A NEW DIRECTION FOR RACQUET HEAD SPEED
ADDING PRECISION TO YOUR COACHING BY SUBTRACTING DOUBT.

by James Shaughnessy, USPTA Master Professional

Nick Bollettieri, the legendary coach, wrote in a 2008 in *TennisLife* magazine article that "Generating this (racquet head) speed consistently is the solution to a more powerful game." This sounds compelling.

But, will swinging with a high racquet head speed cause the ball to travel faster to the opponent's court? The answer is sometimes. Will contacting a ball that is below the net with a high racquet speed project the ball into your opponent's court successfully? The answer is sometimes.

Coach Bollettieri used the terminology "powerful game." The mechanical definition of power is "the rate of doing work." Although we cannot know for sure what Bollettieri meant by powerful, we do know that, in contemporary tennis vernacular "power," incorrectly, refers to how hard or fast a player can hit the ball from point A to point B. Therefore, without adding precision modifiers to the term "racquet head speed" a student may not have a clear idea of how to be successful with a stroke. The following study demonstrates how, the term "racquet head speed" is not nearly clear enough.

Using the SCiO 3D Sports Library, a 3D motion analysis of live match play was conducted on 48 forehands from players with a Universal Tennis Rating (UTR) ranging from over 16 to 10.88. An independent-samples t-test was conducted to compare a group of forehands by top pros (UTR 15.5 or higher) with a group of forehands by top college players, blue chip and 5-star recruits (UTR 10.88 -15.1) The forehands in this study were selected only if the shot was a winner, forced an error or created an opportunity to attack the opponents next shot. The variables studied for differences and correlations at impact were racquet head speed, outgoing ball velocity, incoming ball velocity, tip trajectory, forward racquet tip velocity, upward racquet tip velocity and racquet tip trajectory at impact. Normal distributions of the data were found for all variables using the Shapiro-Wilk test.

As most coaches would expect, there was a significant difference in the scores for top ATP pro racquet speeds (M=73.5 mph, SD=6.3) compared to college and blue chip recruits (M=68.1 mph, SD=7.55); t(46)=2.56, p = .014." The study also found a significant difference in favor of the ATP pros in speed of the outbound ball toward the target (M=86.6 mph, SD=5.8 mph).
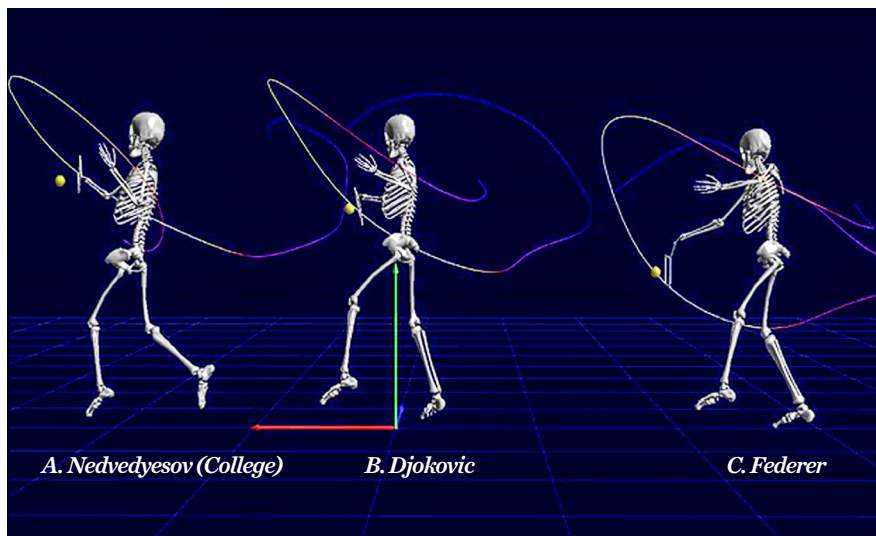
Although these results suggest that racquet head speed

How does racquet head speed influence ball speed.

is the solution to hitting a ball that moves rapidly from point A to B, looking at the data more closely reveals noteworthy conflicting examples in which racquet head speed does not result in higher ball speeds toward the target. In one example, Roger Federer connects with a ball moving 8 mph with a racquet speed of 69.6 mph and the ball leaves the racquet at 78.54 mph. In another example, Novak Djokovic meets a ball traveling at 9.9 mph with a racquet speed of 81 mph. In this example, Djokovic's ball projects at 75 mph, which is slower than Federer even though his racquet speed is higher. Both players hit the ball solidly close to the center of the string bed, with little wind, on the same day. In an alternate example, a college player, Nedvedyesov, connects with a forehand traveling 6 mph with a racquet head speed of 69mph and the ball leaves the racquet at 89 mph. So how can Nedovyesov swing with less racquet head speed than Federer or Djokovic and make his shot travel toward the target faster?

According to a Pearson Correlation test run on all 20 of the top ATP forehands, there was no correlation between racquet head speed toward the target and ball speed toward the target in the ATP group. However, when the same Pearson test was performed on data from the top College group the results showed a strong correlation between racquet speed toward the target and ball speed

A. Nedvedyesov (College)   B. Djokovic   C. Federer

Racquet speed did not correlate to ball speed in ATP pro tennis.

SD=6.56 deg); t(38)=3.03, p=.004. Analysis of 48 forehands in the study found a correlation between racquet trajectory and UTR. In other words, the ATP players racquet paths traveled upward on a steeper angle. (See Figure 2)

The evidence shows that upward racquet head velocity and higher racquet head trajectories correlate with higher UTR. The study also shows that top ATP pros hit through the ball less than players with lower UTRs. Therefore, using the term "racquet head speed" with students is meaningless without qualifying a direction. Simply increasing your racquet head speed may not get the intended effect. Should your player be required to hit the ball with a higher speed toward the target give the precise cue to "increase your forward racquet head speed toward the net" and train the skills and muscles that cause that
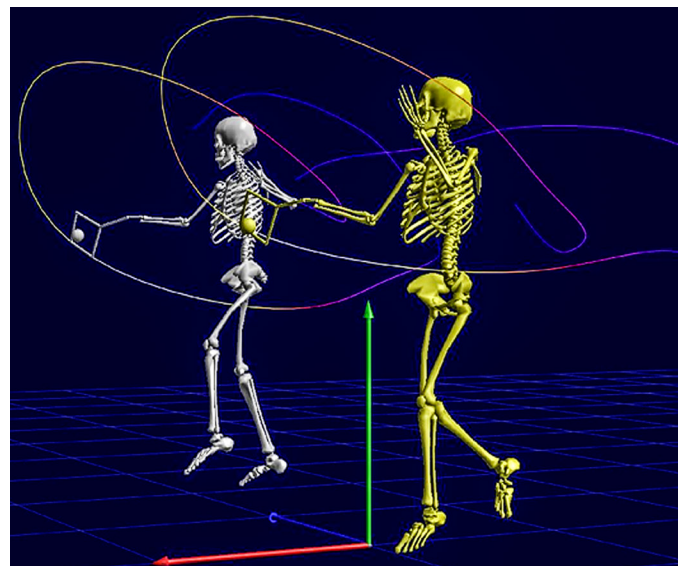
toward the target.

This data suggests general racquet head speed improvement does not evolve the college players to the pro player stroking level.

Why do the pro's racquet head speeds not correlate to their ball speed? Here's why.

Racquet head speed calculations use 3 values:
1. Forward racquet velocity toward the net
2. Upward racquet velocity toward the sky
3. Sideward racquet velocity toward the sideline

Notice each one of these values has a specific direction, forward toward the net, upward toward the sky, sideward toward the sideline. Kwon et. al. (2017) report that upward velocity of the racquet has been shown to significantly correlate with topspin. ATP players' racquet head speed has a much higher component of upward racquet velocity contributing to total racquet head speed. This higher upward racquet velocity component slows the ball speed with topspin.

ATP pros show a significant difference in the scores for upward racquet velocity to the sky (M=37.67 mph, SD=5.63) compared to the College group (M=31.88 mph, SD=5.83); t(38)=2.316, p = .026.

ATP pros show a significant difference in the scores for angle of upward racquet trajectory at impact (M=35.75 deg, SD=4.9 deg) compared to the college group (M=30.20,

Figure 2 White ATP #1, Yellow Top College Player.

motion. If your player needs more topspin, then precisely cue them to "increase your upward racquet speed toward the sky." Avoid using the term "power" and alternately use the cue "high forward ball speed." Finally, when training to increase your players' UTR, add the simple precision modifiers that indicate direction. ✵

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