Does Framing The Hot Hand Belief Change Decision-Making Behavior In Volleyball?

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Abstract

Purpose: Previous discussions of the hot hand belief, wherein athletes believe that they have a greater chance of scoring after two or three hits (successes) compared to two or three misses, have focused on whether this is the case within game statistics. Researchers have argued that the perception of the hot hand in random sequences is a bias of the cognitive system. Yet most have failed to explore the impact of framing on the stability of the belief and the behavior based on it. Method: The authors conducted two studies that manipulated the frame of a judgment task. In Study 1, framing was manipulated via instructions in a playmaker allocation paradigm in volleyball. In Study 2, the frame was manipulated by presenting videos for allocation decisions from either the actor or observer perspective. Results: Both manipulations changed the hot hand belief and sequential choices. We found in both studies that the belief in continuation of positive or negative streaks is non-linear and allocations to the same player after three successive hits are reduced. Conclusions: The authors argue that neither the hot hand belief nor hot hand behavior is stable but rather both are sensitive to decision frames. The results can inform coaches on the importance of how to provide information to athletes.

Keywords: *streak, fallacy, cognitive bias, choice*

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People perceive streaks every day: A scientific paper is rejected three times in one year; there are three days of sunny weather; black comes up three times in a row in a game of roulette. People might believe such streaks are based on bad luck in the case of rejections, on base rates in the case of sunny weather when living in Florida, and on chance when playing roulette. Even in cases of independence of sequentially observed outcomes, people tend to behave as if there is a greater chance of one outcome occurring after the other outcome has occurred three times, such as believing red will come up in roulette after black has come up three times—a belief known as the gambler's fallacy (Ayton & Fischer, 2004). Yet in roulette, winning on red or black has the same probability and thus the belief does not harm the gambler's chances of winning. In sport, however, such beliefs could harm or benefit a team when they drive strategic decisions such as to whom to allocate the ball.

In sports, fans and players often believe in the opposite pattern to the gambler's fallacy, called the hot hand, where streaks are expected to continue (Raab, Gula, & Gigerenzer, 2012). Whether the sequential outcome of basketball shots is independent has been hotly debated. The majority of studies have shown that the sequences are independent, among them a study by Gilovich, Vallone, and Tversky (1985), a narrative review by Bar-Eli, Avugos, and Raab (2006), and a meta-analysis (Avugos, Köppen, Czienkowski, Raab, & Bar-Eli, 2012).

Regardless of whether it reflects reality, belief in the hot hand can nevertheless influence the success of a behavior (Burns, 2004). In sports, a positive relationship between the hot hand belief and the success of a behavior was recently found in conditions in which the base rates of players were highly variable, not known, or correlated positively with the number of streaks (Raab et al., 2012). The study used a computer experiment in which participants viewed videos of successful or unsuccessful attacks from the perspective of a playmaker in volleyball and had to decide to whom they would allocate the next ball. Results indicated that the belief that either

Player A or Player B was "hot" changed over natural breaks such as sets, as did the behavior of favouring one of the players. Thus, the hot hand belief and a behavior associated with it were changeable. Could these changes have been produced by different frames?

A frame refers to a mental model that is used to perceive a task and influence a judgment (Soman, 2004). Stability and framing in the hot hand belief and hot hand behavior have not been extensively studied, and most explanations of the belief have been general in nature. For instance, in their original study, Gilovich et al. (1985) explained the hot hand belief of basketball fans and players as a fallacy originating from the law of small numbers. This law describes how an observer of small samples of hits and misses such as three hits or three misses believes that the sequence is representative (e.g., Kahneman, 2012). Representativeness ignores the base rate of the player or how often in a given sequence three hits or misses can come about by chance. Another account of the hot hand belief that does not consider framing has been recently introduced in a review of how individual success can breed success by modelling duration, intensity and frequency of streaks (Iso-Ahola & Dotson, 2014). Although this argument seems to explain individual behavior when judging one's own decisions it is unclear whether such effects easily transfer to observations of the behavior of others in sports.

Experimental evidence suggests that observers use streaks as a cue for an agent's intentionality. For instance, if streaks such as basketball shots are performed by a player intentionally, participants predict that streaks may continue, whereas if a robot performs the same task, hot hand streaks are attributed to chance (Caruso, Waytz, & Epley, 2012). It seems, then, that humans are well equipped for understanding the goal-directed behaviors of others and, critically, also attuned to contextual factors.

A test to understand the effects of agency, given the arguments above, would be to instruct participants either to judge their own sequential decisions or to observe others. For instance, in athletes there is convincing evidence that the performance outcome in decision-

making or anticipation tasks is affected by whether the task requires independent choices as an actor or as an observer (Ward, Suss, Eccles, Williams, & Harris, 2011). Whether such effects generalize to sequentially (in)dependent choices in sports is unknown, but there is evidence in non-sports tasks that serves as a basis for predictions (Lyons, Weeks, & Elliot, 2013). For example, it has been argued that rolling dice or observing someone else rolling dice produces different predictions of the continuation of streaks (Langer & Roth, 1975). A manipulation of control (self vs. other) would allow us to determine if framing through agency (one's own or others' movements) has an impact on sequential judgments. This has yet to be explored in hot hand research and it could have an impact on how to frame sequential choices in sports.

Recent evidence suggests that the rather generic and stable beliefs and behaviors based on streak perception are also exposure-based and can be altered by the frequency of exposure. This can be explored by using different expertise groups (Köppen & Raab, 2012; MacMahon, Köppen & Raab, 2014; MacMahon & Starkes, 2008). Given all this literature, and acknowledging that agency and exposure are factors in decision frames, another potentially stronger way of investigating the stability of the hot hand belief and hot hand behaviors would be to manipulate the judgment frame via instructions.

One type of judgment frame is an outcome frame. A typical outcome frame manipulation would be to present a problem in terms of gains or losses. For example, Tversky and Kahneman (1981) presented participants with information about an Asian disease and framed the problem for participants by either asking them to focus on saving lives or on reducing deaths, which had an effect on choices.

Framing may have an effect on the perception of and behavior pertaining to streaks, as well. For instance, in a study on the hot hand belief, participants were asked to take the perspective of the playmaker and allocate balls to the best player. This produced more allocations to the hot hand player. In comparison, when asked to replace poor players, there were

fewer allocations to a weaker player (Köppen & Raab, 2012). Further, belief in both the hot and cold hand was reported by participants. If participants are instructed to focus on a cold hand (streaks of failures) they may be more likely to detect it and change their allocation to a stronger player, compared to participants who are instructed to focus on wins, who may focus on hot streaks that they believe will continue. A manipulation of this kind, using different sets of instructions, would allow a test of whether a generic focus on positive streaks is stable in different frames, as is suggested by Wilke and Barrett (2009), who propose that detection of streaks is adapted from the need to detect food sources.

In sum, current research on the hot hand belief and hot hand behavior focuses on stable behaviors that rely on stable hot hand beliefs. Evidence suggests, however, that both beliefs and behavior change and are adapted to the information they are exposed to during sequential choices. Although some individual and situational differences have been shown recently, a systematic manipulation of outcome framing has not been done. Therefore we conducted two studies that systematically manipulated outcome frames by presenting different instructions (Study 1) or different visual perspectives in video clips (Study 2).

If framing alters hot hand beliefs and behavior, participants should give different responses depending on the frame. Specifically, we predicted that outcome framing using a win frame would increase participants' hot hand belief and lead to more balls being allocated to a hot player than when a losing frame is used. We predicted that framing from the actor perspective would increase participants' sense of control and their belief in streak continuation and would result in a longer continued allocation to a hot player than when framing was from the observer perspective. Given that framing has not yet been tested in this context, we used two kinds of framing to explore the general effects of framing on the hot hand belief and the hot hand behavior. However, we tested the main effects of different kinds of framing independently and thus no interaction of these effects was assumed.

Study 1

Method

Effects of outcome framing on the hot hand belief and allocation decisions were tested in a within-subjects design with the two factors agency frame (actor vs. observer) and goal frame (win or lose), resulting in four conditions (actor–win frame, actor–lose frame, observer–win frame, observer–lose frame). Hot hand belief was measured after each condition and framing effects on allocation decisions were described as mean allocation per condition as well as the length of allocations continuation to the hot hand player after sequences of one to four consecutive hits (and vice versa for cold players and sequences of one to four consecutive misses).

Participants. Twenty-nine students who majored in sport from a university (M = 23.5 years, SD = 3.8, 15 male and 14 female) participated in this study. We chose students who majored in sport, as they would be able to understand the displayed volleyball situations and have experience in both watching and playing volleyball during their physical education program at the university. We controlled for gender, age, and the number of years spent training (M = 5.26, SD = 3.48) as well as for sport-specific experience (sport type: team or individual sport, see Köppen & Raab, 2012) that could alter choices in our study but found no significant moderators. Further, we checked comprehension of instructions and motivation levels on a six-point Likert scale (1 high, 6 low) asking explicitly whether they understood the instruction and whether they were motivated to perform the task. Results showed high motivation on average (M = 1.4, SD = .6) and good instruction comprehension (M = 1.2, SD = .7). Debriefing showed no specific answers from the participants other than acting as instructed. All participants in this study provided informed consent and the university's ethics board approved the study.

Materials and Apparatus.

Videos for decision making behavior: We used videos of sequential decision making in

volleyball to measure choice behavior presented on a computer screen (Raab et al., 2012). Participants were instructed that the game was the final of the volleyball World Cup. Winning was thus important. The video clips were filmed from the stands as is typical in television broadcasts and lasted around 3 seconds each. The videos displayed one volleyball team serving and the playmaker's team preparing its attack. At the moment of the freeze frame, the ball was on its way to the playmaker, thus neither the position of the playmaker nor his movements revealed any cues for allocation.

Experimental measures of the hot hand belief: We used questionnaires on the hot hand belief that were validated in previous research (Gilovich et al., 1985; Raab et al., 2012) to measure if participants believed in the hot hand and if they applied this belief to choice behavior. The predictive validity was shown in Gilovich et al.'s (1985) belief–behavior experiments, and Raab et al.'s (2012) studies showed that reliable results could be obtained using a modified paper and pencil version of the questionnaire. There were two Yes/No questions on current hot hand belief that were asked after each condition: (a) Do you believe that it is important to allocate the ball to a player who just successfully performed two or three hits? (b) Does a player who scored a hit in the last two or three attempts have a better chance of scoring on the next ball compared to when previously missing two or three balls?

Post-experimental measures of self-reported allocation strategy: There were six questions after the experiment about allocation strategies (c-g multiple choice questions or filling in a discrete number, question h is an open question that was labelled by two independent raters with .92 inter-rater reliability to higher order themes): (c) Which of the two players (A or B) was more successful, or were they equal? (d) Consider a game in which the last point in the last set will decide the game. You are the playmaker and allocate the ball. Do you allocate the ball to the player with the better average performance or to the player who scored the last three attempts? (e) For your choices in the experiment, how often did you shift your allocation from one player

who just made an error to the other player? (f) For your choices in the experiment, how often did you shift your allocation from one player who just made a hit to the other player/keep your allocation with the same player? (g) How often did you consider at least the last three attempts of the players for your next allocation? (h)When you considered the last one or more attempts, please describe your allocation strategy.

Decision making task: The basic task was to decide to which attacker - Player A or B - to pass the ball, via a keypress on the computer keypad. After participants had chosen to whom they would allocate the next ball (Player A or B) a clip was displayed in which the chosen player was either successful (spike) or not successful (spike hits outside the court or hits the net).

There were 176 trials, separated into four sets of 44 clips representing the four conditions of actor perspective with either a win or a lose frame and observer perspective with either a win or a lose frame. The number of hits and misses was identical for Players A and B. Within each set we twice showed three consecutive hits and twice three consecutive misses. These sequences are real game footage sequences selected from male volleyball games of the national Premier League.

There were two framing manipulations: agency and goal. In the agency manipulation, participants were instructed to imagine themselves as either the playmaker (actor) or an observer (observer perspective). Whether they followed the instruction to imagine themselves as an actor (actor frame) or an observer (observer frame) was checked in the debriefing. In the goal manipulation, participants were instructed to allocate the ball to the player who would likely score (win frame) or to indicate which of the two players would likely not score (lose frame). For the frame manipulation in which we manipulate the agency, participants were instructed either (a) to take the playmaker's perspective and make all the decisions in that role or (b) to observe the playmaker in the video and indicate from an observer's perspective how the playmaker should allocate the ball. For the outcome frame, we instructed participants either (a) to press the

key that represents the player to whom the playmaker should allocate the ball (seek to win) or (b) to press the key that represents the player to whom the playmaker should not allocate the ball (avoid loss).

After the first set and for all following sets of 44 trials a display asked the participants to indicate how many hits Player A and Player B just had as well as to type in their allocation strategy for the first 11 trials of the next set ("In how many of 11 trials would you allocate the ball to Player A" and "In how many of 11 trials would you allocate the ball to Player B"). The first question was asked to explore to what extent choice behavior was influenced by the memory of players' base rates, that is, the number of hits out of the number of trials. The question about future allocation was used to analyse to what extent allocations change as a result of actual experienced hit and miss sequences. We used a small (11 out of 44) and unequal number of trials to evaluate choice behavior (i.e., the unequal number forced a greater number of allocations to one player).

Procedures. We tested each participant individually in a maximum of 90 minutes, using written instructions to inform them about the goal of the experiment, and collected personal data and informed consent. Then we provided participants with the video test of 176 trials. Using a within-subject design, we counterbalanced the four sets of 44 trials per condition to manipulate the win–lose and observer–actor framing with a break of about 2 minutes between conditions. After each trial the participants produced an allocation decision for the next trial. We asked Questions a and b after each block and Questions c–h only after the experiment. Finally, participants were debriefed.

Data Analysis. We tested whether framing has an affect on the hot hand behavior and the hot hand belief. For the hot hand behavior we expected differences in choice variables using ANOVAs or t-tests between framing conditions. For hot hand belief we asked questions during the video task and after the experiment.

For hot hand behavior we calculated (a) the average allocation to Player A and Player B for each condition; and (b) autocorrelation tests of participants' choices to provide sequential analyses of the choices following the autocorrelation claim by Hales (1999) and (c) participants allocation strategy.

For (b) we used autocorrelation to analyse the sequence of choices by correlating the original sequence of choices with a sequence shifted by one position (lag 1). An autocorrelation of 1 means a participant only ever chose one player (i.e., Player A or Player B), and a -1 autocorrelation means a participant always alternated between Player A and Player B on consecutive trials. Because the base rates of Players A and B were equal and at .5 (5 out of 10 trials are hits) and we had an equal number of positive and negative streaks in the trials, we could expect an autocorrelation of zero if sequential choices were independent of each other. However, if participants believed in the continuation of a streak we could expect a positive autocorrelation, and if they believed in the gambler's fallacy (after two or three hits a miss on the next trial is more likely) we could expect a negative correlation.

For (c) we calculated allocation strategy during the experiment, by comparing the number of trials that represented a win–stay, lose–shift strategy (where only the previous response is considered, n = -1) to the number of trials in which other strategies were considered (including a strategy that considered more than the previous attempt, n = -2 or more). A win–stay, lose–shift strategy counts the number of trials in which participants allocated the ball to the same player after a hit (win–stay) and changed to the other player after a miss (lose–shift). If the allocation did not follow a win–stay, lose–shift strategy it was marked as 'other'. The general tendency of following a win-stay lose-shift strategy can be assessed by t tests using one or zero as a criterion of a win–stay, lose–shift strategy (or the mirrored version, win–shift, lose–stay).

For hot hand belief we examined (a) whether the reported allocation strategy for the next 11 trials (how many balls should be allocated to Player A or Player B) and responses to base rate

questions (how many hits Player A and Player B achieved the last ten trials) queried between each set of 44 trials, differed based on differences in framing conditions, using chi-square tests; and (b) answers on questions a,b indicating general beliefs in the hot hand, compared between framing conditions.

Alpha criterion was set to .05, with expected mean effect sizes given previous studies and sample size (Köppen & Raab, 2012). Effect sizes are not displayed for *F, t* values lower than 1 as these findings may be unreliable.

Results

Hot Hand Behavior. Allocations were equally distributed to Player A and Player B (see Table 1), averaged over all participants and conditions (*t* values from .11 to 2.7, effect sizes from .05 to .11, $p > .05$) and thus reflect the equal base rates of the displayed players. We performed a two-way analysis of variance (ANOVA) on the number of allocations to the players using the framing conditions actor–observer and win–loss. We found neither statistically significant main effects, $F(1,25) = 1.6$, $p > .05$, nor interaction effects, $F(1,25) = .41$, $p > .05$, in participants' mean allocation behavior. To test our main hypothesis that agency (actor-observer) and goal (win-lose) framing will change sequential decisions we performed a number of tests. First, when we analysed the sequential choice strategies rather than average behavior, we found that choices based on a 1-back strategy—such as win–stay, lose–shift— differed depending on participants' condition. T-tests showed that participants differed significantly in all conditions from such pure strategy behavior (*t* values from .21 to 1.4, effect sizes from .04 to .52, all $p_s < .05$) indicating that sequences of more than 1-back are used. This finding extends previous research on 1-back sequences in hot hand research (Attali, 2013). Yet contrasting the number of trials using a win–stay, lose–shift strategy with chance level (t-test with .5 as criterion) revealed that a win–stay, lose–shift strategy is used roughly about the same amount as predicted by chance (t values from 2.27 to 14.4, effect sizes from .42 to 2.67, $p_s < .05$).

In Table 1 the percentage of trials per condition in which participants followed a win–stay, lose–shift strategy are displayed for up to four sequential hits or misses. We set the *x* axis at 50% as this percentage of trials using a win–stay, lose–shift strategy would be predicted by chance if participants ignored the previous hit or miss in consecutive choices. We used a sequence length of four hits or misses as sequences of three hits or three misses are preceded by a hit or miss. Participants in the actor condition tended to use a win–stay, lose–shift strategy more often ($F(1,28) = 1.14$, $p = .07$, $\eta^2 = .21$) than participants in the observer condition, potentially reflecting a greater perception of control as argued in the introduction. No such effect was found for the win–lose goal frame manipulation. As we used the same number of hot and cold hands in the video clips, this finding partly confirms our expectations that framing can alter sequential choice behavior complementing previous research in basketball (Aharoni & Sarig, 2012; Attali, 2013).

In a second approach to understanding sequential allocation behavior we performed two additional tests. We (a) compared the number of win–stay, lose–shift strategies between conditions of different streak length, streak direction, and actor-observer framing only for streak patterns within the trials. We (b) performed autocorrelations to allow for a general pattern of consecutive allocation behavior from one trial to another. Both tests should provide us with information on whether framing has short-term effects on allocation decisions.

First , we performed a three-way ANOVA with sequence length (one to four hits/misses), streak direction (positive streak of hits or negative streak of misses), and agency frame (actor/observer) as within-subject factors. The number of win–stay trials increased in positive streaks (hit streaks) and the number of lose–shift trials decreased over sequence length, non-significantly, $F(3, 27) = .6$, $p > .05$. The number of win–stay trials in positive streaks was non-significantly greater than the number of lose–shift trials in negative streaks, as indicated when we tested the main factor streak direction, $F(1, 27) = 3.11$, $p = .08$, $\eta^2 = .10$. There was no

significant actor–observer effect or any interaction effects of the number of win–stay, lose–shift strategies again confirming our argument that hot hand analyses beyond 1-back strategies such as three hits/misses in a row are a crucial component of the hot hand belief.

Second, we analysed lag-1 autocorrelations for each player over all allocation choices of 176 trials. We found that of 29 participants, 7 had significant correlations in the range of .22 and .39 either positive (4 times, $p < .05$) or negative (3 times, $p < .05$). Thus, for all allocations the majority did not show a systematic dependence on consecutive allocations. Comparisons to previous studies indicate that the data are in the ball park of results: Gilovich et al. (1985) had a significant autocorrelation of 1 out of 12 players and Raab et al. (2012) 13 out of 26. Given that these autocorrelations are run within sequences of positive and negative streaks this measure may not be as sensitive as a measure of runs represented in win–stay, lose–shift strategies, described above. This adds further evidence to our tenet that 1-back strategies are limited in showing hot hand allocation behavior in contrast to sequences of longer runs as displayed in Table 1.

Hot Hand Belief During Experiment. The hot hand belief during the experiment was assessed after each condition when asking about the performance of the players and the future allocation strategies of the participants. Our results indicate that allocation strategies could not be explained by false representations of players' base rates. Averaged over all conditions and participants, the base-rates of players were correctly recalled by about 1 more or less hit attributed to a player than the real base-rates (t-tests for each condition between real vs. recalled base-rates is non-significant, t values from .87 to 1.6, effect sizes from .16 to .30, $p_s > .05$). This nearly exact recall confirms base-rate recall in previous studies (e.g., Raab et al., 2012). Further, when participants were asked about their allocation strategies before a next set of video clips they produced almost identical allocation strategies for Player A and Player B reflecting the absence of fixed mind sets and reflecting their equal allocation behavior to Player A and Player

B as reported above.

However, when we analyzed condition-specific beliefs, we found an actor–observer difference concerning the belief in playing more to a hot player. In actors (using only the responses to Question a) after the manipulation of an actor instruction), 11 of 14 participants were in favour of playing more to a hot player, whereas in observers (using only the responses to Question a) after the manipulation of an observer instruction), only 6 of 15 participants were in favour of doing so, $\chi^2(1, n = 28) = 4.88$, $p < .05$, Cramer's V = .93. We found no significant interaction between the win–lose and actor–observer framing manipulations on playing more to a hot hand player ($p > .05$).

Hot Hand Belief After The Experiment. After the experiment we asked participants if they believed in the hot hand, testing whether the sequential allocation behavior is correlated to a belief in the hot hand. Over all conditions, 57% indicated a belief in the hot hand. Participants indicated that both players were equally good and when participants allocated balls, 55% used information about the base rate and 45% the previous success indicated by a hot hand. We found no indication that hot hand behavior and hot hand belief significantly correlate, and thus even if beliefs about the hot hand change as a result of instructions, the average distribution between two players in allocation performance remained unaltered. However, as previously reported, framing does alter the sequential strategies participants use to decide whether Player A or Player B receives the next ball and confirms previous research (Raab et al., 2012).

Discussion

Does framing sequential choices from an actor versus observer perspective or framing a problem with the goal of winning or avoiding losing change either belief in the hot hand or hot hand allocation behavior? The answer is yes, but this effect is stronger for the belief system measured by the questionnaire than for the behavior measured by participants' allocations. In contrast to a recent study (Raab et al., 2012), where 91% of the participants believed in the hot

hand, in the current study fewer participants (57%) held this belief after engaging in behavior related to the belief. This difference cannot be explained simply by the sport used, the task, or the sample, as these were the same in the two studies (volleyball, allocation decisions, and students majoring in sports with similar experience). One explanation that could be explored in future studies is the specific within-subject design. Asking the same two questions four times or using framing instructions may have reduced the hot hand belief.

Mechanisms discussed in general psychology may be candidates for further tests such as "explicit discounting" or the "mere exposure effect". Frequently asking about the hot hand belief may cause explicit discounting of the degree of participants' belief in the hot hand. Even without explicit discounting just the "mere exposure" to the belief questions may have changed the degree to which participants liked the hot hand belief. Up to half of the participants may have had their levels of liking lowered after the experiment due to too much "mere exposure", resulting in less belief in the hot hand (Bornstein & Craver-Lemley, 2004). Further studies could test these effects by incorporating different between-subject designs and looking for changes in the belief before, during, and after the experiments. One limit may be the power of the presented studies. In comparison to Gilovich et al. (1985), who tested only 12 players, the recent papers have been using approximately 20 participants per group (Köppen & Raab, 2012) or analyzed streaks for 26 players (Raab et al., 2013) and thus using identical paradigms and sports we believe power is sufficient. Nevertheless, Arkes (2013) argued that the hot hand has been difficult to detect because it occurs very rarely and thus further research with larger data sets is warranted.

In summary, the actor–observer instructions changed the reliance on the 1-back strategy of win–stay, lose–shift. The actor–observer difference can be explained by framing having changed the decision problem. Whether such effects can be replicated and extended for similar choice behaviors may be a matter of design and sample size. Therefore, in a second study we

tested a larger sample and manipulated the agency (actor–observer) frame in a different way. In Study 2 we manipulated the visual perspective by making the observer perspective that of a fan; the actor perspective was that of watching a video as used, for instance, in tactical training or in scouting.

Study 2

Method

In Study 2 the effects of framing manipulations on the hot hand belief and allocation decisions were tested in a between-subject design manipulating the agency frame (actor vs. observer). Rather than using instruction as in Study 1, in Study 2 we changed the video perspective from which allocation decisions had to be made. Hot hand belief was measured after the experiment and framing manipulations using the video perspective effects on allocation decisions were measured as mean allocation per condition as well as the length of allocation continuation to the hot hand player after sequences of one to four consecutive hits (and vice versa for cold players and sequences of one to four consecutive misses).

Participants. Two hundred and two students (M = 24.9 years, SD = 2.1, 129 male and 73 female) from a university were tested. None had been involved in Study 1. We randomly assigned participants to either an actor visual perspective or an observer visual perspective (dividing the sample equally into groups of 101 participants each). Participants received course credit as the experiment was part of a lecture integrating theory and experimental studies. As in Study 1, we controlled for gender, age, and training age (M = 4.31, SD = 2.67) as well as for sport-specific experience that could alter choices in our study but found no significant moderators. When each group was asked how well they could imagine the perspective of the group to which they were assigned, most of the participants (> 70%) indicated good to very good role identification. Debriefing showed no specific answers from the participants other than acting as instructed. All participants in this study provided informed consent and the university's ethics

board approved the study.

Materials and Apparatus. We used the same paradigm as in Study 1 but manipulated the video perspective. Clips were identical in structure and hit and miss sequences to those of Study 1 but differed in their perspective: The observer perspective was from the visual angle of a fan sitting in the stands; the actor perspective showed the performance of the team from behind, at court level, as a player might experience while playing or in a team video feedback meeting.

Procedure. We used the same procedure in terms of instructions and questionnaires as in Study 1, but we asked the hot hand belief questions only once after the experiment. The video test was applied with the same procedure as in Study 1 (176 trials) with the only exception being we presented the videos from two perspectives and no win–lose framing in the instructions was applied.

Data Analysis. The dependent variables were average allocation to players and the autocorrelation score. Strategy description was identical to Study 1 as far as setting the alpha criterion to .05 and reporting effect sizes.

Results

We controlled for effects other than framing and asked about experience in observing or playing volleyball. In both the actor-frame and the observer-frame groups, approximately 85% indicated that they did not watch much volleyball (fewer than four times a year). Further, skill level in volleyball was nearly identical, as over 80% reported having no volleyball experience at the club level.

We found an equal distribution of allocations to Player A and Player B averaged over participants and conditions compared in a *t* test ($t(201) = .72$, $p > .05$, Table 1). We thus replicated the findings from Study 1 showing that, in average allocation behavior, there were no significant differences for an actor–observer manipulation. As in Study 1,we performed further tests.

First, *t* tests with a criterion of 1 (all trials based on a win-stay, lose-shift strategy) or 0 (all trials based on the mirrored strategy) would not be significant if participants always allocated the ball to the same player in the case of a hit, and changed allocation in the case of a miss for the win–stay, lose–shift strategy. The opposite would also be the case if players always shifted their allocation after a hit, and stayed with the same allocation after a miss, the win–shift, lose–stay strategy). This was what we found. Participants clearly did not show a 100% win–stay, lose–shift or win–shift, lose–stay strategy. However, the number of win–stay, lose–shift trials was significantly different from chance if we used .5 as a criterion for the *t* tests (t values from 1.67 to 14.39, effect sizes from .12 to 1, $p_s < .05$), assuming that chance in a two-option choice task with equal base rates of the options at 50% would produce allocation that reflects a win–stay, lose–shift strategy. Indeed in all but one condition of actors in positive streaks with a streak length of 1, allocations were at chance levels.

Second, we compared sequential allocations by contrasting the number of trials in which a win–stay (in sequences of one to four consecutive hits) or lose–shift (in sequences of one to four consecutive misses) strategy was applied. For this we performed a three-way ANOVA with sequence length (one to four hits/misses) and streak direction (hit or miss streak) as within-subject factors and agency frame via visual perspective (actor/observer) as a between-subject factor. The number of win–stay trials increased in positive streaks and the number of lose–shift trials decreased over sequence length, $F(3, 201) = 26.7$, $p < .01$, $\eta^2 = .31$. Post hoc comparisons between streak lengths of one to four revealed that this difference was driven by meaningful contrasts between sequence lengths of 1, 2, and 4, whereas the number of win–stay strategies was almost identical between streak lengths of 2 and 3. In positive streaks the number of win–stay trials was higher than the number of lose–shift trials in negative streaks, as indicated by a main effect of streak direction, $F(1, 201) = 89{,}58$, $p < .01$, $\eta^2 = .34$. There was no significant actor–observer effect on number of win–stay, lose–shift strategies but we did find a three-way

interaction of Sequence Length × Streak Direction × Actor–Observer Frame, $F(3, 600) = 4.96$, $p < .05$, $\eta^2 = .03$. We refrained from further analysis of these effects as they were not predicted.

Thus when we compared sequential behavior between the conditions, we found for both the actor and the observer perspective that sensitivity to both the hot hand and the gambler's fallacy depended on the streak length (Table 1). The number of times participants applied a win–stay, lose–shift strategy increased after a hit until three hits in a row and then decreased as confirming the rule of three (Hahn & Warren, 2009). This effect was more pronounced for observers than for actors, although this did not reach significance. The effect is reversed for sequences of misses, where the win–stay, lose–shift strategy decreased from the first miss to three misses in a row. This means participants believed that streaks would continue, that is, that hits would follow hits and misses would follow misses. However, in both cases this belief changed if participants had already seen three consecutive hits or misses, as streaks in sports may not be overly lengthy and will not run forever (MacMahon, Köppen & Raab, 2014).

>>>Table 1 about here<<<

Third, to test the dependencies of allocation choices, we performed autocorrelations as described above. If the video perspective changes the hot hand belief, we should find more participants in one of the conditions producing dependent sequential choices. When we performed all trials for each individual in an autocorrelation we found 22 participants (21.8%) in the observer condition produced significant and positive autocorrelations and 38 (37.6%) in the actor condition. It is possible that actors, as argued in the introduction and confirmed in Study 1, perceived a greater sense of control.

Hot Hand Belief During The Experiment. As in Study 1, we analysed if allocation strategies could be explained by false representations of players' base rates. We found, averaged over all conditions and participants, that base-rates of players are correctly recalled by less than 1 more or less hit attributed to a player than the real base-rates (t-test between real and recalled

base-rates, $t(201) = 2.69$, $p > .05$, $\eta^2 = .38$). This confirms independent empirical evidence to Study 1 and previous research (Raab et al., 2012). Allocation strategies for Player A and Player B before a next set of video clips are almost identical and thus influences of fixed mind sets seem unlikely.

Hot Hand Belief After The Experiment. When asked about their hot hand belief after the experiment, fewer than half of the participants (47%) indicated that a player has the same chance of performing a hit after two or three hits as after two or three misses. Belief in the hot hand, that is, that a player has a greater chance of hitting after two or three previous hits, was indicated by 31% (actor frame) and 28% (observer frame) of the participants. When we asked participants after the experiment which of the two players they would like to allocate balls to—Player A with a hit (1)–miss (0) sequence of 101010101010101010 or Player B with a "streaky" sequence of 111000111000111010, 61% in the actor condition chose the streaky performance, whereas only 52% in the observer condition chose the streaky performance, nearly reflecting the equal base rates of the players.

Discussion

Did framing the video from different perspectives conceptually replicate the perspective framing effects from instructions in Study 1? The answer is yes, the effects of framing were present in both the belief and sequential behavior. We speculated in the discussion of Study 1 that the reduced hot hand belief may be caused by the within-design of framing. However when we use a between subject design the general hot hand belief is smaller than in other studies before (31% and 28%, compared to previous belief between 60-91%). This seems hard to explain simply by differences in the questions (which were the same as in Gilovich et al., 1989, Raab et al., 2012) or the paradigm, type of sample or sports (same sport as in Raab et al., 2012).

A new finding of Study 2 is that framing effects can be subtly manipulated. Here we just changed the video perspective in which the same hit-miss sequences are presented. Further

research may focus on the impact of manipulating frames more or less explicitly and with that provide further data on when frames may influence choices in real environments. Finally, Study 2 provided evidence that winning and losing streaks produce decisions that take the streak length into account. If streaks continue for a while participants believe that streaks may stop and they thus change their allocation behavior.

General Discussion

The studies used here asked whether framing sequential choices from an actor versus observer perspective change either belief in the hot hand or allocation behavior of the hot hand. The answer for both beliefs and behavior is yes. In Study 1, framing participants as observers seems to have reduced their hot hand beliefs compared to when they were asked to behave as actors. Observers relied more on a simple win–stay, lose–shift strategy than actors did. One important difference from previous studies (Gilovich et al., 1985; Raab et al., 2012) is the much lower number of participants who believed in the hot hand. This finding provides further evidence that the often-cited stability of the hot hand belief is not as high and stable as previously thought and this finding also extends notions about differences in the hot hand belief and behavior between groups with different levels of expertise (Köppen & Raab, 2012; MacMahon et al., 2014). Whether the difference in amount and stability of the belief is the result of design features or the samples used is a potential line of future research.

A new finding is that participants in the actor condition did not switch after they had chosen a player for allocation as often as participants in the observer condition did. When players exhibited streaks, participants tended to choose the hot player after streaks of hits and the not-cold player after streaks of misses up to about three hits or misses. Thereafter, it appears that all participants believed that neither a lucky nor an unlucky streak would continue and reversed their strategy. This inverted-U function of allocation behavior for hot players (or U function in the case

548 of cold hand allocations) is important for scouting and predicting the allocation behavior of
549 opponent teams. The Study 1 finding that the longer the sequence the less likely the allocation to
550 that player was replicated in Study 2 with a different frame manipulation, indicating that the
551 video perspective from which participants perceive a situation can alter their belief and behavior.
552 What is new is the finding that from the actor perspective, players who show sequences of hot
553 hands are preferred for ball allocation, as indicated by positive autocorrelations in Study 2.
554 Why did framing influence the belief and the behavior as predicted? We can find
555 explanations in general psychology. First, it seems likely that when confronted with this
556 volleyball task, our participants—who were studying physical education or sports science—did
557 use reference points from experience. Sports experience could produce reference points from
558 which the perceived behavior of the players in the video can be compared. This comparison
559 process may change the hot hand belief and the hot hand behavior conceptually replicating
560 previous evidence (Köppen & Raab, 2012, MacMahon et al., 2014). Framing via instructions or
561 video perspective may alter such reference points when the decision problem is encountered.
562 Whether framing also has an influence on the mental representation or memory of previous trials
563 has not been tested yet, but given the changes we saw in the average choice decisions in hot or
564 cold streaks, some intermediary processes need to be considered to explain the differences.
565 Limitations of the current two studies could be overcome by differentiating the influence
566 of frames at different stages of the decision-making process. As well, sophisticated measures of
567 internal frames are needed—that is, participants' representations and memory of previous
568 performance—which could have an additional effect on their beliefs and choices. For instance,
569 framing research suggests that we judge winning two lotteries of $50 and $30 differently from
570 winning $80 in one lottery. Framing using aggregated or disaggregated quantities of hits and
571 misses is unexplored and may help us understand under which situations playmakers aggregate
572 performances of players for their allocation decisions. In addition, knowledge of such effects has

implications for how scouts should provide statistics for teams, as well as the opponent teams they are preparing to face. There are further limitations that come from the studies themselves: We were able to use frames successfully with participants, but we by no means know how they used the frames to produce a specific representation of the problem. Similarly, the actor perspective in the video clips is not fully identical to a first-person perspective and thus further study could use stimuli that present the environment from an actor's head-mounted camera. Previous research has convincingly demonstrated that the visual perspective in sports changes the responses in anticipation and decision-making tasks (Farrow, 2007; Williams, Ward, Ward & Smeeton, 2008). Therefore, future research should test the individual effects of such a manipulation in a Latin square design. Finally, carry-over effects between conditions cannot be fully controlled by simply counter-balancing conditions in our design. Similarly, explanations to account for why about 40% of the participants did not believe in the hot-hand in contrast to previous studies are beyond this study and need to be tested in varying designs and tests.

What Does This Article Add?

This article adds to theory and the understanding of sequential decisions in sport by highlighting the influence of framing. We introduced outcome frames that affect the hot hand belief and hot hand behavior, indicating that neither the belief nor the behavior is a stable entity that can be explained by generic mechanisms. Rather, future research needs to understand how people adapt their strategies when exposed to ever-changing environments. Recent models of why success breeds success (Iso-Ahola & Dotson, 2014) propose that psychological components such as individual perceived momentum play a crucial mediating role in explaining behavior. This explanation cannot be applied to framing-observer effects, however. Future research may therefore focus on assumptions within these models that specify the likely role of influential dimensions of perceived streaks such as duration, intensity and frequency.

598 The framing perspective on the hot hand belief and hot hand behavior may have practical
599 consequences in the long run, as well. For instance, coaches could use winning or losing frames
600 in their game preparation or in time outs during a game that could alter the playmakers' belief in
601 streaks as well as their behavior. For example, showing videos of the players or the opponents
602 from the first-person or observer perspective could alter the belief and behavior evaluation.
603 Furthermore, in time outs the orientation of a coach's flip-chart can determine if the perspective
604 is that of an actor or observer. Whether these effects are positive or negative for performance is
605 still hotly debated and has not yet been tested in the field by manipulating pregame routines or
606 instructions in time outs, but it may be worth doing so.
607
608 **References**
609 Aharoni, G., & Sarig, O. H. (2012). Hot hands and equilibrium. *Applied Economics, 44*(18),
610 2309-2320. doi: 10.1080/00036846.2011.564141
611 Arkes, J. (2010). Revisiting the hot hand theory with free throw data in a multivariate
612 framework. *Journal of Quantitative Analysis in Sports, 6*(1), 2. doi: 10.2202/1559-
613 0410.1198
614 Attali, Y. (2013). Perceived hotness affects behavior of basketball players and coaches.
615 *Psychological Science*. doi: 10.1177/0956797612468452
616 Avugos, S., Köppen, J., Czienskowski, U., Raab, M., & Bar-Eli, M. (2013). The "hot hand"
617 reconsidered: A meta-analytic approach. *Psychology of Sport and Exercise, 14*, 21-27.
618 Ayton, P., & Fischer, I. (2004). The hot hand fallacy and the gambler's fallacy: Two faces of
619 subjective randomness? *Memory & Cognition, 32,* 1369–1378.
620 Bar-Eli, M., Avugos, S., & Raab, M. (2006). Twenty years of "hot hand" research: Review and
621 critique. *Psychology of Sport and Exercise, 7,* 525-553.
622 Bornstein, Robert F. & Craver-Lemley, C. (2004). "Mere exposure effect". In Pohl, R. F. (Ed.).

Cognitive Illusions: A Handbook on Fallacies and Biases in Thinking, Judgement and Memory (pp. 215–234). Hove, UK: Psychology Press.

Burns, B. (2004). Heuristics as beliefs and as behaviors: The adaptiveness of the "hot hand". *Cognitive Psychology, 48,* 295-331.

Caruso, E. M., Waytz, A., & Epley, N. (2012). The intentional mind and the hot hand: Perceiving intentions makes streaks likely to continue. *Cognition, 116,* 129-153.

Farrow, D. T. (2007). The effect of viewing perspective on decision-making performance in water polo. *Journal of Sport & Exercise Psychology, 29*, 70-71.

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

Hales, S. D. (1999). An epistemologist look at the hot hand in sports. *Journal of the Philosophy of Sport, 26,* 79-87.

Iso-Ahola, S. E. & Dotson, C. O. (2014). Psychological momentum: Why success breeds success. *Review of General Psychology, 18,* 19-33.

Kahneman, D. (2012). *Thinking, Fast and Slow*. New York, NY: Farrar, Straus and Giroux.

Köppen, J., & Raab, M. (2012). The hot and cold hand in volleyball: Individual expertise differences in a video-based playmaker decision test. *The Sport Psychologist, 26*, 167-185.

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.

Lyons, J., Weeks, D. J. & Elliot, D. (2013). The gambler's fallacy. A basic inhibitory process? *Frontiers in Psychology, 4,* 1-11.

MacMahon, C., Köppen, J., & Raab, M. (2014). The hot hand belief and framing effects. *Research Quarterly for Exercise and Sport, 85*(3), 341-350.

MacMahon, C. & Starkes, J. L. (2008). Contextual influences on baseball ball-strike decisions in umpires, players, and controls. *Journal of Sports Sciences, 26*(7), 751-760.

Hahn, U., & Warren, P. A. (2009). Perceptions of randomness. Why three heads are better than four. *Psychological Review, 116*, 454–461.

Raab, M., Gula, B., & Gigerenzer, G. (2012). The hot hand exists in volleyball and is used for allocation decisions. *Journal of Experimental Psychology: Applied, 18*, 81-94.

Soman, D. (2004). Framing, loss aversion, and mental accounting. In D. J. Koehler & N. Harvey (Eds.), *Blackwell handbook of judgment and decision making* (pp. 379-398). Oxford, UK: Blackwell.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211,* 453-458.

Ward, P., Suss, J., Eccles, D. W., Williams, A. M., & Harris, K. R. (2011). Skill-based differences in option generation in a complex task: A verbal protocol analysis. *Cognitive Processing: International Quarterly of Cognitive Science, 12*, 289-300.

Wilke, A., & Barrett, H. C. (2009). The hot hand phenomenon as a cognitive adaptation to clumped resources. *Evolution and Human Behavior, 30,* 161-169.

Williams, A. M., Ward, P., Ward, J., & Smeeton, N. J. (2008). Task specificity, role, and anticipation skill in soccer. *Research Quarterly for Exercise and Sport, 79*, 428-433.

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