Cognition 116 (2010) 149–153

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

Brief article

The intentional mind and the hot hand: Perceiving intentions makes streaks seem likely to continue

Eugene M. Caruso *, Adam Waytz, Nicholas Epley

The University of Chicago, Booth School of Business, 5807 South Woodlawn Avenue, Chicago, IL 60637, USA

ARTICLE INFO

Article history:
Received 13 July 2009
Revised 14 April 2010
Accepted 18 April 2010

Keywords:
Streaks
Intention
Anthropomorphism
Hot hand
Gambler's fallacy

ABSTRACT

People can appear inconsistent in their intuitions about sequences of repeated events. Sometimes people believe such sequences will continue (the "hot hand"), and sometimes people believe they will reverse (the "gambler's fallacy"). These contradictory intuitions can be partly explained by considering the perceived intentionality of the agent generating the streak. The intuition that streaks will continue (reverse) should emerge in contexts involving agents that are perceived to be intentional (unintentional), and should be most common among those who are most inclined to attribute intentions to other agents. Four studies support these predictions, identifying both situational and dispositional determinants of the perceived continuity of streaks. Discussion focuses on the foundational nature of intentionality for perceptions of interdependence between events, the relationship between these findings and existing theoretical accounts, and the inverse possibility that people use perceptions of streakiness as a cue for an agent's intentionality.

1. Introduction

For almost 2 years, the number 53 had not been drawn a single time in Italy's national lottery. Those who noticed this pattern poured more than 3.5 billion Euros into bets on the number (Arie, 2005). This "national obsession" led to massive debt, suicide, and even murder, and became so severe that one consumer group urged the government to ban the number from future draws to halt the country's "collective psychosis" ("Number 53 brings relief," 2005).

This behavior highlights two important aspects of human intuition: a fascination with randomness, and a fundamental misunderstanding of it. This misunderstanding of randomness is not itself random, but appears primarily in two systematic, and seemingly inconsistent, misunderstandings. The first is belief in the *hot hand* – the intuition that a short run of consistent, but statistically independent, events is likely to continue (e.g., Gilovich, Vallone, & Tversky, 1985). The second misunderstanding is the *gambler's fallacy* – the intuition that a short run of consistent events is likely to reverse (e.g., Tversky & Kahneman, 1971, 1974). Although these two tendencies appear contradictory, they are often explained by the identical mechanism – the representativeness heuristic (Kahneman & Tversky, 1972). Appealing to the same mechanism to account for precisely opposing outcomes is of little help, however, in predicting *when* people will believe that streaks will continue versus reverse (Gigerenzer, 2000). The present research attempts to provide a partial reconciliation by identifying a critical determinant of people's intuitions regarding the continuation of streaks: the perceived intentionality of the agent generating the streak. Simply put, we predict that an observed streak will be judged more likely to continue the more people perceive that the agent generating the streak is acting intentionally.

When observing streaks, people appear to make inferences about the characteristics of the agents generating them. Previous theorists have suggested a number of cues – including randomness, controllability, goal complexity, and intentionality – that underlie such beliefs (see Oskarsson, Van Boven, McClelland, & Hastie, 2009). For instance, people tend to predict that streaks generated by a non-random agent will continue whereas those generated by

* Corresponding author. Tel.: +1 773 834 3847.
E-mail address: ecaruso@chicagobooth.edu (E.M. Caruso).

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doi:10.1016/j.cognition.2010.04.006

a random agent will revert (Ayton & Fischer, 2004; Burns & Corpus, 2004). And simply describing an ostensibly random agent like the stock market in animate, goal-directed terms increases people's tendency to report that a streak will continue compared to when the random agent is described as an object (Morris, Sheldon, Ames, & Young, 2007).

Although many factors may play a role, we suggest that the perceived intentionality of the streak's agent may be the one unifying determinant of people's beliefs. Assessments of an agent's intentions tend to be relatively automatic, and therefore are likely to be a foundational determinant of other cues used to identify systematic patterns in others' behavior (Malle, 1999; Malle, Moses, & Baldwin, 2001). Intentional agents behave systematically, in accordance with underlying goals, with at least some presumed control over their actions. When people see an agent performing an action consistent with an intention to obtain a specific outcome, they conclude that the agent is skillfully guiding that action and therefore controlling the outcome (Malle & Knobe, 1997). In one study, participants who observed a streak of four correct predictions of a coin toss in a row attributed personal skill to the agent, and increased their belief in the agent's ability to control future outcomes (Langer & Roth, 1975). Perceiving a run of events to be generated by an intentional agent should therefore increase the judgment that the agent is willing and able to produce the desired outcome, increase the perceived dependence between successive outcomes, and thereby increase the perceived likelihood that a run consistent with the intention will continue.

Other research has tested different determinants of predictions of repeated events, but has produced mixed (and sometimes inconsistent) results. For example, findings suggesting that the observation of human skilled performance is the critical factor that elicits predictions of streak continuance (Ayton & Fischer, 2004) stand in opposition to findings demonstrating that predictions of streaks are contingent on the perceived randomness of the performance, regardless of whether it is human or not (Tyszka, Zielonka, Dacey, & Sawicki, 2008).

However, we suggest that both sets of findings are consistent with the key role of perceived intentionality, and that a focus on intentions differentiates our work in two important ways. First, although some existing research has compared judgments of ostensibly intentional versus unintentional agents (a roulette player versus a roulette wheel, Ayton & Fischer, 2004; a salesperson versus a roulette wheel, Burns & Corpus, 2004; a basketball player versus a coin flip, Tyszka et al., 2008), no study has directly tested the role of intentionality per se. Thus, intentionality in these studies is confounded with humanness or (non)randomness. Rather than comparing judgments of different types of agents, we address these problems by holding the agent – and hence its humanness and randomness – constant, and manipulating the presence (Study 1) or salience (Study 2) of the agent's intentions.

Second, because people naturally assess intentionality to different degrees when attempting to identify and explain systematic patterns in complex behavior (Rosset, 2008), we can use this variation to identify individual differences in perceptions of randomness. In particular, we predict that those who are more likely to see agents as intentional will judge observed streaks as more likely to continue. Past work has documented individual differences in the use of prediction strategies akin to belief in the hot hand and the gambler's fallacy, but had "no explanation of *why*... people differ in their perceptions of the world with respect to continuation or reversal of trend in various processes" (Tyszka et al., 2008, pp. 107–108, emphasis added). We provide at least a partial answer to this question by measuring perceptions of intentionality in human (Study 3) and nonhuman behavior (Study 4) to specify the relationship between individual differences and predictions of streaks. We are not suggesting that previous treatments of prediction strategies are wrong, but rather are incomplete, and that studying perceptions of intentionality offers a more precise and parsimonious explanation of the process underlying people's predictions about the outcomes of repeated events.

Table 1
Percentage of participants predicting an outcome of 1 following a streak of 1s in the intentional and unintentional conditions (Study 1).

Prediction following:	Condition		χ^2, p, Φ
	Intentional	Unintentional	
Streak	39%	17%	4.18, <.05, .25

2. Study 1

2.1. Method

Seventy-seven participants watched a video of a person rolling a single six-sided die into a box and made a prediction about the outcome of the final roll.[1] All participants were told to imagine a casino game in which the best outcome was to make the die land on the number 1. Participants were further reminded that a tossed die will normally land on the number 1 about 17% of the time. Participants in the *intentional* condition were told that the person was a professional gambler who is able to roll the number 1 about 50% of the time. Participants in the *unintentional* condition were told that the die was "loaded" so that it will land on the number 1 about 50% of the time.

All participants watched the same 13 rolls of the die, in which the die landed on the following numbers: 3-4-1-2-4-1-6-1-5-3-1-1-1. On the toss following the "streak" of 1s, the video stopped as the die was in mid-air and participants indicated (1) which number they thought the die was most likely to land on and (2) the likelihood that the die would land on each of the six possible numbers, on scales ranging from 1 (*not at all likely*) to 7 (*very likely*).

2.2. Results and discussion

Participants in the intentional condition were more than twice as likely as participants in the unintentional

[1] Readers may watch a sample video clip at http://faculty.chicagobooth.edu/eugene.caruso/dice.htm.

Table 2
Percentage of participants predicting an outcome of heads following a streak of heads or a random sequence in the intentions and actions conditions (Study 2).

Prediction following	Condition		
	Intentions	Actions	χ^2, p, Φ
Streak	67%	28%	23.36, <.0001, .39
Random	51%	53%	.02, .88, .08
χ^2, p, Φ	3.92, <.05, .16	9.61, <.01, .25	

condition to indicate that the next toss was most likely to land on 1 (see Table 1). On the continuous likelihood scale, those in the intentional condition also rated the likelihood that the die would land on number 1 as higher ($M = 4.27$) than those in the unintentional condition ($M = 3.54$), $t(66) = 2.10$, $p < .05$, $d = 0.52$.[2]

3. Study 2

Study 2 tests our prediction that intentions only influence predictions following a streak of intended outcomes, rather than increasing the perceived likelihood of an intended outcome in general. Study 2 was also designed in a way that could document both the hot hand and gambler's fallacy in predictions of the very same agent depending on whether perceivers were focused on the agent's intentions or not.

3.1. Method

One hundred fifty-four participants watched a video of a person tossing a coin and predicted the outcome of the coin toss at two separate points.[3] All were told that the tosser was trying to flip heads, but were told nothing about whether doing so was theoretically possible. Those in the *intentions* condition were told to focus on the tosser's intentions: "what he is trying to accomplish with his tosses." Those in the *actions* condition were told to focus on the tosser's physical movements and actions: "the specific movements of his hands and fingers."

All participants watched 24 coin tosses. The first eight were identical for all participants (H-H-T-T-H-T-T-H). The remaining 16 were divided into two counterbalanced blocks, with participants predicting the next outcome after each block.[4] The blocks either ended with a "streak" (T-H-H-T-H-H-H-H) or a "random" sequence (H-T-T-H-H-T-T-H).

3.2. Results and discussion

Following a streak, participants in the intentions condition showed intuitions consistent with the hot hand whereas those in the actions condition showed intuitions consistent with the gambler's fallacy. However, no significant difference emerged between conditions following the random sequence (see Table 2). These results demonstrate that perceiving intentionality does not indiscriminately increase the perceived likelihood of the intended outcome, but rather influences those perceptions immediately following apparent streaks. Even when the agent's intentions were held constant, simply manipulating attention to those intentions influenced the perceived likelihood that a streak would continue or revert.

4. Study 3

Studies 1 and 2 demonstrated that the presence and salience of intentions each affect streak predictions. Understanding the importance of perceived intentions, however, not only explains variance in streak predictions across situations, but can also explain variance in streak predictions across individuals. Because some people are more naturally inclined than others to represent a given behavior in terms of its unobservable intentions (Vallacher & Wegner, 1985), they should be most likely to perceive that a run of events will continue. Demonstrating such individual differences would provide more definitive support for the foundational role of perceived intentionality in hot hand judgments. Study 3 provides a first test of the role of dispositional sensitivity to intentions in predictions of streaks.

4.1. Method

Twenty-seven participants first completed the Behavioral Identification Form (BIF; Vallacher & Wegner, 1989). This questionnaire measures individual tendencies to view an activity (e.g., "locking a door") in terms of the low-level actions for how it is performed ("putting a key in the lock") compared to the high-level intentions for why it is performed ("securing the house"). This measure essentially mirrors the manipulation of attention to low-level (hand movements) or high-level (intentions) factors from Study 2. After completing the BIF, participants predicted the outcomes of six different scenarios, three that involved judging the likelihood on a 10-point scale that a streak would continue (e.g., whether someone trying to draw a spade card would draw one after drawing three spades in a row) and three that involved judging events irrelevant to streaks (e.g., whether a woman had overestimated the number of peanuts in a jar).

4.2. Results and discussion

Participants' average rating of all streak scenarios was slightly below the scale midpoint ($M = 4.21$, $SD = 1.05$). Using a standardized composite of all streak scenarios ($\alpha = .52$) as the dependent measure, a linear regression revealed that the BIF predicted judgments that streaks would continue, $\beta = .45$, $t(25) = 2.55$, $p < .05$, even when the composite of all nonstreak scenarios (or all nonstreak scenarios individually) were included as predictor variables ($ps < .05$). Furthermore, the BIF did not significantly predict judgments of the nonstreak composite or any of the non-

[2] Nine participants who suspected that we had manipulated the sequence of outcomes in the video were excluded from these analyses.

[3] Readers may watch a sample video clip at http://faculty.chicagobooth.edu/eugene.caruso/coins.htm.

[4] The order of blocks did not influence any results in this study.

streak scenarios individually (*ps* > .36). As predicted, the more participants were naturally inclined to represented actions in terms of intentions, the more likely they were to predict that streaks would continue.

Although humans are clearly capable of intentional action, people vary reliably in the extent to which they see nonhuman agents such as an amoeba, a robot, or a poodle as capable of intentional actions (Epley, Waytz, & Cacioppo, 2007). Study 4 tested whether individuals inclined to attribute these mental states to nonhuman agents are more likely to predict that repeated actions of a nonhuman agent would continue.

5. Study 4

5.1. Method

Seventy-seven participants completed the Individual Differences in Anthropomorphism Questionnaire (IDAQ; Waytz, Cacioppo, & Epley, 2010). This 15-item questionnaire assesses how much people attribute humanlike mental characteristics (e.g., free will, a mind, and intentions) to nonhuman technological, natural, and animal agents (e.g., "to what extent does the wind have intentions"). We computed a sum composite score for the IDAQ ($\alpha = .86$) as a measure of how much participants perceive nonhuman stimuli to be intentional agents.

Next, a computer program presented graphs of market activity for four different stocks over 2-week periods, and asked participants to predict the following day's stock price. The first and third graphs displayed upward and downward trends, respectively, whereas the second and fourth graphs showed no discernable trends. To assess predicted continuation of the trends, we subtracted (for each stock separately) participants' predicted next-day value from the last given value on the graph.[5] We then collapsed over the two trending stocks [$r(75) = .37$, $p < .001$] to create a composite index of predicted trend continuance.

5.2. Results and discussion

Participants' average next-day predictions for the upward trending stock (final day price 140) and the downward trending stock (final day price 110) were 141.42 (*SD* = 3.29) and 108.62 (*SD* = 2.62), respectively. Consistent with our hypothesis, a linear regression revealed that the IDAQ predicted participants' assessments that trends would continue, $\beta = .23$, $t(75) = 2.02$, $p < .05$. This relationship remained when including the composite of values for both nontrending stocks (or both nontrending stocks individually) as predictor variables (*ps* < .05). The IDAQ did not, in contrast, significantly predict judgments of the nontrending stocks composite, or either nontrending stock individually (*ps* > .13). Furthermore, because the IDAQ included three items apiece assessing attributions of *emotion*, *intention*, *free will*, *consciousness*, and "*a mind of its own*," we created composites for each specific attribute and regressed them on predicted trend continuance. Consistent with our overarching prediction that perceived *intentionality* in particular should predict judgments of trend continuance, the intention composite ($\alpha = .43$) in isolation was the best predictor of predictions of trend continuance, $\beta = .26$, $t(75) = 2.30$, $p < .05$. The more people naturally attribute intentions to nonhumans, the more likely they are to predict that observed trends generated by a nonhuman agent will continue.

[5] We reverse-scored the value for the third stock because it trended downward.

6. General discussion

These four studies suggest that seeing intentions in an agent generating a streak increases predictions that the observed streak will continue. Beyond helping to reconcile seemingly inconsistent intuitions about repeated events, perceiving intentionality is a basic feature of social cognition that likely moderates perceptions of the apparent randomness of everyday behavior. The critical role of intentions for understanding goal-directed agents is learned at an early age: infants at 12 months and younger expect a human hand to continue the pursuit of an existing goal, but do not have that expectation for a rod, claw, or even a gloved hand that obscures the surface properties of the hand (Guajardo & Woodward, 2004; Woodward, 1998).

Intentionality therefore is a basic and fundamental cue for predictions about the likelihood that an observed series of outcomes will continue. Note that this hypothesis also applies to outcomes that are perfectly opposed to an agent's intentions, such as when a gambler loses five times in a row at a roulette table. Instead of seeming "hot," this gambler may appear to be in a slump or systematically "cursed," likely to lose again not in spite of his intentions but (as with a series of wins) because of them. Although such relationships were not our focus in the present studies, intuitions about streaks of unintended outcomes would be worthwhile to explore in future research.

If perceptions of intentionality lead people to see streaks and order in an agent's behavior, so too may the reverse occur: they may interpret apparent streaks in behavior as evidence that the agent has intentions. Many iPod users notice orderly patterns even when using the "shuffle" feature that randomizes the songs. This experience leads them to describe their devices as psychic, telepathic, moody, temperamental, and empathic (Levy, 2006). One journalist, in fact, was so convinced that his iPod had a preference for Steely Dan that he contacted Apple CEO Steve Jobs, who had an engineer test and confirm that the playlist algorithm was *truly* random (Levy, 2005).

The tendency to anthropomorphize non-living agents, or to perceive complex mental states in other humans, may therefore depend on the apparent streakiness of their behavior. Agents that appear morphologically similar to humans elicit anthropomorphism (Morewedge, Preston, & Wegner, 2007), and streakiness may cue this similarity. Indeed, people tend to anthropomorphize nonhuman stimuli that behave in a contingent and systematic manner (Bassili, 1976; Opfer, 2002), whereas individuals whose behavior appears random and erratic (such as schizo-

phrenics) may be "de-humanized" and stripped of higher-order mental states (Kramer & Buck, 1997). Furthermore, just as the present research shows that individuals who readily see intentions in behavior are the most likely to perceive streaks, it may be that individuals who readily perceive streaks may be the most likely to anthropomorphize and attribute intentions to others.

The ability to recognize another's intentions helps people predict the future and maintain a sense of control over their lives (Dennett, 1987). In fact, perceiving intentionality and perceiving patterns (such as streaks) share a common antecedent in the motivation for control and mastery (Epley et al., 2007; Whitson & Galinsky, 2008). However, as the lottery craze in Venice makes clear, a misunderstanding of randomness can sometimes be disastrous. Although the current research is not intended to correct these faulty intuitions in human reasoning, it does help to explain the process that underlies them. At times people believe streaks will continue, and at times they believe they will reverse, but these opposing beliefs are not applied haphazardly. They are instead the predictable outcome of perceiving an agent to be intentional or unintentional.

Acknowledgments

This research was funded by a Graduate Research Fellowship from the National Science Foundation to Caruso, Grant SES-0241544 from the National Science Foundation to Epley, and the Booth School of Business. We thank Andrew Gallucci, Mina Kang, Angela Kim, Jasmine Kwong, Kristian Myrseth, Aram Seo, Gary Sherman, Paul Thomas, Bree Tse, and Erin Whitchurch for assistance conducting these experiments.

References

Arie, S. (2005). *No 53 puts Italy out of its lottery agony*. The Guardian. <http://www.guardian.co.uk/italy/story/0,12576,1410701,00.html?gusrc=rss> Retrieved 11.02.05.

Ayton, P., & Fischer, I. (2004). The hot hand fallacy and the gambler's fallacy: Two faces of subjective randomness? *Memory & Cognition, 32*, 1369–1378.

Bassili, J. N. (1976). Temporal and spatial contingencies in the perception of social events. *Journal of Personality and Social Psychology, 33*, 680–685.

Burns, B. D., & Corpus, B. (2004). Randomness and inductions from streaks: "Gambler's fallacy" versus "hot hand". *Psychonomic Bulletin & Review, 11*, 179–184.

Dennett, D. C. (1987). *The intentional stance*. Cambridge, MA: MIT Press.

Epley, N., Waytz, A., & Cacioppo, J. T. (2007). On seeing human: A three-factor theory of anthropomorphism. *Psychological Review, 114*, 864–886.

Gigerenzer, G. (2000). *Adaptive thinking: Rationality in the real world*. New York: Oxford University Press.

Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive Psychology, 17*, 295–314.

Guajardo, J. J., & Woodward, A. L. (2004). Is agency skin deep? Surface attributes influence infants' sensitivity to goal-directed action. *Infancy, 6*, 361–384.

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive Psychology, 3*, 430–454.

Kramer, A., & Buck, L. A. (1997). Encountering people labeled "schizophrenic". *Journal of Humanistic Psychology, 37*, 12–29.

Langer, E. J., & Roth, J. (1975). Heads I win, tails it's chance: The illusion of control as a function of the sequence of outcomes in a purely chance task. *Journal of Personality and Social Psychology, 32*, 951–955.

Levy, S. (2005). *Does your iPod play favorites?* Newsweek, Inc.. <http://msnbc.msn.com/id/6854309/site/newsweek/> Retrieved 06.02.05.

Levy, S. (2006). *The perfect thing: How the iPod shuffles commerce, culture, and coolness*. New York: Simon & Schuster, Inc..

Malle, B. F. (1999). How people explain behavior: A new theoretical framework. *Personality and Social Psychology Review, 3*, 23–48.

Malle, B. F., & Knobe, J. (1997). The folk concept of intentionality. *Journal of Experimental Social Psychology, 33*, 101–121.

Malle, B. F., Moses, L. J., & Baldwin, D. A. (Eds.). (2001). *Intentions and intentionality: Foundations of social cognition*. Cambridge, MA: MIT Press.

Morewedge, C. K., Preston, J., & Wegner, D. M. (2007). Timescale bias in the attribution of mind. *Journal of Personality and Social Psychology, 93*, 1–11.

Morris, M. W., Sheldon, O. J., Ames, D. R., & Young, M. J. (2007). Metaphor and the market: Consequences and preconditions of agent and object metaphors in stock market commentary. *Organizational Behavior and Human Decision Processes, 102*, 174–192.

Number 53 brings relief to Italy (2005). *BBC News.* <http://news.bbc.co.uk/2/hi/europe/4256595.stm> Retrieved 06.02.05.

Opfer, J. E. (2002). Identifying living and sentient kinds from dynamic information: The case of goal-directed versus aimless autonomous movement in conceptual change. *Cognition, 86*, 97–122.

Oskarsson, A. T., Van Boven, L., McClelland, G. H., & Hastie, R. (2009). What's next? Judging sequences of binary events. *Psychological Bulletin, 135*, 262–285.

Rosset, E. (2008). It's no accident: Our bias for intentional explanations. *Cognition, 108*, 771–780.

Tversky, A., & Kahneman, D. (1971). Belief in the law of small numbers. *Psychological Bulletin, 76*, 105–110.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 195*, 1124–1131.

Tyszka, T., Zielonka, P., Dacey, R., & Sawicki, P. (2008). Perception of randomness and predicting uncertain events. *Thinking & Deciding, 14*, 83–110.

Vallacher, R. R., & Wegner, D. M. (1985). *A theory of action identification*. Hillsdale, NJ: Erlbaum.

Vallacher, R. R., & Wegner, D. M. (1989). Levels of personal agency: Individual variation in action identification. *Journal of Personality and Social Psychology, 57*, 660–671.

Waytz, A., Cacioppo, J. T., & Epley, N. (2010). Who sees human? The stability and importance of individual differences in anthropomorphism. *Perspectives on Psychological Science, 5*, 219–232.

Whitson, J. A., & Galinsky, A. D. (2008). Lacking control increases illusory pattern perception. *Science, 322*, 115–117.

Woodward, A. L. (1998). Infants selectively encode the goal object of an actor's reach. *Cognition, 69*, 1–34.