Can Basketball Players Actually be “On Fire”?

The Hot Hand in Basketball: On the Misperception of Random Sequences

By Thomas Gilovich, Robert Vallone, and Amos Tversky

This is the first major study on the existence of the hot hand phenomenon in basketball. The study takes all shots equally because they assume the shots are randomly and independently chosen from all difficulties. They only consider shots taken in the same game by the Philadelphia 76ers during the 1981 season. They grouped shots by fours and classified them into categories based on how many of the four shots were made. They then found the probability of making on the next shot for each category. They found the opposite of what would be expected if the hot hand phenomenon existed. Players were less likely to make a shot following makes than they were following misses.

The researchers also did an analysis on the number of runs in the shooting. A run was a group of one or more made shots or misses (For example :Make, Make, Miss, would have 2 runs). If a player was streaky, then they should have less runs since a made shot would make the next shot more likely to be made and a missed shot would make the next shot more likely to be missed (more likely to continue a run than end it and begin a new one). They compared the actual number of runs with the expected number of runs for a process with a similar success rate and independent trials. They found many players had more runs than expected and one player had a statistically significant amount of runs more than expected. This also contradicts the hot hand phenomenon.

The Hot (Invisible?) Hand: Can Time Sequence Patterns of Success/ Failure in Sports Be Modeled as Repeated Random Independent Trials?

By Guy Yaari and Shmuel Esienmann

These authors sought out a way to test whether an NBA player has hot streaks and cold streaks in shooting. Yaari and Esienmann conjectured many basketball phenomena that could skew the results of a potential experiment, in response to the original article by Gilovich, Vallone, and Tversky. For example, the defense is often more likely to guard a player who has made a few shots in a row than a player who hasn’t. This likely increases the difficulty of the next shot which could cancel out the effect of being on a hot streak. Also, players who think they are on a hot streak can become more confident in their abilities and become more likely to take difficult shots. To eliminate these issues ,they only considered free throws. This provides a situation where defense and shot selection do not have any effect on the results of the shot.

The results of their experiments suggested “strong evidence for the existence of a ‘hot hand’ phenomenon in free [throws] of NBA players.” The authors discovered “hot hand” patterns at both the aggregate and individual levels. They discovered that the probability of making a free throw increases with each shot in a sequence of free throws and that the probability of making a free throw is greater following a made free throw than it is following a missed free throw. They suspected that this could be the result of better and worse shooting periods of a player over time rather than positive/negative feedback loops. Under this assumption, a player’s true shooting percentage changes over time due to various causes (injuries, changing form, more practice, etc.). If a player makes a shot, it is more likely that they are currently shooting at a higher percentage than at a lower percentage. Thus, the player is more likely to make the next shot.

The Hot Hand: A New Approach to an Old “Fallacy”

By Andrew Bocskocsky, John Ezekowitz, and Carolyn Stein

The authors of this research article took a similar view point to Yaari and Esienmann. They pointed out that previous research had failed to account for situations where shot selection and shot difficulty are not randomly determined. They conjectured that if a hot hand phenomenon exists, then it is likely to influence shot selection and shot difficulty. This could cancel out any hot hand effect to be found. To overcome this , they used technology to create a better model.

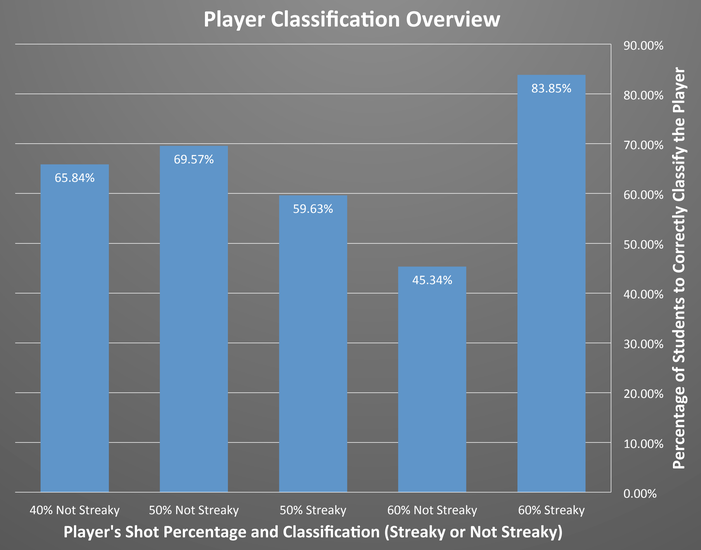
The original study only had basic box score information from one team. For this study, the researchers were able to use data from an optical tracking system that has recently been used in the NBA. Through this data, they were able to create a system for shot difficulty based on shot selection, defensive pressure, and game conditions. This system adjust s for the different difficulties between a layup and a three pointer, as well as the difference between being guarded by a short player or a tall player. The most interesting adjustment had to do with defining what constitutes a hot player. In the past, studies have used a measure that calculates the actual percentage over the past few shots. Players with a higher than average percentage were considered hot and players with a lower than average percentage were not. This study uses a new measure that subtracts out the expected percentage the player should shoot based on the difficulty of the shots taken. This provides a net measure of how well the player is doing compared to the average expected performance of that player under the conditions. Using this new measure of whether a player is hot, the researchers determined that NBA players experience an increase in shooting percentage between 1.2% and 2.4% for their next shot when they are hot. This is the first study that firmly supports the existence of a hot hand phenomenon in basketball.

Abstract:

The purpose of my symposium project is to apply mathematical analysis towards the phenomenon of hot and cold shooting in basketball. There is research that both supports and refutes the occurrence of hot streaks. In order to test this, I created a mathematical model to represent a basketball player, allowing for varying shooting percentages and correlations between shots. The model was used to create a survey to determine whether students could tell the difference between a streaky player and a normal player. The surveys were filled out voluntarily by college students. The results showed that students who believed in streaky shooting were more likely to identify shooters as streaky and students tended to identify better players as streaky players. The conclusion from my test is that people perceive the phenomenon of hot streaks to be more impactful than it is in reality.

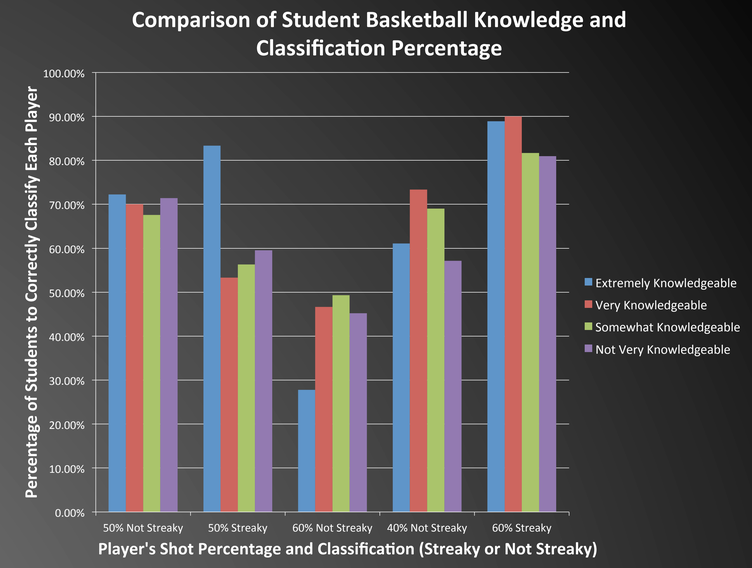
Survey Process:

I created a survey to get data about how familiar a person was with basketball and then had them decide whether they believed in streaky (hot/cold) shooting. The survey then asked participants to classify a group of five players as either streaky or not streaky based on a string of 40 shots. The series of shots was created by a two-state Markov Chain where the correlation between shots could be adjusted. The survey included three players with no correlation between shots and two players with a 0.2 correlation between shots. The actual shooting percentages varied from 40% to 60% to test whether students could tell the difference between better players and streaky players. The survey was handed out to various math classes by faculty and voluntarily filled out by students. 161 surveys were filled out completely and used in the study.



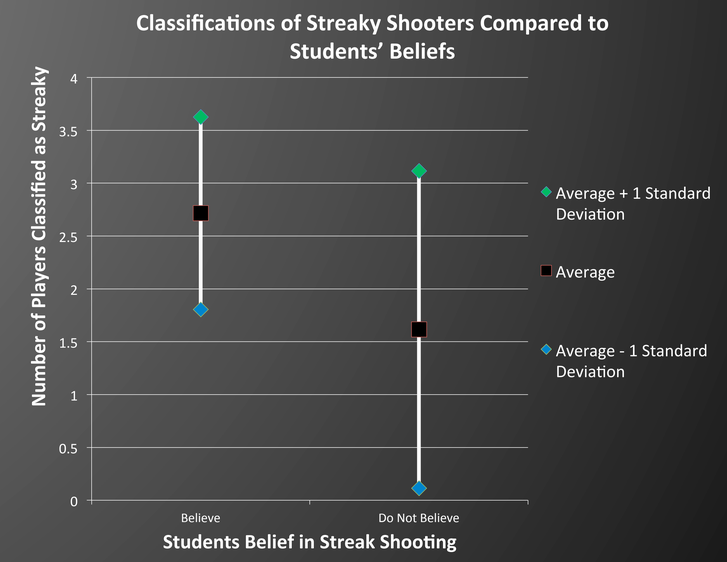
Player Classification Results:

Students did better than expected on the surveys. They correctly classified approximately 65% of the 5 players on average. Which suggests that they were somewhat able to distinguish between streaky and non-streaky players. The two players that were not close to the average were the players who shot 60%. A strong majority of over 80% of students were able to classify the streaky 60% player as streaky while only 45% classified the non-streaky 60% player correctly. This is likely because a player shooting 60% will have more made shots than missed shots and therefore have more prevalent streaks of made shots. This likely caused a slim majority of students to mistake the better player as a streaky player.



Does Basketball Knowledge help Identify Streakiness?

It seems logical that someone who is more knowledgeable about basketball would have an advantage in determining whether a player is streaky or not. This was not the case for the students surveyed. Those that identified themselves as extremely knowledgeable were not able to classify players any better than those that identified themselves as very knowledgeable. These two groups of students only did marginally better than those in the lower knowledge categories. All four categories of knowledge levels achieved an average between 63% and 67% of the players correctly identified. Those in the extremely knowledgeable group were able to identify the streaky players well with over 80% correct on both; however, they did very poorly overall on classifying non-streaky players. Based on the sample of students to participate in the survey, basketball knowledge did not provide any tangible advantages for classifying players as streaky or not streaky.



Did Student Belief’s Play a Role?

Students who believe in streaky shooting were much more likely to classify players as streaky than students who did not believe in streaky shooting. On average, the students who believe in streaky shooting identified approximately one more player as streaky. They also determined that over half of the total players were streaky. This suggests that they were more likely to associate regular variations in the random outcomes as hot and cold periods of shooting. In conclusion, the students often perceived the players in a way that matched their own beliefs and classified the players accordingly.