Perceptions of Psychological Momentum in Basketball

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Abstract

Psychological momentum (PM) and the hot hand are related concepts describing people's beliefs regarding streaks of superior performance. This study examined the susceptibility of perceptions of PM to changes in the streakiness of otherwise equivalent series. Fifty-five male participants (31 basketballers and 24 control) completed a 'hot-cognition' experiment where they rated individual and team momentum and assessed the likelihood of a future shot's success after watching sequences of basketball shots. The experimental manipulation of the order of shots strongly affected participants' ratings of momentum and, less strongly, the probability they assigned to the future shot (i.e. the hot hand effect). Basketballers showed stronger reactions to manipulations of order than the controls, which could be attributed to greater investment in the task. The results demonstrate the importance of distinguishing between PM and the hot hand and also provide a valuable extension of prior work showing such effects into more realistic scenarios.

Keywords: hot hand; psychological momentum; basketball.

Introduction

The 'hot hand' is regarded as a crucial determinant of success by coaches (Raab, Gula, & Gigerenzer, 2012), fans (Markman & Guenther, 2007) and players (Gilovich et al., 1985) – with players altering the frequency and difficulty of their shot attempts after making a series of shots in a row.

Early research, however, mostly suggested that the hot hand in basketball was a 'fallacy', finding field and 'free-throw' shooting streaks did not significantly deviate from what was expected by chance (Gilovich, Vallone, & Tversky, 1985). Conversely, some studies support the hot hand in intercollegiate (Mace, Lalli, Shea, & Nevin, 1992) and professional basketballers, but some had issues of limited sample size and questionable method of analysis.

Failures to detect a hot hand, however, have also been questioned on several fronts. For example, the complexity of the basketball environment, wherein the 'hot' player may start to take lower probability shots due to their increased confidence or the opposing team may pay additional attention to a 'hot' player thereby disguising any effect.

Attempts to counter such objections include analysis of free-throws (e.g., Gilovich et al., 1985) but others (Koehler & Conley, 2003) have argued that free throws are not conducive for a hot hand due to their relatively high probability of success (~75% for professionals) and the time lag between free throw attempts for the same individual. In fact, given the hot hand is considered a temporary phenomenon (Hamberger & Iso-Ahola, 2004), which breaks disrupt (Mace et al., 1992), the conditions of ordinary NBA games – with time outs, substitutions and a single player rarely making 15 shots in a game - may not be conducive to its occurrence. This suggests that, if the hot hand exists, its existence is overgeneralized – that is, occurs less often than it is perceived to have. Indeed, Koehler and Conley's (2003) analysis of the National Basketball Association (NBA) Long Distance Shootout Contest - in which a shooter is unguarded but the available time and number of shots is constrained – failed to detect non-random shooting patterns, despite commentator's accounts to the contrary.

However, people have demonstrated an ability to discriminate between streaky and steady shooters in basketball shot sequences where statistical tests could not (Hammack, Cooper, Flach & Houpt, 2017). While observers have the tendency to be sensitive to runs, this does not necessarily indicate cognitive error, but perhaps rational mechanisms for processing complex information. That is, observers will act as if the hot hand exists and they are capable of accurately perceiving and harnessing its effects.

Iso-Ahola and Mobily (1980) proposed psychological momentum (PM) as a construct to account for these perceptions and subsequent behaviors: "an added or gained psychological power that changes a person's view of him/herself or of others, or others' views of him/her and themselves" (p. 392). In competitive scenarios, PM is a zero-sum game: obtained at the expense of a competitor.

Importantly, PM does not reflect superior performance i.e. a hot hand, as suggested by Avugos and Bar-Eli (2015), but rather a psychological phenomenon (Iso-Ahola & Dotson, 2015). The key distinction stems from an individual experiencing improved neurophysiological performance, as opposed to just changes in psychological components (e.g. confidence, internal attributions, perceived superiority over opponents). For example, an athlete may experience improved belief in their ability due to previous success, but not have this result in meaningful changes in skill execution.

Furthermore, it cannot be assumed that improvements to confidence necessarily result in a greater probability of subsequent success. As noted above, initial success could lead to 'over-confidence', causing athletes to make riskier decisions than normal (Jones & Harwood, 2008).

With this in mind it is important to distinguish between psychological momentum, the perception of hot hand effects, and actual hot hand effects in experimental tasks.

Examining the thoughts and attitudes of athletes during live play is, of course, unfeasible. Accordingly, this study focusses on the perception of PM by spectators and the

implications of this for their predictions/behaviors – that is, their expectations regarding the effects of such psychological momentum (e.g., the Hot Hand). Previous studies examining people's perceptions about sequences have presented hypothetical scenarios (e.g. Ayton & Fischer, 2004), but context is important to making inferences about sequences (Matthews, 2013) and actual sporting experiences are thought to be more conducive to perceptions of PM (Jones & Harwood, 2008). Therefore, the intent was to maximize participant engagement, without the difficulties arising from assessing participants during live play. A 'hot cognition' experiment was, therefore, devised wherein both basketballers and non-basketballers watched actual footage of basketball games with varied presentation of sequences of successful and unsuccessful shots.

Aims and Hypotheses

1. Reordering series of basketball plays with the same number of successes and failures will alter the psychological momentum assigned by observers to a featured team/player.
2. This will alter the probability assigned to a future outcome following the observed sequence (Hot Hand).
3. Basketballers, with greater investment in the game, will react more strongly to manipulations of momentum.

Method

Participants

Participants were 55 male, English speakers with at least a basic understanding of basketball rules and terminology, aged 18-31 (M = 21.4, SD = 3.2) and recruited from three sources: local basketball clubs (n=22), 1st year Psychology students (n=7) and the general public (n=26). Participants were grouped as basketballers (N = 31) or control (N = 24) by their self-reported frequency of involvement in basketball. The basketballers were somewhat younger (M = 20.6, SD = 2.6) than the control group (M = 22.4, SD = 3.7).

The psychology students participated for course credit. Additional participants, recruited via emails to basketball clubs, flyers posted on the Adelaide University campus and Facebook advertising, received a $10 gift card for their participation or chance to win a $50 gift voucher.

Materials

Online Survey

Prepared in SurveyMonkey, the survey asked for demographic details and required participants to indicate how often (daily, several days a week, weekly, fortnightly, monthly and rarely/never) they engaged with various aspects of basketball: playing, watching or taking an interest in (e.g., reading about). The survey also included measures of: representation bias, numerical reasoning, perception of sequences, susceptibility to outcome bias, risk-attitudes, impulsivity and hot hand beliefs as described below. These were included as potential covariates/confounds that might differ between the groups and thus need to be controlled for:

Representativeness Bias. Four items were used to assess respondent's beliefs about sequences in random processes: Lambos, Delfabbro and Puglies' (2007) coin toss scenario, where participants judge which of three series of outcomes (e.g. HTHTTHTHTHTH) is most likely; and three items adapted from Ayton and Fischer (2004) asking whether sequences of 16-digit long binary outcomes with equal hits and misses but different alternation rates (0.81, 0.31 and 0.19) were generated by random or human processes.

Cognitive Reflection. Frederick's (2005) 3-item CRT was used to measure participants' tendency to override predictable, but incorrect intuitive responses. Lower CRT scores indicate greater susceptibility to decision-making biases (Toplak, West & Stanovich, 2011) and lower numeracy (e.g., Welsh, Burns & Delfabbro, 2013).

Outcome Bias. Two scenarios described a physician's decision to conduct surgery on a suffering patient (based on Baron & Hershey, 1988). These were near identical but the first described an 8% chance of death but a good outcome (successful operation) while the second gave a 2% chance of death but bad outcome (patient death). Rating the 1st decision as better therefore displays outcome bias.

Risk Attitude. As belief in a hot hand is greater in those who regularly gamble and demonstrate a willingness to take greater risks in these scenarios (Wilke, Scheibehenne, Gaissmaier, McCanney & Barrett, 2014), the 12-item gambling Domain-Specific Risk-Attitude Scale (Weber, Blais, and Betz, 2002) was used to assess risk attitudes towards: likelihood of gambling; perception of gambling risk; and expected benefits of gambling.

Impulsivity. The BIS-15 (Spinella, 2007) was used to assess impulsivity.

Hot Hand Beliefs. A 2-item, self-report measure developed by Gilovich, Vallone and Tversky (1985), which assesses a respondent's endorsement of sequential dependence among shots in basketball.

Hot Cognition Task

The experimental task was composed of four sequences of basketball edited from footage of American college basketball games. The broadcast scoreboard was blurred out in the video footage to control for outcome bias, and the audio was removed to prevent crowd and broadcast commentator reactions influencing participant's responses. All the plays within a sequence featured the same player.

Each sequence condition included three made shots (H) and three missed shots (M) but a different order of shot outcomes (see Table 1). All were followed by the identified player being fouled in the process of making another, successful shot: resulting in a free throw (*AND1* outcome), but the outcome of this was not shown. Given the absence of audio, the researcher indicated when the identified player was fouled – signaling the end of the video.

Looking at Table 1, one sees that the conditions convey varying senses of psychological momentum (PM). The Positive Recency (PR) and Negative Recency (NR) conditions have low alternation rates of hits versus missed shots and, therefore, longer outcome runs. Prior to the

AND1 outcome, the PR sequence contains a streak of three hits, while the NR sequence contains a streak of three misses to convey lower momentum (although weakened by the need to have the same successful, fouled basket at the end of the sequence). The two other conditions were intermediate between these – with greater alternation.

Table 1: Shot sequence outcomes for experimental conditions.

Increasing Momentum ↓

Condition	Order of Shot sequence						
	1	2	3	4	5	6	7
Negative Recency	H	H	H	M	M	M	H
Alternation	H	M	H	M	H	M	H
Weak Positive	M	H	M	H	M	H	H
Positive Recency	M	M	M	H	H	H	H

Note: H = hit, M = miss.

Procedure

Participants completed the survey detailed above prior to taking part in the experiment – either online or in person. The experiment was conducted individually for each participant to avoid confounds arising in groups (e.g. verbal commentary influencing responses). Participants were provided information regarding the nature of the experiment and screened for (basic) understanding of basketball rules and terminology used for various self-report measures.

The experiment was conducted within-subjects, with participants shown the four, Hot Cognition Task sequences (in a randomized order). Following each, participants were asked 4 questions assessing their beliefs around:

1) a player's likelihood of making the free throw resulting from the last play (Free Throw);

2) the player being 'on a roll' (Individual Momentum);

3) how difficult his shots were (Difficulty); and

4) the team having momentum (Team Momentum).

Responses were scored on a 5-point Likert scale: 1 (not at all) to 5 (extremely). These questions - based on a pilot study and previous qualitative research e.g. Koehler & Conley (2003) - measure the participant's perception of individual and team momentum, and perceived difficulty due to theorized mediation effects.

Results

The first two Hypotheses were that perceptions of psychological momentum would vary with the patterns of hits and misses in the four different conditions. To examine this, the mean ratings given by participants to each of the four dependent measures under each of the four conditions are shown in Figure 1. Looking at this figure, a clear distinction can be seen between the pattern of results for the measures of psychological momentum (Individual and Team Momentum) and the remaining measures – Free Throw likelihood and Shot Difficulty. Starting with the last it seems that, as would be hoped, participants' perceptions of shot difficulty did not vary across conditions in any obvious manner. A One-Way RM ANOVA, however, indicated that the differences across conditions were significant, F(3,162), p <.001, indicating that Shot Difficulty needed to be included as a covariate in the analyses described below. Analysis of the Free Throw ratings look similar, F(3,162), p <.001, but here Bonferroni post hoc tests confirmed that two positive conditions (Weak Positive and Positive Recency) produced significantly higher ratings than the conditions with more recent negative outcomes.

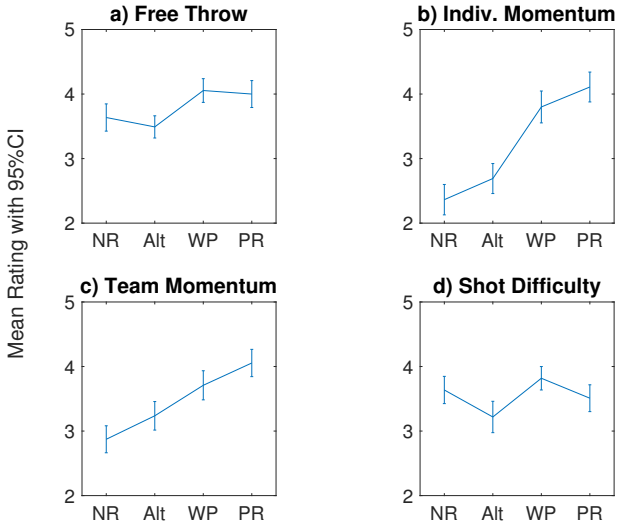

Figure 1. Mean ratings of dependent measures by condition. Note: NR = negative recency; Alt = alternating; WP = weak positive recency; and PR = positive recency.

By contrast, the measures of individual and team momentum both show clear, linear trends with participants giving higher ratings in those conditions with more, recent positive outcomes. One-way Repeated Measures ANOVAs confirmed these differences as significant F(3, 162) = 63.4 & 26.7, respectively, p < .001 in both cases and Bonferroni post hoc tests indicated that all conditions differed significantly from all others.

Covariates

Correlational and principal component analyses (excluded for reasons of space) were used to determine which covariates should be accounted for in comparisons between basketballers and controls. This indicated only five variables/factors related significantly to the dependent measures: 1) Representation bias (coin toss); 2) Representation bias (high alternation rate); 3) CRT; 4) Outcome bias; and 5) Outcome perceptions (a factor composed of beliefs about hot hand and momentum).

Basketballers vs Non-Basketballers

Our third hypothesis was that basketballers, due to their relative investment in the sport, thus responding to the experimental manipulations more strongly. That is, that their ratings would tend to be more extreme than non-basketballers – lower in the conditions with more negative

outcomes and/or higher in conditions with more positive outcomes prior to the final observation.

To examine potential differences, the ratings provided by the two groups for the dependent measures are shown in Figure 2. Looking at the three subplots of Figure 2, one sees two distinct patterns. The first is in the Free Throw data (subplot a), where, in every condition, the basketballers rate the likelihood of the free throw being successful as higher than the non-basketballers – reflecting perhaps a better understanding of the difference in accuracy between field shooting and free throw shooting.

In subplots b and c, by comparison, we see the pattern predicted by Hypothesis 3 – with Basketballers' responses being more extreme than control subjects – i.e., lower when there has been a run of missed shots (NR condition) and higher following a series of successful shots (PR condition).

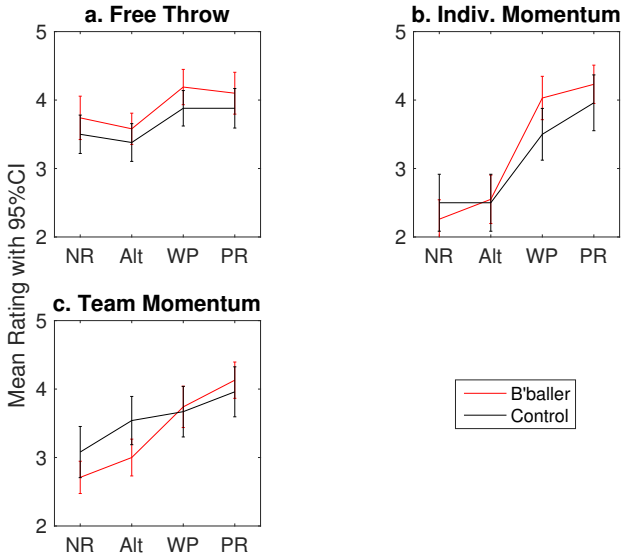

Figure 2. Comparisons between Basketballer and Control subject ratings of dependent measures by condition. Note: NR = negative recency; Alt = alternating; WP = weak positive; and PR = positive recency.

Group by Condition Repeated Measures ANCOVAs were run for each dependent measure, incorporating the covariates noted above. The results of these are shown in Table 2. Looking first at the data for Free Throw probability, one sees that, despite the pattern in Figure 2, the main effect of Group in the ANCOVA just fails to reach significance (p = .07, 2-tailed). The effect of condition was clearly non-significant (p = .84, 2-tailed) and there was no interaction between the two factors.

For Individual Momentum perceptions, by contrast, a significant main effect was found for condition (p < .001, 2-tailed) but not between groups (p = .67, 2-tailed). However, in line with our hypothesis, there was a significant Group × Condition interaction (p = .03, 2-tailed). Bonferroni post hoc tests indicated that Basketballers perceived more individual momentum than the Controls in the PR (d = 0.16) and WP (d = 0.30) conditions, and perceived less in the NR (d = 0.14) and Alt (d = 0.20) conditions. There was also a significant covariate interaction: Condition × Representation bias (high alternation), F(3, 46) = 2.60, p < .05. This suggests that Individual Momentum is predicted by susceptibility to attribute random outcomes to human action.

For Team Momentum, a significant difference was found between groups (p < .05, 2-tailed), but the main effect of condition and the Group × Condition interaction just failed to reach significance (p = .07 and .13, respectively, 2-tailed). Given the directionality of our hypotheses, these near significant results were examined with post hoc Bonferroni tests, which indicated that Basketballers perceived less momentum than the control group in the NR (d = 0.25) and Alternation conditions (d = 0.35), but no more in the PR (d = 0.11) and WP (d = 0.04) conditions, which partially support the hypothesis.

Table 2: Summary of ANCOVAs for dependent measures

	Group			Condition			Interaction		
	F	p	η^2	F	p	η^2	F	p	η^2
FT	3.48	.07	.07	0.29	.84	.01	0.07	.98	.00
IM	0.19	.67	.00	6.89	<.001	.13	3.02	.03	.06
TM	4.12	.05	.08	2.60	.07	.05	2.01	.13	.04

Note: FT = Free throw, IM = Individual momentum, TM = Team momentum. Greenhouse-Geisser corrections applied. Degrees of Freedom. Two-tailed p values in all cases.

Discussion

The above results provide support for all three Hypotheses. There is strong evidence that reordering the same number of successful and failed basketball plays to produce streaks of hits and misses affected the participants' perceptions of psychological momentum – for both the individual player and their team (H1). The evidence that this perception of momentum translates into a belief in a hot hand in the statistical sense (H2) – that is, altering the probability of a future shot is, however, weaker. Finally, there are significant differences between the responses of basketballers and non-basketballers and clear interaction effects between group membership and the strength of our psychological momentum manipulation (H3). These results are discussed, individually and in greater detail, below.

Perception of Psychological Momentum

As noted above, Hypothesis 1, that perceptions of psychological momentum (PM) could be influenced by simple reordering of sets of basketball plays, was supported by the results. Specifically, participants rated the momentum of both the individual player and their team as significantly higher when the plays were ordered so as to have longer strings of hits at the end.

Parker, Paul & Reinholtz (2016) similarly found that changes in perceived momentum of a contrived guessing game were greater as outcomes alternated. While perhaps not surprising, building upon the findings from hypothetical

manipulations is a valuable extension of such work – demonstrating that the effect holds in a task more closely approximating real world situations but which removed a number of cues for momentum that would exist in real-world situations. For example, the broadcast scoreboard in the game footage shown to participants was blurred to control for potential outcome bias and prevent the score being used as a reference point by participants regarding a team's actual momentum. The footage was also played without sound so as remove the crowd reaction which might provide another cue to a team's momentum.

While these were confounds for the present study, their omission is also expected to have dampened the extent to which participants identified patterns of team momentum. That is, in equivalent, real world situations their effects seen here might well be stronger.

Expectations Regarding the 'Hot Hand'

Given the clear distinctions drawn by participants between the momentum of the individual players and their teams across the different order conditions, the weaker effect of the experimental manipulation on their predictions of future success requires some explanation. While there was some evidence that people who had seen longer sequences of successful shots tended to rate the probability of the following free throw succeeding more highly than those who had seen more failures at the end of the task, this relationship was weak and non-significant when controlling for several covariates and did not follow the clearly linear pattern seen in the perceptions of momentum.

Had no relationship been seen, that could have supported the notion that PM is just a performance label used to evaluate whether past performances were successful or not (Cornelius et al., 1997) with no relevance to the future. The partial relationship, however, requires more explanation.

A possibility is that the experimental task, which had participants watch a series of seven field shots but then asked them to rate the likelihood of a following free throw being successful acted to limit the perceived transferability of momentum. That is, not only does the foul and subsequent free throw provoke a break in play (thereby potentially ending a hot hand effect, as described in Hamberger & Iso-Ahola, 2004) but also introduces a change in the type of task. Participants may have recognized that a free-throw is a markedly different shot than any field goal attempt and thus, regarded the player's shooting form as less relevant, reducing the strength of any effect.

Group Differences

As predicted in our third hypothesis, basketballers' responses differed significantly from those of non-basketballers. The first observation, while not hypothesized, is that basketballers rated the chance of the free throw being successful higher in every case than the non-basketballer, reflecting their superior understanding of the actual success rates for elite level athletes. Other than this, though, their pattern of free throw predictions across the four conditions is near-identical to that of the non-basketballers.

Of course, the fact that results supporting Hypothesis 3 are seen for perceptions of individual and team momentum – with basketballers being more strongly affected – but this fails to be converted into greater predicted likelihood of free throw success could fit with explanation given above regarding the overall weakness of these results. That is, if basketballers have a stronger belief in the separation between field shooting and free throw shooting performance, that would tend to flatten out their estimates of free throw likelihood more than is seen in the non-basketballers – thereby counteracting their stronger perceptions of momentum.

As to why basketballers showed these stronger effects: perhaps simple interest in the game increases investment and thus cues greater attention to the scenario and patterns within it; or seeing such patterns calls to mind prior experiences of momentum and, within the experimental context, basketballers have more than non-basketballers.

Covariates

As a brief note: as ANCOVAs were used to eliminate the possibility that results might be driven by differences between the groups. In these analyses, one covariate (a measure of representativeness bias) was highlighted as predicting individual momentum ratings: i.e., participants who attributed random sequences to human agents were more likely to rate the player as being 'on a roll'. However, none of the four measures of representativeness bias differed significantly between the groups.

Caveats and Future Directions

While providing interesting results and at least some support for all of our hypotheses, there are a number of limitations of the study, which could be addressed in future work.

The first is the limited sample size. This resulted from difficulties in recruiting sufficient basketballers and was exacerbated by the decision to limit recruitment to males so as to eliminate the potential for gender moderation effects of PM (Iso-Ahola & Dotson, 2014). Extending the study to include women (while taking into account how perceptions of may PM differ between men and women) and widening the recruitment (via online participation, for instance) could address this and assist in determining whether the less convincing results herein result from insufficient power.

A secondary concern lies in how the experimental measures were scored - on a 5-point scale from 'not at all' to 'extremely'. The question arising here is whether 'not at all' was regarded as a neutral (e.g., not on a roll) or negative (e.g., on a losing streak) response by participants. This should be clarified in future work.

Participants' responses to the dependent variables may have been influenced by undertaking several cognitive bias measures. To avoid this potential confound the hot cognition experiment could be conducted prior to completing relevant individual differences measures.

Finally, as noted above, while the use of a free throw as the shot to be predicted was done purposely – in order to

minimize other contextual factors for the predicted shot (e.g. in any differences in distance, angle, and opposition actions) – this may have undermined the transference of perceived momentum into future outcomes. This could be avoided in a number of ways – none, however, simple. For example, an exhaustive pre-test assessment of plays could have experts rate their equivalency prior to constructing the scenarios.

Alternatively, it might be possible to stage specific plays – either using real players or within a basketball game, for example. All of these, however, would require a significant amount of pilot work prior to any experimentation.

Conclusions

While most research into momentum and the hot hand has been concerned with directly substantiating or refuting their existence, the present study aimed, instead, to explore participant's beliefs and perceptions regarding these - within the context of basketball shot sequences. Consistent with much of literature regarding PM, the ordering of sequential outcomes affected participant perceptions: positive recency sequences increased the likelihood that the focal team and player had momentum; while negative recency sequences were considered by participants as evidence of the player and team not being on a roll. These effects were more strongly reported by basketballers across conditions in the present study, compared to the control group, suggesting that domain-specific experience influences the perception of these patterns. The results also illustrate that further research is warranted to clarify why differences exist between participant's perceptions of momentum and their predictions of future success (i.e., hot hand beliefs).

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