

EPHE 117
Tennis
Stroke Analysis

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Skill → Service

Introduction

The serve is arguably the most important stroke in the game of tennis. Ultimately, if you cannot serve the ball, a rally doesn't even begin. This is why I chose to analyze my tennis serve for this assignment. The objective of the serve is to get the ball into the service area on the opponent's side of the court. This is most effectively done with a high velocity serve, which will reduce the amount of time the opponent has to react. There are also many variations on the serve to deceive your opponent including putting various spins on the ball. No matter what type of serve you make, there are two consistent goals: service accuracy and service speed. There are certain techniques that must be implemented for the successfulness of the serve. To analyze these techniques we have broken down the serve into four main phases: the preparatory phase, wind-up phase, force-generation phase, and recovery phase.

Stages and Description of Expert Performance

Phase #1 – Preparatory Phase

The preparation phase is very mental, as the player determines where he or she wants the serve to go and what type of serve he or she is going to make. For most serves, it is important to have a continental grip, with the base knuckle on the upper part of bevel number two (Rich, 2006). This will allow for pronation of the hand at the end of the swing that will cause the ball to travel accurately into the opponent's court. Professional tennis players (like Pete Sampras depicted below),



use knowledge of their opponent's weaknesses to their advantage. For example, if their opponent has a weak backhand, then the expert tennis player might serve to the backhand so that their return is weaker.

Biomechanically, the preparation phase begins in a static position with eyes intently focused on the ball. As Sampras is a right-handed player, he has his left leg flexed at his hip in front of him and his left foot dorsiflexed at the ankle. His balance of weight is primarily shifted backwards on his

right leg, and his arms are extended in front of him. The set-up includes the ball touching the racquet, with a slight bend in the elbows. Although Sampras is bent at the hips, his back remains straight and relaxed. Remaining focused and relaxed is imperative as he begins his serve. Without this relaxed state, Sampras could lose focus and serve a fault, instead of serving it successfully into the opponent's court.

Phase #2 – Wind-Up Phase

The wind-up phase is extremely crucial for the set-up of a good serve. Below, you can see Pete Sampras has tossed the ball high into the air to allow time for the wind-up of his swing. The wind-up is important to generate a potential elastic energy through a stretch in the muscles (McGinnis, 2005). It is this elastic energy, when the muscles rapidly contract, that will produce an extreme force on the ball.



The faster the force put on the ball, the greater the velocity of the ball and thus, the faster reaction time needed by the opponent. During the wind-up, there is a transfer of weight from the front foot to the back foot and a bend in the knees. It is extremely important to lean back, to prepare for the angular momentum that will be generated. It is this angular momentum that will generate a downward force of the ball just over the net, as desired. Note

that Sampras' eyes are fixated intently on the ball during and after his toss. Also, his left arm (tossing arm) follows the ball for both concentration sake, and as an aid to counteract the flexion of the racquet arm. This left arm also increases the radius of gyration of the arms to eliminate unwanted angular momentum. The bend of his knees is extremely important as it will allow him to generate a maximum force against the ground, allowing him to jump in the air for his jump serve.

Phase #3 – Force-Generation Phase

The force-generation phase begins with a rapid accelerating contraction of the legs. Newton's Third Law states that every reaction has an equal and opposite reaction (McGinnis, 2005). This is the case here, as Sampras (below) produces a



force on the ground with his legs, there is a ground reaction force that pushes back and generates his body upward. This weight transfer (and heightening his centre of gravity) allows for Sampras to have a greater momentum for his swing, while remaining stable. As soon as his body is at the highest point, he then rapidly downwardly accelerates his left arm (non-racquet arm). This allows for rotation in the hips to occur, and an

increased angular momentum of the racquet arm. Angular momentum in the body is transferred in the body from one set of muscle groups to another. This is known as kinetic linking (McGinnis). Kinetic linking helps generate the most force possible by making sure that every joint is working to its best capacity. Contact with the ball is made at the centre of the racquet and spin can be generated by offsetting contact location. In most cases, a downward spin is desired, as we want the ball to land inside the opponent's service court (either ad court or deuce court depending on where the serve takes place).

Phase #4 – Recovery Phase

The recovery phase begins after contact with the ball is made. The racquet arm of Pete Sampras (below) follows across the body after contact is made to absorb the force of the serve. Impulse is defined as the amount of time a force is applied (McGinnis, 2005). Note that the greater the amount of impulse, the greater the force. Sampras accomplishes this impulse by landing first on the ball of his foot,



and then back on his heel. This control at the feet converts the angular momentum generated by the swinging of the racquet arms is converted into a linear momentum. This allows for the force to be generated in a straight, accurate line. Notice how Sampras (left) has a low centre of gravity. This helps with his stability and balance of weight, as well as his ability to get into the ready position as fast as possible. This is extremely important in the recovery phase,

as the opponent's service return will be coming back extremely quickly. It is important to keep a low centre of gravity, and do the split step as soon as the ball is returned.

Stages and Description of My Performance

Phase #1 – Preparatory Phase

In my preparatory phase, I am concentrating and psychologically concentrating on where I want my serve to go. This is evident as my eyes are fixated on the place where I want the ball to travel too (and my feet are pointed in the direction of my shot). This will be important when force is generated, through the kinetic linking that my body produces. My body is quite flexed at the torso, though still in a stable position with my balance of weight on the front foot, leaning over my racquet. My arms are slightly flexed at the elbow and brought together (with the ball and the racquet). During my preparation phase, I also noticed that I bounce the ball quite a few times before getting into the ready position. I feel as though this helped in my mental preparation of the serve.



Phase #2 – Wind-Up Phase

In my wind-up phase, I have transferred my weight by leaning backwards and extending my body at the trunk. This helps create the elastic potential energy (as described in the expert performance of Pete Sampras above). I am also preparing my movement for the angular momentum that will occur in the next phase (force-generation phase). My eyes are fixated on the ball to ensure I know when to bring my racquet down on to contact the ball. My racquet arm is brought back behind my head to generate the most downward force as possible.



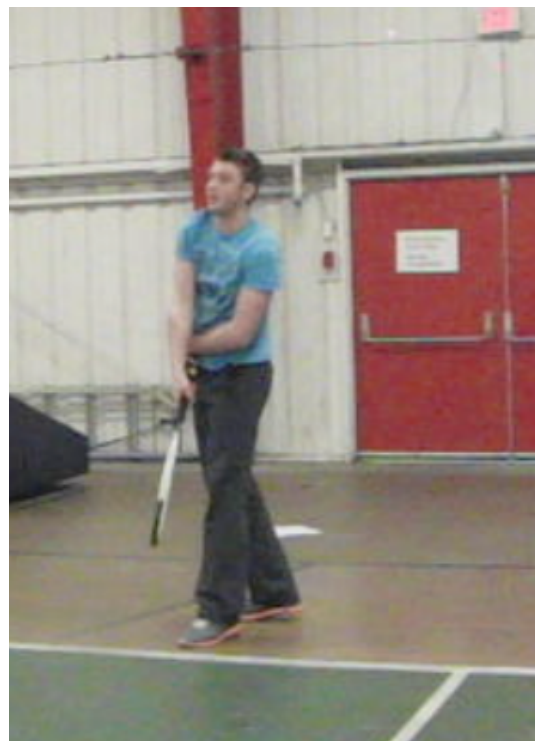
Phase #3 – Force-Generation Phase

In this force-generation phase, it is evident that I have applied a downward force on the ground, and my centre of gravity is now quite high. The ground reaction force that pushed my body back from the ground through the kinetic linking/chaining (described in the expert performance force-generation phase) allows me to get over the ball and apply a downward acceleration on the ball. Contact is made in the middle of my racquet with a quick, rapid flexion of my wrist. Not only does this flexion of my wrist make the ball travel downwards, but also generates a downward spin on the ball, which is desired as the ball just soared over the net. This downward spin also makes it very difficult for my opponent to return the ball as he has less time to react.



Phase #4 – Recovery Phase

In my recovery phase, my eyes are focused on the ball, which has now travelled into my opponent's ad court. This will help me prepare for his or her service return, which will come back at me quite fast. My racquet is now pointing downwards after the follow through from the force generation phase. Although my lower body is not in the ideal placement (see improvements below), I still have an average degree of stability, and the balance of my weight is still evenly distributed with my centre of gravity over my feet.



Improvements

Phase #1 – Preparatory Phase

- My balance of weight is primarily on my front foot, while Pete Sampras has his weight shifted backwards in the preparatory phase. By correcting this, it will give me a better control of my toss in the air, and a better ability to create angular momentum on the ball
- Dorsiflexing my left foot will also help in shifting my weight backwards (like Pete Sampras). Again, this will help give me better control of my toss and allow for a greater controlled force to be applied on the ball
- Other than the aforementioned corrections, my preparatory phase is generally well done, with a good degree of stability

Phase #2 – Wind-Up Phase

- My wind-up phase is the most errorful of my phases and needs the most correction to better the technique of my tennis serve
- Firstly, my legs are extremely extended (almost locked). When looking at Pete Sampras' wind-up phase, it is evident that he significantly bends his knees. If I were to do this as well, this would help in generating a greater ground reaction force in my force-generation phase. This would also help increase my angular momentum, as right now, my angular momentum is mostly being generated by my hips, and not my lower body
- Although my eyes are fixated on the ball, my left arm (non-racquet arm) is quite low, and not as high as Pete Sampras'. If I were to raise it above my head, this would help in the control of my toss and increase the amount of angular momentum I can produce (as described in the expert description of the wind-up phase)

Phase #3 – Force-Generation Phase

- The small, finite errors in my force-generation phase generally originate from the errors made during my wind-up phase. This is often the case for most skills. That is why it is fundamentally necessary to determine which are the larger gross errors that affect other aspects/techniques of performance
- My force-generation phase is generally performed quite well, however a difference does lie in the torque that is created at my hips. Pete Sampras has quite the angular momentum generated during the wind-up phase. As I didn't wind-up very well, there is little rotation of my trunk, and thus, a lower angular momentum (and torque) is achieved. Therefore, it is easier for the opponent to return my serve

Phase #4 – Recovery Phase

- My centre of gravity during the recovery phase is quite high compared to that of Pete Sampras. Although this may not cause a problem for my actual service, it may be a hindrance to when I need to next hit the ball. Due to Sampras' low centre of gravity, he will be able to quickly get into the ready position for the service return, and quickly split step to prepare for the hit. As my centre of gravity is quite high, it will take me longer to get into position
- My follow through is too far. If you look at my left arm, it is completely wrapped around the front of my body. This will, again, make it hard for me to get into the ready position for the next shot as soon as possible. Controlling my follow through is important, like Pete Sampras does
- Finally, Pete Sampras generates so much force that it carries his body onto the court leading by his right leg. In my service, my feet remain planted on the ground. Again, this most likely stems from my errors in the wind-up phase (my inability to bend my knees). If I was to bend my knees, then I would be able to jump during my serve, generate a better downward acceleration of the ball, and follow through using my whole body instead of just my arms

References

McGinnis, P.M., (2005). *Biomechanics of sport and exercise: Second edition*. Champaign, IL: Edward Brothers, Inc.

Rich, S. (2006). *The tennis handbook: A complete guide to the modern game*. Whitby, ON: McGraw-Hill.