

The "Hot Hand" Myth in Professional Basketball

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The "hot hand" describes the belief that the performance of an athlete, typically a basketball player, temporarily improves following a string of successes. Although some earlier research failed to detect a hot hand, these studies are often criticized for using inappropriate settings and measures. The present study was designed with these criticisms in mind. It offers new evidence in a unique setting, the NBA Long Distance Shootout contest, using various measures. Traditional sequential dependency runs analyses, individual level analyses, and an analysis of spontaneous outbursts by contest announcers about players who are "on fire" fail to reveal evidence of a hot hand. We conclude that declarations of hotness in basketball are best viewed as historical commentary rather than as prophecy about future performance.

Key Words: momentum, streaks, probability

The "hot hand" suggests that an athlete's performance temporarily increases beyond his or her base rate following a string of successes. Despite much research, debate persists about whether athletes elevate their performance following streaks of success (Albert, 1993; Ayton, 1998; Berry, 1999; Gilken & Gray Wilson, 1995a, 1995b; Hooke, 1989; Kaplan, 1990; Larkey, Smith, & Kadane, 1989; Morrison & Schmittlein, 1998; Stern, 1997; Tversky & Gilovich, 1989a, 1989b; Vergin, 2000; Wardrop, 1995). In this paper we take criticisms and limitations of previous research into account and offer new evidence against the phenomenon.

The hot hand has always been most closely associated with basketball. Here the metaphor is so common that television and radio announcers provide us with information about shooters' "temperatures" throughout the game (e.g., "Starks is ice cold," "Kerr is starting to heat up"). Because one of our goals was to examine hot hands in an environment where they are readily perceived, we conducted our research in the context of basketball.

Prior Research

Scientific support for the hot hand is minimal at best. Researchers typically investigate the hot hand by looking for outcome dependencies across individual

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performance trials. Adams (1992), Gilovich, Vallone, and Tversky (1985), Shaw, Dzewaltoski, and McElroy (1992), and Tversky and Gilovich (1989a) did not find evidence for dependencies in basketball shots. That is, the chance that an athlete would make a shot (e.g., a free throw) was about the same regardless of whether the athlete made or missed one or more similar shots. Larkey et al. (1989) claimed to have found hotness in a single professional basketball player (Vinnie Johnson), but Tversky and Gilovich (1989b) immediately discredited their evidence. Proof of hot hands in other sports such as baseball is also elusive (Albright, 1993; Frohlich, 1994; Vergin, 2000; but see Jackson, 1993).

Some sport researchers are interested in the hot hand for its implications about the role of psychological momentum on athletes and athletic performance (Adams, 1992; Cornelius, Silva, Conroy, & Petersen, 1997; Perreault, Vallerand, Montgomery, & Provencher, 1998). Like hotness, momentum is an intuitively compelling but scientifically unproven phenomenon (Burke & Houseworth, 1995; Cornelius et al., 1997; Kerick, Iso-Ahola, & Hatfield, 2000; Miller & Weinberg, 1991; Silva, Cornelius, & Finch, 1992).

Some believe that studies that failed to detect hotness are flawed. For example, Kaplan (1990) suggested it is inappropriate to search for hotness in rich contexts where the effect may be masked by other effects. In basketball, hot shooters may believe they are hot and therefore take relatively more difficult shots. Also, defenses may guard streak shooters more closely, thereby reducing the likelihood of future successful shots (Forthofer, 1991; Larkey et al., 1989).

An early study by Gilovich et al. (1985, Study 3) controlled for these factors by searching for sequential dependencies in free throws. Their study found that the probability of free-throw success was unaffected by the outcome of previous attempts (see also Shaw et al., 1992). However, free throws are not a paradigmatic setting for perceived hotness. The high probability of free-throw success (about 75% for professionals, *Sports Illustrated*, 2001) and the time lag that occurs across free throw attempts (Shaw et al., 1992) may inhibit perceptions of hotness.

These criticisms may have some merit. Recent data indicate that most people do not regard a shooter who makes easy shots over an extended time span to be hot. In contrast, people do regard a shooter who has a three-shot run of success on a difficult shot over a short time horizon to be hot (Koehler & Conley, 2001). With this in mind, we searched for hotness in a naturally occurring basketball setting that controls for these factors. We also sought a context that closely mirrored various NBA game conditions such as professional players, competition, high stakes, professional court, and a large crowd and television audience.

Long Distance Shootout Contest

The National Basketball Association's Long Distance Shootout contest satisfies these requirements. The Long Distance Shootout is an annual shooting contest that pits eight of the best 3-point shooters in professional basketball against one another. The rules are simple. Each player takes 5 uncontested shots from each of five predetermined spots around the NBA's 3-point arch. Players have 60 seconds to complete all 25 shots. The four top scorers from the initial round of eight move to semifinal matches, and the top two scorers from the semi-finals compete in the finals.¹ The winner receives \$20,000.

Procedure

We obtained videotapes from four annual shootout contests (1994–97) from the NBA. The contests included three rounds (1st round, semifinals, and finals). We studied the scoring patterns of all shooters in all three rounds during these 4 years. We did not include data from tie-breaking playoffs between two shooters. In the end, we examined 56 sets of 25-shot performances from 23 contestants in four shootout contests. Contestants in the finals and semifinals were, of course, the same as those from the first round. Also, some of the same contestants competed in different years. On several occasions, shooters did not complete the full set of 25 shots due to time constraints. The median number of shots for the 23 shooters was 49 (range = 24–174).

For comparability with previous hot-hand analyses, we searched for evidence of sequential dependency within each shooter across all shots. We also searched for sequential dependencies *within* each shooter per set of 25 continuous shots, and employed a variety of novel techniques for isolating hot performance.

Results

Data from the 3-point shootout contests gave no evidence for hotness or sequential dependencies. First we performed a runs analysis on the data from each of the 23 shooters (see Table 1). The advantage of this technique is that it allowed us to search for evidence of streakiness within each shooter. A disadvantage of this technique is that it treats data from players who participated in more than one round of the contest as if performance was continuous. A "run" was defined as a set of one or more hits and misses. Thus the sequence HHHHH has one run and the sequence HMHMH has five runs. Under the hot-hand hypothesis, shooters should have *fewer* runs (i.e., more hit-and-miss clusters) than would be expected by chance alone, conditioned on the shooter's base rate for hits and misses. Only two shooters (Anderson and Scott) had significantly fewer runs (i.e., more clusters) than would be expected by chance. No shooter had significantly more runs than would be expected by chance. About half of the shooters (12 of 23 = 52%) had fewer runs than expected, and about half (11 of 23 = 48%) had more runs than expected.

Second, we compared the shooting performance of players following hit-and-miss clusters to their base rate shooting success. In aggregate, shooters made 57.3% of shots (122 of 213) following streaks of three or more hits, and 57.5% of shots (73 of 127) following streaks of three or more misses. These data are more consistent with the chance hypothesis than with the hot-hand hypothesis.

Individualized analyses yielded similar results. Among players who had at least five 3-hit sequences ($n = 11$), $P(\text{Hit} | 3 \text{ Hits})$ was greater than the player's base rate in five cases (Ellis, Kerr, Price, Legler, and Scott) and less than the player's base rate in six cases (Barros, Burrell, Miller, Rice, McCloud, and Williams). Among players who had at least five 3-hit sequences *and* at least five 3-miss sequences (n

¹ In the contest, the fifth shot from each location is worth more points than the other four shots if it goes in. However, for purposes of analyzing hot performance, all shots were treated equally in our analyses.

Table 1 Runs Test for Players in the NBA Long Distance Shootout Contests (1994–1997)

Player	Base rate	Hits	Misses	Actual runs	Expected runs	Z
Ellis	.467	35	40	33	38.3	-1.246
Kerr	.586	102	72	78	85.4	-1.162
Price	.640	48	27	33	35.6	-0.647
Barros	.504	63	62	61	63.5	-0.448
Murdoch	.480	12	13	14	13.5	0.213
Richmond	.480	12	13	18	13.5	1.850
Curry	.400	10	15	11	13.0	-0.853
Armstrong	.333	8	16	10	11.7	-0.787
Burrell	.580	29	21	28	25.4	0.775
Miller	.587	44	31	44	37.4	1.589
Person	.520	26	24	29	26.0	0.870
Rice	.547	81	67	70	74.3	-0.722
Anderson	.440	11	14	8	13.3	-2.207*
Marjerle	.280	7	18	11	11.1	-0.041
McCloud	.580	29	21	30	25.4	1.362
Legler	.640	96	54	71	70.1	0.157
Robinson	.440	11	14	18	13.3	1.941
Scott	.587	44	31	27	37.4	-2.488*
Davis	.560	14	11	15	13.3	0.697
Williams	.531	26	23	28	25.4	0.751
Mills	.440	11	14	9	13.3	-1.792
Stockton	.440	11	14	12	13.3	-0.548
Perkins	.320	8	17	16	11.9	0.947
Totals	.539	738	632	674	685.4	-0.034

* $p < .05$ (two-tailed)

= 6), $P(\text{Hit} \mid 3 \text{ Hits}) > P(\text{Hit} \mid 3 \text{ Misses})$ for three players (Barros, Legler, and Scott), and $P(\text{Hit} \mid 3 \text{ Hits}) < P(\text{Hit} \mid 3 \text{ Misses})$ for the three other players (Ellis, Kerr, and Rice).

Finally, we conducted runs analyses for each of the 56 sets of 25 continuous shots. The advantage of this technique is that the 25 continuous shots were produced in a short and continuous time span. The disadvantage of this technique is that the 56 sets of shots were not produced by 56 different shooters, thus violating independence. Nevertheless, the data are instructive for their failure to provide even a hint of evidence for a hot hand. The mean number of runs per set was 12.5. This is very close to the expected number of runs, 13.

*Announcers' Spontaneous Temperature Outbursts:
"Legler is on Fire!"*

A natural indicator of perceived hotness occurs when knowledgeable observers *spontaneously comment* on the "temperature" of an athlete. With this in mind, we searched for evidence of performance deviations following Shootout announcers' comments about a player's temperature.² We coded all play-by-play comments related to temperature provided by the shootout announcers in the semi-final and final contests across each of 4 years. Examples include: "Dana Baros is red hot!" and "Legler is on fire!" To increase the power of our analyses, we also included comments that strongly hinted at an underlying belief in hotness even when the comment did not explicitly refer to temperature (e.g., "He's on a roll").

Players made 55.2% of the shots (16 of 29) that immediately followed an announcer's reference to their temperature. Because this is about the same as the players' overall base rate in the shootouts (53.9%), the announcers' comments had little predictive value. Not surprisingly, shooting performance *prior* to the announcers' temperature comments was excellent: 86.2% of the shots (25 of 29) that immediately preceded the outbursts and 80.5% of the 3-shot sequences (70 of 87) that preceded the outburst were successful. A stricter coding scheme in which only explicit "temperature" references counted as a spontaneous hot-hand outburst yielded similar results: 54.5% of the shots (6 of 11) immediately following a hotness outburst were successful, and 90.9% of the shots (10 of 11) immediately prior to the outburst were successful.

Discussion

In this paper we identified the NBA Long Distance Shootout contest as a superior context for investigating the hot hand, and offered new evidence against this phenomenon in professional basketball. Traditional sequential-dependency runs analyses, individual level analyses, and a review of spontaneous outbursts by contest announcers about players who are "on fire" did not support the claim that athletes outperform their base rates following runs of shooting success. These data suggest that coaches, managers, and athletes should resist the temptation to predict future performance based on recent short-term runs of uncharacteristically strong performance. Instead, an athlete's base rate for success in similar competitive circumstances is probably a better indicator of future success. Based on the available data, we conclude that declarations of hotness are probably best viewed as a commentary on past performance rather than as prophecy about future performance.

Nevertheless, we caution that no single study can be the last word on this topic. For example, it may be that certain individuals *are* prone to becoming hot in certain situations for limited periods of time. It is also possible that hotness does exist, but only in tasks that involve a large psychological component (Adams, 1995), high levels of arousal (Perreault et al., 1998), or a certain level of expertise (Kerick et al., 2000).

Future research might focus more on implications of false belief in the hot hand rather than on pinpointing where hotness exists. Even if hotness exists in

² "Cold" references of any sort were too infrequent to analyze.

some form in some contexts, there are probably many more contexts where people behave below optimum due to a false belief in a hot-hand effect. For example, economics research shows that perceived hotness affects the point spreads in sports betting markets (Badarinathi & Kochman, 1994; Brown & Sauer, 1989; Camerer, 1989). There is evidence that these market inefficiencies can be exploited profitably (Badarinathi & Kochman, 1994; Woodland & Woodland, 2001), though some remain unconvinced (Brown & Sauer, 1989; Camerer, 1989; Oorlog, 1995). If future research clearly identifies exploitable market inefficiencies that arise from mistaken beliefs in hotness, then the hot hand may ultimately be more notable for the irrational behavior it promotes than for the elevated athletic performance it was thought to produce.

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