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The hot hand phenomenon as a cognitive adaptation to clumped resources

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Abstract

The hot hand phenomenon refers to the expectation of "streaks" in sequences of hits and misses whose probabilities are, in fact, independent (e.g., coin tosses, basketball shots). Here we propose that the hot hand phenomenon reflects an evolved psychological assumption that items in the world come in clumps, and that hot hand, not randomness, is our evolved psychological default. In two experiments, American undergraduates and Shuar hunter–horticulturalists participated in computer tasks in which they predicted hits and misses in foraging for fruits, coin tosses, and several other kinds of resources whose distributions were generated randomly. Subjects in both populations exhibited the hot hand assumption across all the resource types. The only exception was for American students predicting coin tosses where hot hand was reduced. These data suggest that hot hand is our evolved psychological default, which can be reduced (though not eliminated) by experience with genuinely independent random phenomena like coin tosses.

Keywords: Decision-making; Ecological rationality; Patchy environment; Aggregation; Streaks; Hot hand

1. Introduction

1.1. A brief history of the hot hand phenomenon

A large body of research in psychology suggests that people have difficulty thinking about randomness, often perceiving patterns that simply are not there (e.g., Falk & Konold, 1997; Nickerson, 2002). In particular, people seem to have difficulty thinking properly about independent events: series of events each of whose outcome has no influence on the outcomes of future ones. One of the best known of these confusions was first identified by Gilovich, Vallone, and Tversky (1985) and has come to be known as the hot hand fallacy (here, because we will be questioning whether it is a fallacy, we will refer to any assumption of clumps as the "hot hand phenomenon" or, more simply, "hot hand"). The phenomenon was first identified in observers' predictions about the likely outcomes of basketball shots. Gilovich et al. (1985) found that both basketball players and fans judged that a player's chance of hitting a shot was greater following a successful shot than a miss. These judgments revealed an implicit assumption of "streaks" or "runs" in players' shooting success. This can be described as a positive recency effect: a successful shot, or "hit," boosts the observers' subjective probability of another hit. In other words, the hot hand phenomenon reflects an implicit assumption on the part of the observer that hits are positively autocorrelated, or clumped. However, when Gilovich et al. (1985) analyzed the actual data on which subjects' predictions were made, they found that the shots were, in fact, independent. The hot hand assumption was therefore a mistake, at least in this case.

The hot hand phenomenon is not limited to basketball, however. There exist a variety of studies showing that subjects expect and indeed perceive clumps in data that have no clumps. While most of these studies have been done in other sports disciplines (e.g., Clark, 2003; Dorsey-Palmateer & Smith, 2004), the hot hand phenomenon has also been reported in betting markets (Camerer, 1989) and finance (Hendricks, Patel, & Zeckhauser, 1993). Positive recency effects can also be shown in prediction tasks, such as when placing bets in roulette games (Croson & Sundali, 2005).

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However, most previous studies of hot hand have examined relatively artificial and evolutionarily novel environments like sports and betting markets, so the full range of environments where hot hand might occur is not yet known.

1.2. Previous explanations for hot hand

A variety of explanations for the hot hand phenomenon have been proposed. Most of these view hot hand as the by-product of some cognitive mechanism or process which might be "adaptive," or useful, in some cases, but is misapplied in the case of basketball shots, coin tosses, and other sequences of independent events. What varies in these explanations is the cognitive process that causes the hot hand effect.

The original explanation of hot hand by Gilovich et al. (1985) was that subjects bring an assumption of "representativeness" to the data: hot hand reflects "a general misconception of chance according to which even short random sequences are thought to be highly representative of their generating process" (Gilovich et al., 1985, p. 295), so subjects mistakenly infer an autocorrelation that extends beyond the short sequence sampled. Others suggest that hot hand results from overgeneralization of patterns that subjects have learned from experiences of real world distributions where there are streaks, but that do not apply to cases such as free throws and coin tosses. Ayton and Fischer (2004), elaborating on an argument originally offered by Estes (1964), point out that hits are autocorrelated in a variety of domains of human performance such as golf, darts, and horseshoe pitching (Gilden & Wilson, 1995, 1996; Smith, 2003) and suggest that subjects have learned, perhaps mistakenly, to expect clumps in other domains. Similarly, Raab, Gula, and Gigerenzer (under review) show that streaks exist in volleyball, and Miyoshi (2000) in basketball, suggests that hot hand might not be a fallacy at all. There is thus disagreement about whether hot hand is a fallacy even for sports (Bar-Eli, Avugos, & Raab, 2006). Of course, these arguments would not justify a hot hand assumption for cases such as coin tosses, which are genuinely independent.

Burns (2004) has made perhaps the most explicit proposal that hot hand is adaptive. According to his proposal, this could be true in at least two possible ways. First, he suggests and shows via simulation that, if hot hand is used as a basis not for prediction per se but for decision making—deciding to whom to pass the ball— "belief" in hot hand leads to more scoring by the team because small samples of hit rates are predictive of overall scoring ability, and the ball is passed more frequently to players that recently scored. Second, if there really *are* clumps in the world, then assuming there are clumps will lead to good predictions. Our proposal below elaborates on this latter suggestion by explicitly proposing that hot hand is an evolved cognitive adaptation to a world where clumps are the norm rather than the exception and represents a psychological default to expect clumps in a wide variety of domains.

1.3. Hot hand as an evolved cognitive adaptation

We suspected that prior research on hot hand might have started from the wrong place in asking why people are so bad at thinking about random (independent) events and in focusing on relatively novel domains such as sports and betting. From an evolutionary perspective, we expect cognitive skills to be adapted to the kinds of fitness-relevant problems people faced in ancestral environments, not modern contexts like sports, betting markets, or artificial laboratory tasks. The original hot hand results were considered surprising because they showed that people are poor at making predictions about randomness, but we suggest that it might have been more surprising if it had been the other way around. Truly independent and random events are likely to have been relatively rare in ancestral environments, and there would have been little or no selective advantage to trying to make predictions about the ones that were. Instead, most of the objects and events that would have had a fitness impact on human decision-making would have exhibited at least some statistical patterning, and selection would have occurred if people could detect and take advantage of such patterns in their decision making in a fitness-promoting way. It is in this context—taking advantage of statistical patterns in the environment for the purposes of decision-making—that we believe hot hand evolved.

We propose that hot hand is a cognitive adaptation that evolved to help people predict the presence of items in space and time, that it is designed to exploit the fact that those items are clumped in space and time, and that it evolved for the purpose of foraging, broadly construed. We will briefly explain each of these three features of our proposal in turn.

First, consider the psychological context in which hot hand was originally discovered and has since been repeatedly confirmed. Hot hand occurs when subjects experience a sequence of events that can be classified in a binary fashion into hits or misses and try to predict future ones. Not all human decision-making contexts exhibit this feature of sequential search. In ancestral environments, we believe that the most common case in which such sequential search would have occurred would have been foraging, which we will define below.

A second point to consider is that hot hand appears particularly well-suited for items that are clumped (positively autocorrelated) in space and time, as opposed to truly random (zero autocorrelation) or dispersed (negatively autocorrelated). Indeed, hot hand is empirically operationalized as positive autocorrelation in subjects' predictions. We suggest that it is not a coincidence that an implicit assumption of clumps is easily evoked. In nature, clumps are the norm rather than the exception in diverse natural phenomena including the distributions of animals, plants, minerals, water, human settlements, and weather (e.g., Taylor, 1961; Taylor, Woiwod, & Perry, 1978). There is good reason to suspect that some degree of clumpiness was common for most of the natural