7
Petra Kvitova	91.2	50.4	68.6	88.6	90.5
Caroline Wozniacki	89.6	48.2	70.9	86.8	89.9
Angelique Kerber	81.5	18.3	96.1	94.4	89.1
Coco Vandeweghe	70.0	46.1	89.9	82.9	88.8
Anastasija Sevastova	89.4	37.5	80.3	77.8	88.1
Agnieszka Radwanska	51.9	30.4	91.6	91.4	83.8
Naomi Osaka	40.5	43.7	90.5	88.8	83.3
Shuai Zhang	90.2	46.6	50.3	76.1	83.2
Dominika Cibulkova	57.9	46.6	78.2	78.7	82.7
Ashleigh Barty	54.8	70.6	69.4	62.3	81.5
Daria Gavrilova	44.1	88.0	63.2	59.8	80.9
Petra Martic	43.0	60.7	68.3	76.7	78.8
Jelena Ostapenko	16.0	61.3	82.1	88.3	78.4
Lucie Safarova	75.8	58.5	45.3	65.4	77.5
Kristyna Pliskova	46.9	85.4	67.1	43.6	76.8
Madison Keys	29.7	24.1	94.8	91.2	75.6

Barbora Strycova	78.0	19.7	63.7	76.9	75.0
Magdalena Rybarikova	81.8	2.6	78.4	68.3	72.1
Julia Goerges	32.4	87.2	51.8	45.6	65.6
Elina Svitolina	36.5	41.5	56.7	77.3	63.1
Caroline Garcia	38.2	60.6	42.0	70.7	62.8
Eugenie Bouchard	58.4	74.9	25.3	47.9	60.2
Donna Vekic	69.1	59.6	38.1	38.7	59.7
Anna Lena Friedsam	41.2	41.8	49.8	58.0	51.7
Luksika Kumkhum	48.2	64.0	36.4	33.1	46.6
Belinda Bencic	10.3	49.5	62.2	59.7	46.6
Jelena Jankovic	11.3	85.5	39.4	44.4	46.0
Annika Beck	59.0	65.1	25.6	25.5	43.0
Samantha Stosur	48.4	48.2	38.7	39.9	42.9
Elise Mertens	29.5	33.9	43.4	67.1	42.3
Roberta Vinci	56.5	34.9	40.9	39.3	41.1
Carla Suarez Navarro	62.9	10.7	55.5	40.5	40.0
Su Wei Hsieh	4.1	25.6	78.0	61.8	40.0
Anett Kontaveit	47.9	55.6	26.2	38.6	39.3
Monica Puig	52.1	43.1	33.9	37.4	38.4
Nicole Gibbs	44.9	40.5	36.0	41.8	36.7
Carina Witthoeft	22.2	61.8	39.4	39.0	36.3
Qiang Wang	52.6	40.2	34.4	34.5	35.9
Kaia Kanepi	47.8	21.9	46.6	37.9	32.3
Ana Bogdan	50.8	52.2	22.2	26.4	31.0
Timea Babos	35.1	64.3	30.2	20.9	30.5
Mirjana Lucic Baroni	18.7	34.4	49.2	37.5	25.9
Maria Sakkari	44.3	39.2	24.2	31.6	25.7
Laura Siegemund	40.9	49.7	20.4	25.4	24.6
Camila Giorgi	23.8	13.1	48.3	47.0	23.1
Lauren Davis	39.0	50.7	15.5	15.1	19.0
Kirsten Flipkens	24.6	42.5	30.0	21.3	18.5
Aliaksandra Sasnovich	25.4	50.4	27.0	14.9	18.3
Denisa Allertova	30.2	32.4	28.0	22.3	16.9
Saisai Zheng	48.5	5.2	28.5	27.9	16.1
Mona Barthel	39.8	29.3	13.3	16.1	13.4