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Original Article

Illusionary pattern detection in habitual gamblers☆

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ABSTRACT

Does problem gambling arise from an illusion that patterns exist where there are none? Our prior research suggested that "hot hand," a tendency to perceive illusory streaks in sequences, may be a human universal, tied to an evolutionary history of foraging for clumpy resources. Like other evolved propensities, this tendency might be expressed more stongly in some people than others, leading them to see luck where others see only chance. If the desire to gamble is enhanced by illusory pattern detection, such individual differences could be predictive of gambling risk. While previous research has suggested a potential link between cognitive strategies and propensity to gamble, no prior study has directly measured gamblers' cognitive strategies using behavioral choice tasks, and linked them to risk taking or gambling propensities. Using a computerized sequential decision-making paradigm that directly measured subjects' predictions of sequences, we found evidence that subjects who have a greater tendency to gamble also have a higher tendency to perceive illusionary patterns, as measured by their preferences for a random slot machine over a negatively autocorrelated one. Casino gamblers played the random slot machine significantly more often even though a training phase and a history of outcomes were provided. Additionally, we found a marginally significant group difference between gamblers and matched community members in their slot-machine choice proportions. Performance on our behavioral choice task correlated with subjects' risk attitudes toward gambling and their frequency of play, as well as the selection of choice strategies in gambling activities.

1. Introduction

Why do we gamble? The simple answer, of course, is to win. But when games of chance are truly random and entirely unaffected by human skill, as many are, the rationale for engaging in them is far from obvious. If the statistics of the game mean that the best one can expect in the long run is to break even—and usually not even that—why play? Why do so many people around the world spend substantial portions of their income on games of chance, such as lotteries, that will only make them poorer on average?

One possibility is that gamblers do not fully grasp the random nature of the games they are playing. There is a large psychological literature documenting what is sometimes called "apophenia:" a human tendency to perceive patterns in random data that simply do not exist (e.g., Falk & Konold, 1997). In particular, people seem to have difficulties when perceiving independent events, or series of events whose outcome has no influence on the outcome of future events (Nickerson, 2002). One of the best known of these biases is the "hot-hand" phenomenon, first identified in a study of observers' predictions about basketball shots (Gilovich, Vallone, & Tversky, 1985). Both players and fans tended to judge a player's chance of hitting a shot to be greater following a successful shot than a miss, despite the fact that hit rate was statistically the same in both cases. Perhaps not surprisingly, illusory pattern perception of this kind has also been found among gamblers. For example, roulette players often bet on more numbers after winning than after losing (Wagenaar, 1988). Lottery players tend to redeem winning tickets for more tickets rather than for cash, reflecting a belief that they are more likely to win again (Clotfelter & Cook, 1989). Many lottery players believe in "hot" and "cold" numbers, returning to previously "hot" numbers once they've been given time to cool off (Rogers, 1998). And lottery tickets are sold more often at stores that have just issued a winning ticket, reflecting a hot hand or "lightning strikes twice" mentality (Guryan & Kearney, 2008). Another fallacy, known as the "gambler's fallacy," is in some ways the flip side of hot hand, reflecting a belief that a streak is coming to an end—leading roulette gamblers, for example, to bet on black after several reds in a row (e.g., Ayton & Fischer, 2004; Croson & Sundali, 2005). Both hot hand and the gambler's fallacy, then, seem to reflect illusory perception of clumps or streaks in data that do not contain them.

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Where do these beliefs come from? Why might people systematically perceive streaks where there are none? In previous work, we have proposed that hot hand may have its roots not in basketball or in financial markets, but in a much more ancient mode of human cognition: foraging (see Scheibehenne, Wilke, & Todd, 2011; Wilke & Barrett, 2009; Wilke & Mata, 2012; Wilke & Todd, 2012; see also Reifman, 2011). On this view, a tendency to look for clumps is not just a quirk of modernity, but a deep-seated part of our psychology that evolved because there are many contexts in which the world is *not* random, and looking for clumps is therefore adaptive. In particular, clumped distributions of resources such as plants, animals, water sources, and human settlements are common in natural environments, and animal and human foragers appear to adapt their search strategies to these observable statistical regularities in their foraging landscape (Bell, 1991; Hills, 2006; Krause & Ruxton, 2002; Taylor, 1961; Taylor, Woiwod, & Perry, 1978).

Consistent with this, we found that hot hand occurs in both Western cultures and a traditional foraging culture, and seems to be a kind of psychological default which is only partly erased by experience with true randomizing mechanisms like coin tosses (Wilke & Barrett, 2009). Importantly, hot hand is not necessarily irrational when clumps actually do exist, and in cases where they do not—for example, when trying to predict random sequences of independent and equiprobable events (such as when playing roulette)—hot hand does not decrease accuracy, because all strategies produce chance-level performance (c.f. Scheibehenne et al., 2011). Therefore, the tendency to assume or look for patterns or regularities in a given sequence may be a reasonable default strategy: If there is in fact a pattern, expecting that particular pattern can be advantageous by providing an edge in predicting future events, and if there is no pattern, expecting one will do no worse than any other strategy.

Could hot hand play a role in human gambling behavior? The tendency to search for patterns in random data could explain part of the pleasure humans experience in gambling—for example, the experience of winning several times in a row could be highly compelling, leading one to believe that one is on a hot streak. But in addition to this universal propensity, there could be differences between individuals in just how "hot-handed" they are—just how prone they are to perceive streaks, even when they do not exist—that could lead to differences in how much gambling on random outcomes is enjoyed. As for many evolved traits, individual differences in pattern perception could arise from a variety of factors, including genetic differences, environmental differences, or differences in individual experience. If such individual differences are predictive of propensity to gamble, this could have implications both for developing assessment tools to detect risk of developing a gambling problem and for interventions that might be effective, such as targeting gamblers' perceptions of randomness (c.f. Petry & Armentano, 1999). Moreover, if the hypothesis that hot hand is a universal human cognitive adaptation is right, then the risk of developing a gambling problem might also be a human universal, not restricted to those with a cultural history of gaming, or individual experience with it.

Several prior studies have suggested that beliefs about illusory patterns, such as hot hand and its opposite effect the gambler's fallacy, may play a role in preferences for gambling (Ayton & Fischer, 2004; Croson & Sundali, 2005; Gaboury & Ladouceur, 1989; Joukhador, Blaszczynski, & Macallum, 2004; Oskarsson, van Boven, McClelland, & Hastie, 2009; Toneatto, 1999). However, these studies were based on questionnaires about subjects' gambling beliefs, not on direct measurements of subjects' predictions of streaks. While questionnaires can be useful, asking subjects to report their beliefs about their own behavior is not the same as measuring what subjects actually do (c.f. Nisbett & Wilson, 1977). For example, many college students report understanding that coin tosses are perfectly random. However, their judgments of actual sequences of coin tosses reveal that they expect them to contain fewer streaks than they actually do, revealing a bias that they might not realize they have (Falk & Konold, 1997). To truly measure hot-handedness then, observation of actual behavior is necessary. In the case of gambling, one might expect subjects to prefer to bet on sources that they perceive as containing clumps, compared to sources they perceive as less clumpy—even when the clumps are illusory. Here we gave subjects a choice between paired sequence generators that varied in how hot-handed they actually were, and measured which the subjects preferred to bet on (c.f. Shaffer, Peller, LaPlante, Nelson, & LaBrie, 2010).

In order to assess the possible role of the hot-hand phenomenon in the propensity to gamble, we adopted a mixed-method approach that looked for within-subject correlations between hot-handedness, as measured with a behavioral task, and separate measures of proneness to gamble. Our behavioral task, adapted from Scheibehenne et al. (2011), presented subjects with a choice between two simulated slot machines (see Fig. 1). One was slightly *anti*-clumpy, or negatively autocorrelated, while the other was entirely random, with no clumps. In a prior study, Scheibehenne et al. (2011) found that subjects preferred to play the truly random machine, consistent with the perception that it generated more streaks. Thus, degree of preference for the random over the negatively autocorrelated machine is a direct behavioral measure of preference for an illusorily hot-handed machine.

Our research design looked for correlations between performance on the gambling task, and separate, independent measures of gambling propensity. The latter involved both a natural between-group component and a variety of individual difference measures. For the between-group component, we tested two groups of people: habitual gamblers and a control population. For the individual differences component, we examined several factors potentially related to gambling: measures of cognitive capacity as well as standardized screens of gambling history and psychometric measures of risk-taking propensity (a version of the DOSPERT scale, described below). In addition, because our task involved a long sequence of individual gambling decisions, we used quartile analysis to look for changes in strategy, including possible learning effects, within the task.

Our study examined two main hypotheses. First, we predicted that as a group, habitual gamblers would be more prone to see illusionary patterns in random data sets than a matched sample of non-gamblers (Hypothesis 1). Second, we predicted that individual differences in hot-handedness across groups would correlate with gambling-related risk attitudes and individual differences in gambling experience (Hypothesis 2).

2. Methods

2.1. Participants

We collected data from two target populations. In close proximity to Clarkson University is the territory of the St. Regis Mohawk Tribe, or Akwesasne, who are presently situated on more than 30,000 acres of tribal land extending from New York into Quebec and Ontario. With the permission of the Akwesasne Mohawk Casino, a gaming enterprise under the supervision of the St. Regis Mohawk Tribe, we recruited 92 experienced adult gamblers [58 females (63%), 34 males (37%)]. The Akwesasne Mohawk Casino offers visitors gaming and entertainment experience from more than 1600 slots and 22 live action table games. North Country residents were contacted via newspaper and radio advertisments for recruiting participants for our sample of 72 adults that have only little gambling experience [45 females (62%), 27 males (38%)]. All 164 participants were reimbursed for traveling to Clarkson University and participating in our study. Participants