THE INFLUENCE OF PSYCHOLOGICAL MOMENTUM ON BASKETBALL SHOOTING PERFORMANCE

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The purpose of this research was to examine the influence of fictitious scoring updates on psychological momentum (PM) and athletic performance in a competitive basketball setting. The participants included in this study were 50 male undergraduate students who reported having played basketball previously and qualified by being able to make more than 24% (12 out of 50) of their 3-point shots in a pre-trial session. Participants were told that they were competing in a 50 shot, 3-point shooting competition against another individual, equal in ability. After every 10 shots, participants were given a fabricated score update and answered four questions used to measure PM. Results showed that the fictitious score updates significantly ($p < .01$) influenced participants' PM scores, where those who were told they led had higher PM scores than those who were told they trailed. As for shooting performance, no significant differences ($p = .76$) were found between positive and negative PM states for participants who reported experiencing both during the competition. Together, these findings suggest that manufactured score updates can influence PM, but resultant performance differences may not exist. Results of this study lend support to the notion that PM is experienced by athletes. However, when examining basketball shooting performance, the momentum-performance relationship is statistically unsupported. Thus, although PM is thought of by many as a game-changing factor, this study would suggest that PM plays a negligible role in changes to individual performance.

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THE INFLUENCE OF PSYCHOLOGICAL MOMENTUM ON BASKETBALL SHOOTING PERFORMANCE

Introduction

Athletes, coaches, sportscasters, and spectators often mention that psychological momentum (PM) contributes to the ebb and flow of competition. PM is usually defined as an added or gained psychological power that gives people a feeling that they have an edge over their opponent (Iso-Ahola & Mobility, 1980). For instance, athletes commonly report flow experiences, especially after a tremendous competitive effort (Jackson & Csikszentmihalyi, 1999). These positive experiences conjure up positive feelings that are described as *being in the zone* or *having a hot hand.* Conversely, athletes can experience a loss of PM, or negative PM, often referred to as *being in a slump* or *ice cold*. Athletes, coaches, sportscasters, and spectators regularly highlight shifts in momentum as a contributing factor to performance and outcomes (Gilovich, Vallone, & Tversky, 1985). This momentum-performance relationship has been documented in various sports, such as hockey (Gayton, Very, & Hearns, 1993), racquetball (Iso-Ahola & Blanchard, 1986), and basketball (Mack, Miller, Smith, Monaghan, & German, 2008). In addition, there might be an even more distinct momentum-performance relationship in sports where exerted effort is more closely related to performance outcome, such as cycling (Briki, Den Hartigh, Markman, Micallef, & Gernigon, 2013; Perreault, Vallerand, Montgomer, & Provencher, 1998). Unfortunately, the research thus far has not provided clear evidence of a relationship between momentum and performance, and the resultant outcome. This might be attributed to the varying ways in which PM is thought to affect performance.

The original conceptualization of PM suggested that positive psychological momentum (i.e., people feel that they have a “gained psychological power”) resulted in an increase in performance and a more successful outcome (Iso-Ahola & Mobility, 1980) For example, winning a set in racquetball and as a result, going on to win the match in straight sets. Conversely, poor performance and unfavorable outcomes were a result of not having “gained psychological power” or having negative psychological momentum. However, some research in support of the momentum-performance relationship has shown that PM can have a reverse effect where positive momentum leads to bad performance, and negative momentum can result in better performance. These counterintuitive findings have been termed positive inhibition and negative facilitation, respectively (Briki et al., 2013; Perreault et al., 1998). Regardless of how momentum effects performance, the aforementioned studies would suggest that it plays a role. That being said, some conflicting research has discounted the momentum-performance relationship entirely. In an early study looking at the “hot hand” effect in basketball, which suggests that an athlete is more likely to make a field goal or free throw shot after having made one on the previous attempt, Gilovich et al. (1985) found that the hot hand effect was statistically unsupported. Instead, it was suggested that the commonly held belief of PM was simply a “cognitive illusion.” This same finding was shown in a lab study looking at performance on a novel motor task (Silva, Cornelius, & Finch, 1992), in field studies looking at performance outcome in tennis (Silva, Hardy, & Crace, 1988), and also when looking at team winning streaks (Vergin, 2000). Thus, it appears that this area of research has been plagued by inconsistency. Lack of consistent findings has led to a large amount of criticism. In order to better determine

the role PM plays in performance, additional research is needed. Specifically, research with an improved methodological and research design.

In one of the first studies on PM, Iso-Ahola and Mobility (1980) investigated how winning the first set in a racquetball match affected the outcome of subsequent sets. They found that set one winners went on to win the match 86.6% of the time. In a follow up study, Iso-Ahola and Blanchard (1986) added a cognitive component and found that winning led to an increase in perceptions of confidence and superiority. Furthermore, Mack et al. (2008) showed a significant difference between how winners and losers perceived their chances of winning the next set, their ability to perform, and the momentum that they possessed. This cognitive advantage could help explain why individuals who win the first set were more likely to win the subsequent set, and the match. After studying tennis matches in a similar manner, Silva et al. (1988) offered an alternative explanation. They suggested that the momentum-performance relationship is simply due to a difference in ability between opponents. In tennis matches that went three sets, which would imply a more evenly paired competition, the momentum-performance relationship disappeared. Additionally, tennis matches occurring later in the tournament, when competitors should have been closer in ability, failed to support the momentum-performance relationship. These contradictory findings are not uncommon, and can be attributed partially to poor experimental designs. One limitation of studies that rely heavily on performance outcomes or archival data is that it may mask the effect of PM. That is, if each individual responses differently to PM, the effects may cancel each other out by averaging each individual's performance together. Furthermore, studies that lack internal control make it far more difficult to determine

what is actually taking place with a phenomenon as complex as the momentum-performance relationship. More research on PM in a laboratory setting is needed to determine if and how momentum impacts performance.

In one of the first lab studies investigating PM, participants completed a novel motor task and were provided false feedback to manipulate PM. The results indicated that momentum did not have a significant impact on time of completion or number of errors (Silva et al., 1992). In another lab study, Perreault et al. (1998) investigated how cyclists were affected by being told that they were ahead or behind in a simulated race. It was discovered that cyclists in a positive momentum state exerted more effort than cyclists in a no momentum state, which supports the original understanding of PM. Interestingly, cyclists who experienced a loss of momentum (negative momentum state) found a similar effect. When the cyclists experienced being behind, they showed significantly higher levels of exertion compared to a no momentum state. This failure avoidance reaction has been termed “negative facilitation.” In addition, in a similar study done by Briki et al. (2013), performance diminished as positive momentum became increasingly high; a reaction to success that has been termed “positive inhibition.” These two lab studies were unique in that they were the first to look at PM in a competitive setting, in a sport where exerted effort better predicts performance and outcomes (Briki et al., 2013; Perreault et al., 1998). Clearly, even lab studies have provided mixed results.

Due to the inconsistency of previous research, it is difficult to predict how exactly momentum will influence performance in this study. Many believe the idea that positive momentum will lead to positive performance, whereas negative momentum will lead to

negative performance. However, it has been found that negative PM can result in better performance through negative facilitation (Briki et al., 2013; Perreault et al., 1998) and that positive PM might lead to poor performance through positive inhibition (Briki et al., 2013). In addition, there are many researchers who agree with Gilovich et al. (1985), that PM is simply a “cognitive illusion” (Miller & Weinberg, 1991; Silva et al., 1992; Wanzek, Houlihan, & Homan, 2012). However, by utilizing the control that a laboratory study offers, research can more easily determine the variables that play a role in PM and the resulting effects on performance and outcomes. This research study was designed to account for some of the shortcomings of previous research. The main purpose of this study was to determine the role that PM plays in the performance of a sport skill. Additionally, this study investigated how PM was effected by manipulating the participant’s perceptions of being ahead or behind in a competitive scenario.

When examining the effect score manipulation has on PM scores, participants who are told they are ahead will report higher PM scores than those who are told they are trailing. When examining PM scores on a within group basis, the following hypothesis will be tested:

1a. Participants placed in Group 1, will report PM scores that are significantly lower after Round 2 than after Round 4.

1b. Participants placed in Group 2, will report PM scores that are significantly higher after Round 2 than after Round 4.

When examining PM scores on a between group basis, the following hypothesis will be tested:

1c. After Round 2, participants assigned to Group 1 will report significantly lower PM scores than Group 2.

1d. After Round 4, participants assigned to Group 1 will report significantly higher PM scores than Group 2.

1e. After Round 3, PM scores will be significantly higher in participants in Group 1 (who have come from behind) than Group 2 (who lost the lead).

These findings would support the idea that the score of a competition plays a role in reported PM scores (Mack et al., 2008; Silva et al., 1992). Finally, when examining the momentum-performance relationship using an inter-individual approach, there will be a significant difference between the performance of those who experienced positive PM and those who experienced negative PM, during the competition.

Method

Participants

The sample consisted of 50 male volunteers who were between 18-37 years of age (*M* = 21.66*; SD* = 4.14). They were recruited from the University's physical education classes and from the university recreation center. All of the participants had competed in basketball previously, and self-reported being able to shoot non-game situation 3-point shots at a rate better than 20% when signing up for the study. Each of the participants were required to shoot 50 three-point attempts from five different locations in a competitive setting. The goal was to win the competition by making more shots than their opponent. The participants were also told that as a result of defeating their opponent, they would be entered into a drawing for one of the gift card prizes ($$). Each participant was randomly assigned to one of two groups. Group 1 experienced

being tied, behind, tied, ahead, ahead, while Group 2 experienced being tied, ahead, tied, behind, and ahead, in that order. Each participant was entered to win one of the prizes regardless of the outcome.

Measures

Psychological Momentum

The items used to measure PM were derived from Vallerand, Colavecchio, and Pelletier (1988) and have been implemented by Perreault et al. (1998), Stanimirovic and Hanrahan (2011), and a smaller sample of the original questions were translated to French and utilized by Briki et al. (2013). Vallerand et al. (1988) reported excellent reliability for the measures in no-momentum and momentum conditions ($\alpha = .93$ and $\alpha = .95$, respectively). Furthermore, Perreeault et al. (1998) found Cronbach alpha values ranging from .70 to .94 at four different periods within their experiment. Additionally, Briki et al. (2013) used four of the nine questions developed by Vallerand et al. (1988) and found they had very good internal consistency ($\alpha = .91$). Thus, for the current study participants were asked the following questions, which are a modified subset of the items used originally by Vallerand et al. (1988):

1. At this point in the competition, who has the most momentum?
2. At this point in the competition, who has the most confidence?
3. At this point in the competition, who is the most motivated?
4. At this point in the competition, who is progressing most toward victory?

The reliability for the baseline PM (PM0) items in the current study was .87. Additionally, when examining the mean PM scores between PM0 and PM1, the results yielded a Cronbach alpha value of .75, indicating acceptable test-retest reliability.

Although the data was not analyzed, two dummy questions were also included that related to the Athletic Coping Skills Inventory-28 (ACSI-28; Smith et al., 1995) questionnaire. The following questions were used to better ensure that the participants were unaware of the actual aim of the study:

5. At this point in the competition, who is feeling the most pressure?
6. At this point in the competition, who is the most worried about the outcome?

Although pressure and anxiety are not mentioned in the PM questionnaire, understanding their role in the momentum-performance relationship may be beneficial in the future.

Each question was rated on a 10-centimeter graphic rating scale (GRS) that included two endpoints ("my opponent" and "myself") with a midpoint of ("neither"). For each response the participant drew a short, vertical line through the continuum that indicated where he stood in regard to the question (see Appendix C). Kerlinger (1964) emphasized the benefits of using the GRS when he stated that the GRS is "probably the best of the usual forms of rating scales," because they have equal intervals and are very simple to comprehend and implement (p. 516). One study that utilized this form of response scale in the past found that participants favored larger, positive numbers (Schwarz, Knauper, Hippler, Noelle-Neumann, & Clark, 1991). For this reason, verbal labels, as opposed to numerical labels, were utilized to remove any potential bias toward larger numbers or away from negative numbers (Couper, Tourangeau, Conrad, & Singer, 2006). For this study, PM was measured at five different times throughout (PM0 – just before the competition, PM1 – post score update for Round 1, PM2 – post score update for Round 2, PM3 – post score update for Round 3, and PM4 – post score

update for Round 4). The participant's PM scores for each round were computed by averaging the mean score for all four of the PM questions for that particular round. The difference between the baseline and the mean score for each round was then calculated (i.e., PM1-PM0). That difference was used to categorize PM into positive momentum, negative momentum, and no momentum. Difference scores greater than 1.10 indicated positive momentum, whereas differences of at least -0.10 indicated negative momentum. Any difference between the baseline and individual round that fell between -0.10 and 0.10 were categorized as no momentum. These instances were included in the analysis process for the manipulation check. However, no momentum occurrences were excluded from the analysis process for the performance-momentum relationship The thresholds for positive and negative PM were a) were chosen to make the groups distinct from one another, b) based on the smallest reliable measure (0.10 cm), and c) confirmed based on results from a pilot study.

Performance

Performance was measured by the number of 3-point attempts made. How the ball went in the basket was not considered. As long as the ball went through the basket, the attempt was deemed successful.

Athletic Coping Skills Inventory-28

This scale was used in a couple of ways. First, to deceive participants from being able to determine the exact aim of the study. Second, it was included to determine if the ability to cope with internal and external forces influenced performance in a competitive setting. Although not analyzed, the ACSI-28 might shed light on any personal differences in response to PM. The 28-item scale was composed of the following seven

subscales: Coachability, Concentration, Goal Setting and Mental Preparation, Confidence and Achievement Motivation, Ability under Pressure, Freedom from Worry, and Ability to Cope with Adversity. When conducting a factor analysis on the ACSI-28, Smith, Schutz, Smoll and Ptacek (1995) found an alpha coefficient of .84 when combining each subscales together for only males. Additionally, each of the subscales had acceptable alpha coefficients, ranging from .62 to .86 when taking both males and females into account. Furthermore, in a study conducted by Guenthner and Hammermeister (2007), each subscale was found to have the following alpha coefficients: Coachability (.67), Concentration (.61), Goal Setting and Mental Preparation (.74), Confidence and Achievement Motivation (.56), Ability under Pressure (.87), Freedom from Worry (.68), and Ability to Cope with Adversity (.65). Due to a small sample size of four questions per subscale, the smaller alpha coefficients for each individual subscale were expected. Because each category contains fewer than five items, a coefficient of .60 was deemed acceptable (Amorose & Horn, 2000). Each question was answered on a 4-point scale ranging from *almost never* (0) to *almost always* (3). The following are examples of items used to represent each of the seven subscales assessed originally by Smith et al. (1995):

1. I maintain emotional control no matter how things are going for me.
2. To me, pressure situations are challenges that I welcome.
3. On a daily or weekly basis, I set very specific goals for myself that guide what I do.
4. I handle unexpected situations in my sport very well.
5. While competing, I worry about making mistakes or failing to come through.

6. I feel confident that I will play well.
7. If a coach criticizes or yells at me, I correct the mistake without getting upset about it.

Procedures

Following approval by the University of North Texas Internal Review Board, the first author recruited participants from physical activity classes. A script was used, asking for average to good, male, three-point shooters, who previously played competitive basketball. The participants also reported being able to shoot uncontested, non-game, 3-point shots at a completion rate better than 20%. Participants were also recruited by posting flyers at the university recreation center, calling for volunteers who met the aforementioned criteria. Participants were informed that the purpose of the study was to understand how a competitive setting facilitates or hinders performance over time. Those who participated had an opportunity to be entered into a drawing for gift cards of various amounts. To ensure participants were motivated to compete, they were told that in order to be entered into the drawing they were required to win the shooting competition. However, because the results were fabricated, all participants were entered into the drawing and therefore eligible to win one of the gift cards.

Participants were given an informed consent form and asked to complete a short survey on their basketball experience and expected shooting performance (see Appendix D). Afterward, each participant went through a baseline pre-trial consisting of a 15 shot warm-up. It consisted of three shots from each of the five shooting locations beyond the 3-point line. A time limit of 3 minutes was used for the warm-up session to ensure the trial was completed in a timely manner. Shortly after the warm-up,

participants attempted 50, three-point shots (e.g., 5 rounds of 10 shots) from the same five locations. In order to avoid a learning effect, participants moved from one spot to the next after each shot attempt. A 30 second break was provided between rounds to better simulate the competition day experimental procedures (i.e., completing the PM questionnaire). After the conclusion of the pre-trial shooting task, participants were told their overall score. Participants who made less than 12 of their 50 shots (5 participants out of 55) were told that due to their performance, they were not fit for the study, thanked, and excused. Those who were successful on at least 12 of their 50 shooting attempts, and indicated in their pre-trial demographic survey that they felt they could make at least 20% were scheduled to participate in a shooting competition and were randomly assigned to one of two groups. They were told that they would be paired with someone equal in ability based on the pre-trial shooting task they had just completed and their previous basketball experience. Participants fit for the experiment were told not to change the amount of time they typically practiced or played in the week between the pretrial time and the competition.

When participants arrived in the gymnasium the day of their competition, they completed the ACSI-28. This instrument was used to deceive the participant, and to better ensure that their performance was unaffected by knowing the aim of the study. After completing the ACSI-28, the researcher read aloud a script explaining how the shooting competition would be completed (see Appendix E). Participants were then informed that due to scheduling difficulties, the person they would be competing against had already competed, and he would be provided the score updates throughout the competition. However, they were not actually competing against anyone and each score

update was fabricated systematically. Participants completed the same warm-up routine, completed the baseline PM scale, and then attempted 50 three-point shots in the same manner as the pre-trial shooting task. However, after every 10 shots, participants were updated on the current score of the competition. At this time, participants were deceived on the actual score in an attempt to manipulate their perception of positive, negative, or no momentum. Additionally, between each round of 10 shots, and just after finishing the warm-up session, participants answered a series of questions measuring PM.

After the first 10 shots, participants were told that they were tied with their opponent in an attempt to reinforce the idea that the person they were competing against was equal in ability. After the second round of 10 shots, they were told that they were 2 shots ahead or behind depending on which group they were randomly assigned. After the third round of 10 shots, they were told that the score was once again tied. After the fourth round of 10 shots, participants were told the opposite result of the randomly assigned second round results, either ahead or behind 2 shots. If participants missed more than two or made less than two, making it impossible for the predetermined result to have happened, they were told that the score was the same as the previous round. Additionally, the predetermined result for that round and subsequent rounds were moved back one round. For example, if a participant made 4 shots in the first round he was told he and his opponent were tied just as he would have been had he made 1 shot. If in second round the participant was predetermined to be behind by 2 shots and made 3 shots, he was told he trailed by 2 shots. However, if the participant made 1 shot in the third round, and it was predetermined that the participant was supposed to be tied

after trailing by 2 shots, he was told that he remained behind by 2 shots (the same result as the previous round). Assuming he then made more than two shots in the fourth round, he was told he was tied with his opponent (the original Round 3 result) and the predetermined results continued in order. After the final 10 shots, the participant was told that he had won by 1-3 shots, as long as enough shots were made in the final round for that result to occur. The participant was then told that as a result he would be entered into the raffle for the gift cards. In the event no shots were made in the final round, the participant was told the same result at the end of Round 4. Therefore, it is possible that a participant was down by 2 shots after the fourth round and failed to make a basket in the fifth round. In this scenario, the participant was told he trailed by two after the final round. After the completion of the shooting portion, to ensure each participant believed in the fairness of the study, and that there was no deception involved, he was asked to describe his own experience of the shooting competition (see Appendix F). Any individual who felt that the score updates were manipulated were excluded from the data analysis. For each participant who failed to win the competition, an option to remain in the drawing was given by completing the exit survey. This guaranteed that each participant left with the understanding that he would be included in the drawing upon completion of the study. Once each participant was finished, he was thanked and asked to remain silent about his experience until the study's conclusion. He was told that once each of the remaining participants completed the experiment he would receive an email listing those who were selected in the random drawing for the gift cards. He was also told that upon receiving the email with the raffle winners he would also be debriefed on the study (see Figure 1 for graphic of procedures).

Analysis

Preliminary tests were done to check for normality to determine if there were any outliers in the data. If necessary, outliers were removed from the data before the remaining analyses were conducted. A randomization check was done to ensure the baseline data for each group did not significantly differ. Independent samples t-tests with alpha levels of .05 were run to look for differences between groups on age, ability (competition shooting performance), and PM0 (baseline PM score). In the event significant differences were found between Group 1 and 2 on any of the measures, the variable(s) showing significant differences were controlled for in the following analyses.

In order to determine if the manipulation worked and whether or not having a lead created a positive PM response and having a deficit created a negative PM response, a 3 x 2 (PM2, PM3, PM4 x Group) repeated measures ANOVA was conducted. Alpha was set at .05. Partial eta-squared critical values of .01, .06, and .14 were used to measure small, medium, and large effects, respectively. This analysis was used to test the significance of Hypotheses 1a, 1b, 1c, 1d and 1e, looking at significant differences within and between groups on PM scores after Rounds 2, 3, and 4. Mauchly's sphericity test was conducted to assess if the assumption of homogeneity of variance was met. Nonparametric tests were only utilized if Mauchly's sphericity came back significant ($p < .05$), indicating a sample that lacked homogeneity. Due to the inconsistency in previous research, post-hoc analyses were run regardless of whether or not a significant effect was seen in the repeated measures ANOVA. Post-hoc analyses were used to determine the differences in reported PM scores after score updates for Rounds 2, 3, and 4. A total of five tests were run to determine the exact

effect of the manipulation. A Bonferroni adjustment was made to avoid making a Type 1 error and the resulting critical alpha value was .01 (.05/5). Two separate within groups dependent samples t-tests were conducted to test for differences in reported PM scores between Rounds 2 and 4 for each group (Hypotheses 1a and 1b). Three separate independent samples t-tests were conducted to test for differences in PM scores in Round 2, 3, and 4 between groups (Hypotheses 1c, 1d, and 1e). Additionally, effect sizes were calculated to determine the meaningfulness of the findings. Critical values of 0.2, 0.5, and 0.8 indicated small, medium, and large effect sizes, respectively (Cohen, 1988).

Finally, the main goal of the study was to help determine the role PM had on basketball shooting performance. Due to the inconsistencies in previous literature, Hypothesis 2 was more exploratory than the previous hypotheses. The analysis of the momentum-performance relationship mirrored this by using a two-tailed approach. In order to determine if there was a significant performance difference between the individuals who experienced positive momentum (having a PM score greater than the baseline by .10 or more) and negative momentum (having a PM score less than the baseline by .10), a dependent samples t-test was conducted. Alpha was set at .05. This analysis was used to compare the average performance across rounds in which the participant experienced positive and/or negative momentum. For example, if a participant experienced positive momentum in the second and third rounds and made 3 shots and 5 shots after those reported scores, respectively, 40% would be used as the data point for that participant on positive PM performance. Additionally, an effect size was computed to determine the effect on performance when participants have reported

experiencing positive or negative momentum. The same critical values for effect size listed previously were utilized for this analysis.

Results

None of the participants reported in the exit survey that they felt the scores were unfairly manipulated. Therefore, no exclusions were made based on this occurrence. To ensure the data was not skewed due to the presence of an outlier, a Shapiro-Wilk test was conducted. Where normalcy was not achieved (i.e., PM0 for Group 2), the data was examined for outliers. No outliers were found on the baseline PM variable due to a ceiling effect for that measure. Participants (n = 2) who reported having a baseline PM score of 10 out of 10, prevented themselves from being able to experience a positive PM state. This was taken into consideration during the analysis process. The results did not significantly change regardless of whether or not these participants were included. Therefore, all participants were included in the analysis to keep the data as realistic as possible.

To confirm that the randomization worked, three independent samples t-tests were conducted on age, ability (i.e., shooting percentage during the competition trial), and PM0 (i.e., baseline psychological momentum score). As expected, there was no significant difference (see Table 1 for descriptive statistics) between Group 1 and Group 2 on age ($t_{(43)} = -0.77$, $p = .45$), ability ($t_{(43)} = 1.22$, $p = .23$), or PM0 ($t_{(43)} = 0.84$, $p = .41$). These results indicated that the randomization worked, and that there was no need to control for age, ability, or baseline PM (PM0) during subsequent analyses.

To determine whether or not the score manipulation was successful at creating a change in psychological momentum, a 3 x 2 (Round x Group) repeated measures

ANOVA was conducted. For the within subjects factor, Mauchly's test for sphericity was significant ($p < .001$), indicating that the assumption for sphericity was not met. Therefore, Wilks' Lambda was used to determine significance ($\alpha < .05$). While the main effect for round ($F_{(2,88)} = 0.16$, $p = .85$, $\eta^2 = 0.01$), and condition ($F_{(1,49)} = 0.37$, $p = .55$, $\eta^2 = 0.01$) were not statistically significant, there was a significant interaction effect ($F_{(2,88)} = 50.80$, $p < .001$, $\eta^2 = 0.71$). This indicated that during one or more of the rounds, a difference could be found between groups on the PM measure. In order to determine where the differences had occurred, five separate t-tests were conducted based on Hypotheses 1a, 1b, 1c, 1d, and 1e. The hypotheses suggested that PM scores would be significantly higher for participants who were told they were currently leading or had come back to tie compared to those who were told they were currently trailing or had lost their lead.

To determine if there was a difference within groups on PM scores, two separate dependent samples t-tests were conducted. Hypothesis 1a was supported because Group 1 scored significantly lower ($t_{(21)} = -6.89$, $p < .01$, $ES = -1.79$) on PM after Round 2 ($M = -1.71$, $SD = 1.62$) than after Round 4 ($M = 1.36$, $SD = 1.80$). Hypothesis 1b was supported, because Group 2 scored significantly higher ($t_{(22)} = 7.61$, $p < .01$, $ES = 2.08$) on PM after Round 2 ($M = 1.18$, $SD = 0.97$) than after Round 4 ($M = -1.57$, $SD = 1.60$).

When looking between groups for differences in PM scores, three separate independent samples t-tests were conducted. A lack of equal variance based on Levene's Test ($p = .01$) was found and an adjustment was made to take this finding into account. Hypothesis 1c was supported, because Round 2 PM scores were significantly lower ($t_{(34)} = -7.22$, $p < .01$, $ES = -2.16$) for Group 1 ($M = -1.71$, $SD = 1.62$) than Group 2 ($M = 1.18$, $SD = 0.97$). Hypothesis 1d was supported, because Round 4 PM scores

were significantly higher ($t_{(43)}$ = 5.79, p < .001, ES = 1.72) for participants in Group 1 (M = 1.36, SD = 1.80) than Group 2 (M = -1.57, SD = 1.60). These findings suggested that on average the participant reported higher PM scores after being told he was ahead and lower PM scores after being told he was behind. Hypothesis 1e was not supported, because Round 3 PM scores were not significantly different ($t_{(43)}$ = 1.33, p = .19, ES = 0.39) between participants in Group 1 (M = 0.14, SD = 2.00) and Group 2 (M = -0.49, SD = 1.07). These findings indicated that going from having the lead to having the score tied, or coming from behind to tie the score, had no significant effect on PM. Together, the results indicated that the manipulation was effective and that providing false score updates was a successful way to manipulate PM responses (see Figure 2 for graph of PM scores by Round).

Out of 50 participants, 30 reported having experienced both positive and negative PM states; those who did not experience both PM states were removed from the following analysis process. A two-tailed dependent samples t-test was conducted to determine the effect PM had on performance. Results indicated that there was no significant performance difference ($t_{(29)}$ = .31, p = .76, ES = 0.07) between participants who experienced positive PM (M = 42.8, SD = 15.02) and negative PM (M = 41.78, SD = 12.77). These findings failed to support the main hypothesis, and indicated that PM had a negligible effect on subsequent basketball shooting performance (see Figure 3).

Discussion

This study examined the relationship between PM and basketball shooting performance. Specifically, whether or not having negative or positive PM affected a

change in 3-point shooting percentage, while controlling for ability. In addition, the study investigated if giving score updates affected a participant's perception of PM. Since results indicated that the score manipulation of +/- 2 shots was successful at manipulating PM scores, it was fair to assume a change in performance could be partially attributed to the shift in PM. This finding is comparable to Miller and Weinberg's (1991) which found that a change in score was effective in altering an athlete's perception of PM. The current study's results also support the findings of Mack et al. (2008) where participants reported having a better chance of winning and more momentum than their counterpart after having been told they won. This information can be utilized in future research when manipulations are needed to promote a change in PM perceptions.

In regard to the momentum-performance relationship, no significant difference was found in shooting performance. Not only do these findings contradict those of Briki et al. (2013) and Perreault et al. (1998), which suggested a counterintuitive momentum-performance effect, they contradict the idea of a momentum-performance relationship altogether. These findings support the previous literature that suggests PM is simply a "cognitive illusion." With this, it is fair to assume that Gilovich et al. (1985) were correct in their assertion that a player is no more or less likely to make a basket after having missed or made a basket in their previous attempt. Furthermore, it supports the findings of Silva et al. (1988), which suggested that after controlling for ability, the momentum-performance relationship disappeared. That being said, caution should be used when making these assumptions.

Strengths and Limitations

There are a few alternate explanations as to why no significant differences were found when investigating the effect PM has on performance. First, the type of task or sport must be taken into consideration. It is possible that the effect of PM is more easily seen in certain tasks, such as those where exerted effort is more closely related to the performance outcome. One of the most convincing arguments that PM exists in sport can be seen in the sport of cycling (Perreault et al., 1998; Briki et al., 2013), where it seems reasonable to assume exerted effort is more closely related to performance outcome than in a basketball shooting task. This is not to suggest that cycling is skill-less and basketball requires no effort, but simply to point out the differences in the performance measure of each sport and how that may affect the momentum-performance relationship. In sports where exerted effort is not as closely related to performance outcome, a more extreme change in PM, or score manipulation, may be needed to elicit a stronger performance effect. This methodological challenge should be taken into consideration in future studies looking at the momentum-performance relationship.

The way performance was measured must also be considered. The momentum-performance relationship shown in cycling could be partially due to the amount of statistical power provided by the study design. In cycling, a performance data point (i.e., revolutions per minute) can be measured every second for the duration of the trial, which have lasted up to an hour in past studies (Briki et al., 2013). For the current study, and similar studies looking at basketball shooting, participants only provided up to 5 separate performance measurements (shooting percentage/round). Thus, future

research should include additional data (performance measurement) points when investigating how basketball shooting is related to PM. This could be done by measuring performance on a shot-to-shot basis as done by Gillovich et al. (1985), or by increasing the amount of shooting rounds for each participant. Doing this would provide additional statistical power when analyzing the results.

It is also possible that a PM effect on performance was present, but was simply masked by averaging participant's performance together, for each PM state. Past research in support of the relationship between PM and performance has suggested that it may affect each person differently. For example, studies have shown varying effects (positive inhibition and negative facilitation) when looking at golfers (Livingston, 2012) and cyclist (Briki et al., 2013; Perreault et al., 1998). Whereas, the original understanding of PM was shown in racquetball (Iso-Aholo & Mobility, 1980), hockey (Gayton et al., 1993), and golf performance (Livingston, 2012). The current study showed a wide variety of responses to PM as well. Of the participants whose data was utilized when investigating the momentum-performance relationship, 40% responded to PM in a way that would suggest a positive inhibition and negative facilitation response. Alternatively, 33% of participants experienced a response more aligned with the original understanding of PM. Although these results were not statistically analyzed for significance, the findings suggest that the momentum-performance relationship may vary at the individual level. Therefore, although significant intra-individual PM effects may exist, they are not apparent in analysis testing for significant inter-individual average differences. It would be beneficial for future research to consider a methodological change that would allow for the investigation to look at the PM and

performance relationship on an intra-person, rather than the current study's inter-person, approach. Assuming PM does exist in sport; future research may benefit from investigating the personal traits, previous sport experience, or gender that might influence how one perceives and responds to changes in self-reported PM.

Although there were limitations in the current study, there were many strengths. First, this study utilized a graphic rating scale (GRS), which has not been used at this point in PM research. The GRS was chosen for this study, because it allows for a more accurate self-reported measure than what had been previously utilized. Existing research typically used a 2-point scale ranging from *my opponent* (0) to *myself* (1) to determine who in the competition had the most PM. However, this methodology limits the degree of momentum the participant can report feeling. For instance, if a participant reports having the most momentum, there would be no way to determine if they feel like they have a slight momentum advantage or if the feel they have a more extreme momentum advantage. By allowing participants to mark on a 10 cm GRS, it allows for an exact measure of PM. A limitation of using a GRS scale was the ceiling effect that was found while determining whether or not outliers existed on the baseline PM score (PM0). That being said, this limitation was far outweighed by the many strength's this scale provided. Second, by manipulating PM in a laboratory setting, a greater amount of control could be attained. The benefit of controlling external factors like crowd noise, opponent appearance, and pressure from teammates and coaches, is that it allows researchers to better highlight the influence PM has on performance. Furthermore, this study controlled for ability, which is something many studies in the past failed to do. Without controlling for this factor it makes it difficult to tell whether or not a significant

performance difference is the result of PM, differences in ability, or both. This gain in internal validity has its limits when it comes to generalizability, in that the findings may not transfer to the real world setting. That being said, taking a laboratory controlled approach allowed for a more accurate measure of PM and performance by controlling for external factors. Therefore, until PM is more fully understood, future studies may benefit by utilizing a more controlled research approach.

Implications and Conclusion

Together, these findings indicated that there is not a constant inter-individual effect of PM. This may indicate that there is no advantage to being *zoned in*, *in rhythm*, or *having a boost in confidence* in basketball. Conversely, there was no disadvantage to feeling *under pressure*, *unnerving*, or *worried* like some of the participants in this study reported feeling in the post-experiment survey. This would mean that a cognitive change takes place based on the score update, which supported the findings of Mack et al. (2008) and Silva et al. (1992), but there is no consistent advantage based on this cognitive shift. Instead, the results indicated that the idea of PM in sport is kept alive by focusing on the few instances when PM appears to have an effect on performance and ignoring all the instances where that is not the case. If this understanding of PM is true, the implications within the sport of basketball are worth noting. These findings can be applied in a number of ways. For one, they suggest there is little to no advantage in having someone who reports *feeling it* to take the game winning shot. Instead, the decision should be solely based on who is statistically the best shooter in that situation, disregarding recent shooting performances. Additionally, these findings may change the way we think about scoring streaks in basketball (Gilovich et al., 1985), winning and

losing streaks in sports (Vergin, 2000), and how coaches utilize timeouts (Mace, Lalli, Shea, & Nevin, 1992; Roane, Kelley, Trosclair, & Hauer, 2004) and substituting. However, until a more complete understanding of the momentum-performance relationship is found, we should remain cautious in the application of these findings.

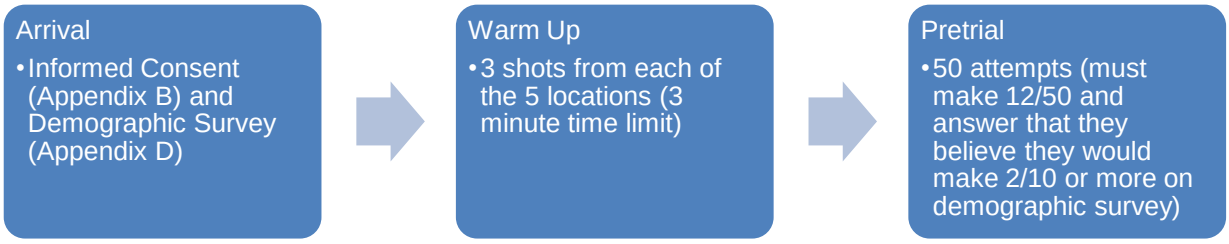
Table 1

Means and Standard Deviations for Potential Covariates

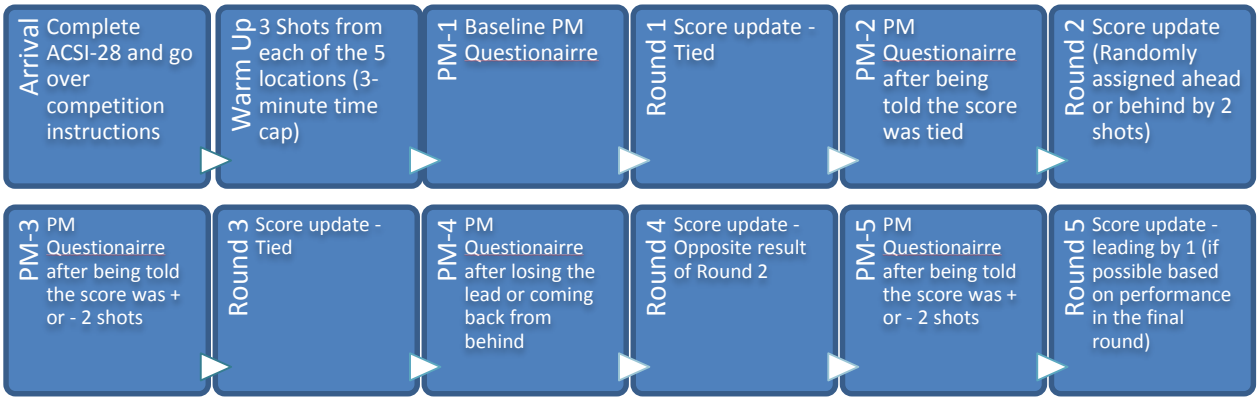
Variable	Group 1	Group 2
	M (*SD*)	*M* (*SD*)
Age	21.18 (3.80)	22.14 (4.76)
Ability	22.14 (5.45)	19.91 (6.71)
PM0	6.92 (1.78)	6.48 (1.75)

Note. No significant differences between groups on age, ability, or baseline PM (PM0)

Pretrial Sequence of Events



One Week Later (without changing the amount of time practicing 3-point shooting)



After Round 5 has been completed

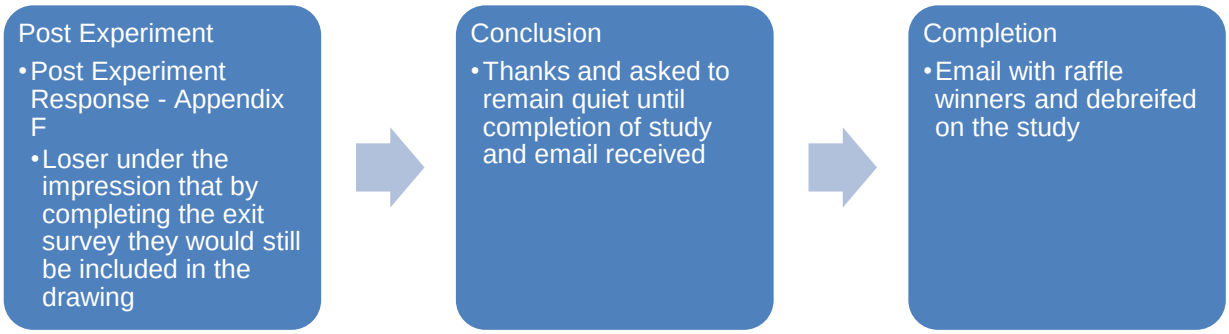


Figure 1. Flow chart of study procedures.

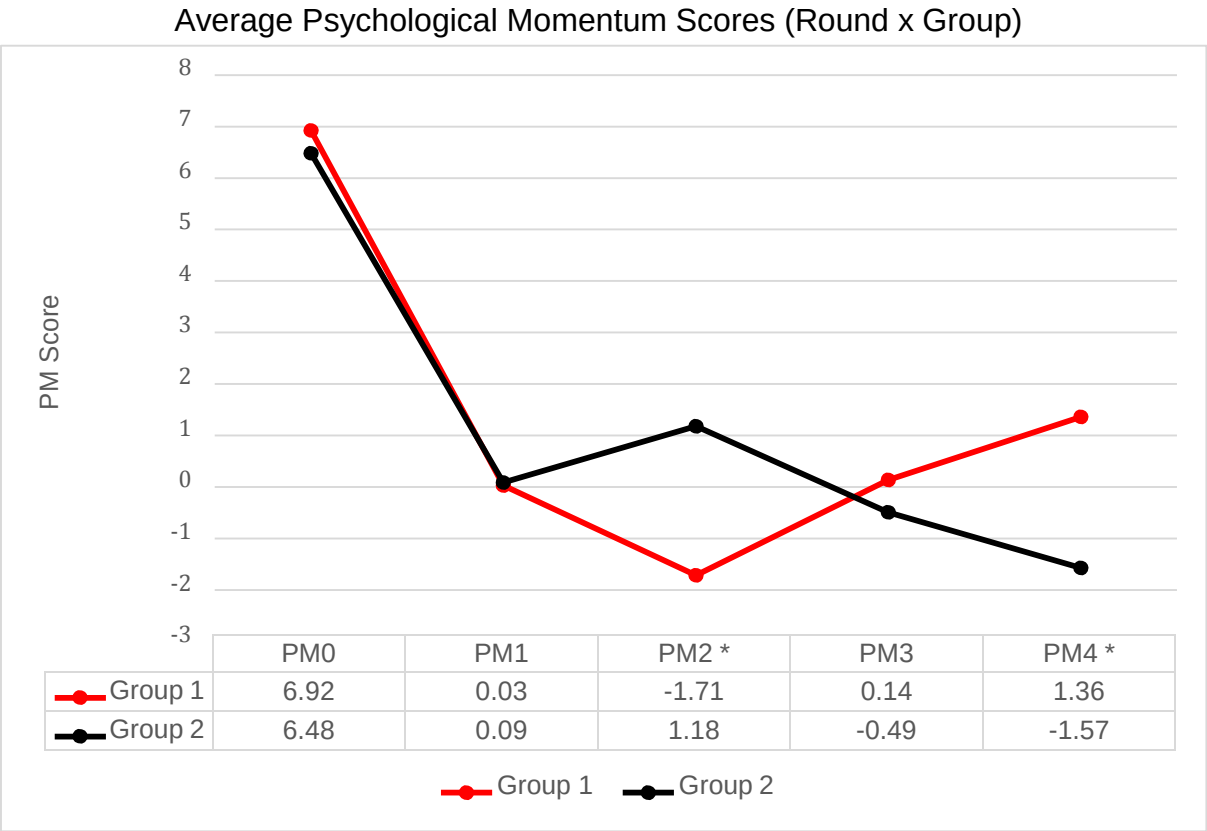


Figure 2. Average psychological momentum scores (Round x Group).

Note. * $p < .01$

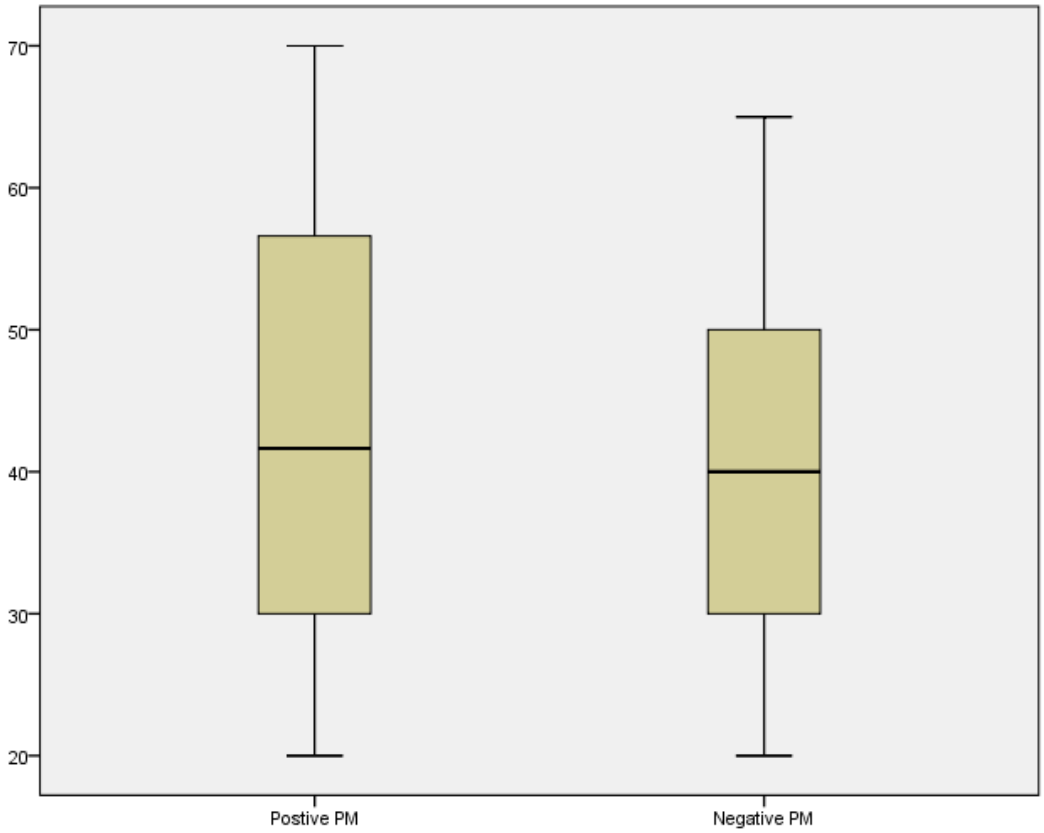


Figure 3. Overall shooting performance (Positive and Negative PM).

Note. No significant performance difference between groups (p = .76)

APPENDIX A

REVIEW OF LITERATURE

Psychological Momentum in Sport

Psychological momentum (PM) is constantly mentioned as an important factor that contributes to the final score. PM is defined as “an added or gained psychological power that gives the person a feeling that he/she has an edge over the opponent” (Iso-Ahola & Mobility, 1980). Although previous research has provided models for PM and supported a momentum-performance relationship in cycling (Briki, Den Hartigh, Markman, Micallef, & Gernigon, 2013; Perreault, Vallerand, Montgomer, & Provencher, 1998), golf (Livingston, 2012), hockey (Gayton, Very, Hearns, 1993), and volleyball (Miller & Weinberg, 1991), it has failed to show this relationship consistently across all sports. Furthermore, there is a lack of research regarding how psychological momentum plays a role in performance.

Early Studies

In one of the first empirical studies done on PM, Iso-Ahola and Mobility (1980) looked at how performance was affected by past performance in a racquetball tournament. In this study, archival data collection was utilized in order to determine the role of momentum in the outcome of a match. One hundred and thirty-four matches were analyzed and included both men and women. The results indicated that 86.6% of the game 1 winner’s eventually won the match. Additionally, when the match went to a decisive game 3 (i.e., when each player had no momentum since each had won a game) match winners were split equally between game 1 and 2 winners. Similar results were found in a study with collegiate tennis players, but the authors interpreted the results differently. In the study done by Silva, Hardy, and Crace (1988), a three-year longitudinal data analysis was used to determine the role of PM on performance.

Findings suggested that positive (i.e., winning leading to winning) and negative (losing leading to losing) momentum were visible. However, when games went three sets, and set two was won by way of tiebreaker, no differences in outcome were found. Thus, an athlete was no more likely to win after having come from behind after losing set 1 and winning in a high-pressure situation in set 2. Two arguments could be made, one as suggested by Iso-Ahola and Mobility (1986) which posits neither athlete has a PM advantage because each has won the same amount of sets and therefore each is as likely as the other to win the final set. Alternatively, it could be argued that PM was present when coming from behind in a highly dramatic way but played a negligible role in the final outcome. The second explanation suggests that the only reason significant findings were seen in the momentum-performance relationship were due to the differences in ability between competitors. Further, this explanation suggests that the momentum-performance relationship is empirically unfounded in sport, a somewhat common research stance.

In an early study looking at the “hot hand” effect (i.e., which suggests that an athlete is more likely to make a field goal or free throw shot after having made one on the previous attempt) in basketball, Gilovich, Vallone, & Tversky (1985) found that the hot hand effect was statistically unfounded. They proposed that the commonly held belief of PM is simply a “cognitive illusion”. This same finding has been shown in a lab study looking at performance on a novel motor task (Silva, Cornelius, & Finch, 1992). In this study, students were given the impression that they were competing against a peer in an unfamiliar motor task. Each participant was updated on the score at the end of each set, much like a tennis match. However, neither participant was aware that the

scores were manipulated to help promote perceptions of positive and negative PM. The findings indicated that as a result of being told the score update, participants who were trailing reported having negative PM, whereas those who were told that they were in the lead reported positive PM. This suggests that the score does affect people's perception of PM. However, when looking performance, defined as successful attempts and amount of errors, no significant differences were found between those experiencing positive PM and negative PM, which supported the "cognitive illusion" stance. This was supported more recently by Mack, Miller, Smith, Monaghan, and German (2008) in a study looking at how outcome was effected by previous match results. In this study, 105 participants volunteered to partake in a best of three (one-on-one) shooting competition. After each game participants were asked about their PM perceptions. The authors found that winning and losing strongly affected perceived PM. Unfortunately, how changes in PM affected future performance was not examined. These early studies were important in that they provided an early framework for the momentum-performance relationship. More importantly, they highlight the issues and inconsistencies that remain in the current literature. In order to fully understand this complex phenomenon, a more controlled and methodologically sound approach must be utilized.

Current Research

Recent literature on the momentum-performance relationship has expanded on the findings mentioned previously by using a more controlled, laboratory designed approach. Two unique studies investigating the effect of PM on cycling performance were able to capture the complexity behind the PM phenomenon.

In hopes of determining the relationship between performance and perceived PM, Perreault et al. (1998) had participants compete in a cycling competition. In this 12-minute competition, participants experienced no momentum or positive momentum and were analyzed on their exerted effort. Furthermore they were asked to recall how they felt at two and a half minute intervals throughout the race in regard to momentum. The findings showed that individuals who reported experiencing positive momentum exerted more effort than those experiencing no momentum. Additionally, they found that going from a positive momentum state to a no momentum state leads to better performance in what they termed “positive inhibition”. Although the concept is counterintuitive to the original understanding of the momentum-performance relationship, the idea behind this finding is that in the process of resisting failure, effort levels increase. This lab study was one of the first to look at momentum in a competitive setting were high effort typically leads to better performance (i.e., cycling).

In a follow up study done by Briki et al. (2013), cyclists competed against one another in a similar fashion. However, instead of only experiencing positive and no momentum conditions like Perreault et al. (1998), each of the 18 highly trained cyclist experienced negative, positive, and no momentum conditions during an hour long competition. Negative, positive, and no momentum were defined as being behind by 16 seconds, ahead by 16 seconds, and tied, respectively. Additionally, instead of having to retrospectively think about how they felt during each moment of the competition, each cyclist was asked questions about PM throughout the course of the competition, which limited error in judgment. The findings were similar to Perreault et al. (1998) in that participants who experienced negative PM exerted more effort than those in a positive

momentum state, which indicated that PM could elicit a failure avoidance drive that increased performance. Briki et al. (2013) add that negative PM is stronger than positive PM because negative PM lasts longer and occurs more quickly than positive PM. It was not until the negative PM state became so extreme and losing had become inevitable that a helplessness effect occurred and effort decreased as a result.

Together, these studies supported the idea that performance is affected by changes in PM in certain conditions. In addition, by using a more controlled approach, the findings were more reliable and valid. Future research in this area should try to replicate the methodology used by Briki et al. (2013) and Perreault et al. (1998) in other sports to determine how the type of competition may influence the impact PM makes on performance.

PM Models

To help better understand how PM and performance interact, a few models have been constructed. Vallerand, Colavecchio, and Pelletier (1988) came up with a model named the Antecedents-Consequences Model of Psychological Momentum. This model helped distinguish between PM causing an increase in performance and the successful performance creating a sense of gained PM. By separating the causes and effects of PM, it allows for a better representation of the underlying mechanisms playing a role by allowing researchers to test particular variables within the model and their impact on performance. This model suggests that positive PM is “a perception that the actor is progressing toward his/her goal” (Vallerand et al., 1988, p. 94). This perception is generally associated with increased motivation, control, confidence, and energy. The

same changes in affect can be seen in individuals experiencing negative PM only in the opposite direction.

Another distinction of this model is that PM perceptions are influences by a combination of situational variables and personal variables. For situation variables, things like previous plays within the game, current score, recent stoppages in play, or crowd noise can dictate when and to what degree momentum plays a role. For example, a series of made three-point attempts to take the lead will have a far greater impact on PM perception than if the same series of shots were made and the team was already up by 50 points. Similarly, experience, ability, competitive anxiety, and need for control are personal variables that would affect the extent to which PM is a contributing factor in performance outcome. It has been suggested that experience level contributes to whether or not someone perceives PM as being a factor in performance. In looking at how experience contributes to belief in the impact of PM on performance, Miller and Weinberg (1991) found that only low-skilled volleyball players thought that PM influenced performance.

Finally, as a result of personal and situational variables creating changes in PM perceptions, it is suggested that a change in performance can be seen. It is important to note, the extent of the performance gains are dependent on contextual variables, such as the nature of the task. Previous research suggests that PM may play a bigger role in high arousal sports, such as cycling (Briki et al., 2013; Perreault et al., 1998) and less of a role in lower arousal tasks (Miller & Weinberg, 1991). The Antecedents-Consequences model adds greatly to the literature but further studies are needed to

determine which factors play the largest role in changes in performance outcome and which factors play a negligible role.

Another model of psychological momentum was proposed by Taylor and Demick (1994). Their model was an extension of the Antecedent-Consequences model by Vallerand et al. (1988) called the Multidimensional Model of Momentum in Sport. In this model, Taylor and Demick (1994) define PM as “a positive or negative change in cognition, physiology, affect, and behavior caused by a precipitating event or series of events that will result in a shift in performance” (Taylor & Demick, 1994, p. 51). The model suggests that there are seven stages to the “momentum chain”. The first stage is a precipitating event. For example, after trailing for most of the half, a player gets a steal on one end of the court, which then leads to a successful three-point attempt on the other end. This initial success then leads to a change in cognition, affect, and physiological state, which comprise of stages two through four, respectively. The fifth stage is a change in performance consistent with the previous changes. This change is followed by the same changes to cognition, affect, and physiological state for the opponent, except in the opposite direction. Finally, there is a change in the outcome as a result of the previous stages of change. This seven stage “momentum chain” model is a significant addition to previous research in that it allows for adequate measurement and validation of each portion of the model. Unfortunately, the model is still in need of support through empirical testing.

Summary

Past research on PM in sport has been inconsistent and inconclusive, which can be largely attributed to poor research design and methodology. Thus, more recent

literature has improved the design and methods used to study PM. As a result more reliable findings have been shown and models describing how the momentum-performance relationship may work have been produced. However, there is still a large amount of contradicting evidence as a result of the complexity of this phenomenon. Future research, specifically, laboratory studies with high internal validity, are needed to better understand if and how PM and performance relate.

APPENDIX B

INFORMED CONSENT

University of North Texas Institutional Review Board

Informed Consent Form (Extra Credit)

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

Title of Study: The Effects of Perceptions and Strategies on Basketball Shooting Performance

Investigators: Connor Harris, University of North Texas (UNT) Department of Kinesiology, Health Promotion, and Recreation. Supervising Investigators: Scott Martin, Ph.D., Whitney Moore, Ph.D., Allen Jackson, Ed.D., UNT Department of Kinesiology, Health Promotion, and Recreation.

Purpose of the Study: You are being asked to participate in a research study that will examine perceptions and strategies used during a basketball shooting competition.

Study Procedures: By participating, you will be completing a couple of questionnaires. Additionally you will be required to complete two shooting tasks consisting of fifty shots each. The two sessions will be separated by one week and each session will last about 30-45 minutes. All of your information will be confidential and anonymous.

Foreseeable Risks: Overall, there are limited risks by participating in the study. Because this study involves a basketball, shooting competition, the potential risks could include injuries related to physical activity.

Benefits to the Subjects or Others: This study will benefit you, the participant, by providing you with an opportunity to compete against another student of equal ability for the chance to win a monetary prize. Additionally, I hope the information gathered from this study will help better understand how to improve athletic performance in competitive settings.

Compensation for Participants: Each of the participants who win the shooting competition will be entered into a random drawing for one of five gift cards to various sporting goods stores. The drawing will take place at the conclusion of the experiment and participants will be notified via email with the results of the drawing. Additionally, your professor has agreed to give extra credit for participating. To receive your extra credit you will need to provide proof that you have participated in the study. Proof of completion will be provided in the form of an email that will be sent after the study. Your professor will provide an alternative extra credit opportunity that requires the same amount of time and effort for the students who did not participate or complete the study.

Procedures for Maintaining Confidentiality of Research Records: Your personal information as it relates to the study will be coded with numbers so that individual information will remain anonymous. Your assessment results and the data related to the study will be stored in a locked office. The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.

Questions about the Study: If you have any questions about the study, you may contact Connor Harris at connor.harris@unt.edu, Dr. Scott Martin at scott.martin@unt.edu, or Dr. Whitney Moore at whitney.moore@unt.edu.

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

Research Participants' Rights:

Your signature below indicates that you have read or have had read to you all of the above and that you confirm all of the following:

- Connor Harris has explained the study to you and answered all of your questions. You have been told the possible benefits and the potential risks and/or discomforts of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- Your decision whether to participate or to withdraw from the study will have no effect on your grade or standing in this course.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You have been told you will receive a copy of this form.

_____
Printed Name of Participant

_____
Signature of Participant

_____
Date

For the Investigator or Designee:

I certify that I have reviewed the contents of this form with the subject signing above. I have explained the possible benefits and the potential risks and/or discomforts of the study. It is my opinion that the participant understood the explanation.

_____

Signature of Investigator or Designee

_____

Date

APPENDIX C

PM QUISTIONNAIRE

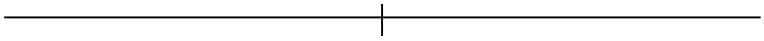
Mark you answer with one vertical line indicating where your answer choice falls on the continuum.

1) At this point in the competition, who has the most momentum?

My Opponent Neither Myself

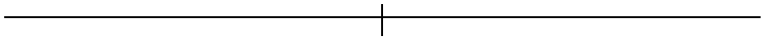
2) At this point in the competition, who seems to be most confident?

My Opponent Neither Myself



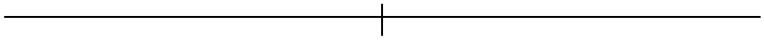
3) At this point in the competition, who seems to be most motivated?

My Opponent Neither Myself



4) At this point in the competition, who seems to progress most toward victory?

My Opponent Neither Myself



5) At this point in the competition, who is feeling the most pressure?

My Opponent Neither Myself

6) At this point in the competition, who is the most worried about the outcome?

My Opponent Neither Myself

APPENDIX D

DEMOGRAPHIC SURVEY

1) Age

_____years old

2) Sex (mark one box)

☐ Male or ☐ Female

3) Please indicate by circling the highest level of basketball that you have participated in:

Recreational (Ex. YMCA, City League, etc.)	NAIA
	Division 3
Junior High	Division 2
High School	Division 1 – AA
AAU	Division 1 – A
Community College	Other _____

3) Please indicate by circling how many shots you think you will make from behind the 3-point line with the understanding that you will be shooting from 5 different spots on the court and you will move from one spot to the next shooting 10 shots total.

1 out of 10	6 out of 10
2 out of 10	7 out of 10
3 out of 10	8 out of 10
4 out of 10	9 out of 10
5 out of 10	10 out of 10

APPENDIX E

SHOOTING COMPETITION INSTRUCTIONS/SCRIPT

Based on your past shooting performance you have been included in a study, on how a competitive setting facilitates or hinders performance over time. You have been paired with a person who has played at the same level as you and answered that they would shoot the same percentage on 3-point shots as you did. You will complete 50 shots from 5 different locations. After 10 shots you will be updated on the current scores of you and your opponent. For example, if you made 1 more shot than your opponent in the first round I will tell you that you are ahead by 1 shot. Directly before the competition and after updating the score on each of the first 4 rounds, you will fill out the questionnaire on the table. You will complete a total of 5 questionnaires, before the first round and 1 after each of the first 4 rounds. You will indicate how you feel by marking somewhere on the line between “my opponent” and “myself”. Due to difficulty with scheduling, the person you are competing against has already participated and I have their scores with me. You are both competing with the same ball and you are shooting at the same basketball goal to ensure that the competition is as fair as possible. Remember, the person you are paired with is equal in ability having made the same amount of shots in pretrial and predicting the same amount of shots made out of 10 on the pretrial questionnaire. In order to be eligible to win the gift cards you will need to defeat your opponent. Do you have any questions for me before we get started?

APPENDIX F

POST-EXPIREMENT SURVEY

Please describe your experience throughout this competition.

How did it feel when you were leading (if applicable)?

How did it feel when you were trailing (if applicable)?

How did it feel when you were tied (if applicable)?

What round do you feel you performed best during? Explain your emotions during that round.

Describe your overall experience during the study

REFERENCES

Amorose, A. J., & Horn, T. S., (2000). Intrinsic motivation relationships with collegiate athletes' gender, scholarship status, and perceptions of their coaches' behavior. *Journal of Sport and Exercise Psychology, 22*, 63-84.

Briki, W., Den Hartigh, R. R., Markman, K. D., Micallef, J., & Gernigon, C. (2013). How psychological momentum changes in athletes during a sport competition. *Psychology of Sport and Exercise*, *14*, 389-396. doi:10.1016/j.psychsport.2012.11.009

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Couper, M., Tourangeau, R., Conrad, F., & Singer, E. (2006). Evaluating the effectiveness of visual analog scales. *Social Science Computer Review, 24*, 227-245. doi:10.1177/0894439305281503

Gayton, W. F., Very, M. & Hearns, J. (1993). Psychological momentum in team sports. *Journal of Sport Behaviour*, *16*, 121-123.

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

Guenthner, S., & Hammermeister, J. (2007). Exploring relations of wellness and athletic coping skills of collegiate athletes: Implications for sport performance. *Psychological Reports, 101*, 1043-1049. doi:10.2466/pr0.101.4.1043-1049

Iso-Ahola, S. E., & Blanchard, W. J. (1986). Psychological momentum and competitive sport performance: A field study. *Perceptual and Motor Skills*, *62*, 763-768.

Iso-Ahola, S. E., & Mobily, K. (1980). "Psychological momentum": A phenomenon and an empirical (unobtrusive) validation of its influence in a competitive sport tournament. *Psychological Reports*, *46*, 391-401.

Jackson, S. A., & Csikszentmihalyi, M. (1999). *Flow in sports*. Human Kinetics.

Kerlinger, F. N. (1964). *Foundations of behavioral research*. New York: Holt, Rinehart & Winston.

Livingston, J. A. (2012). The hot hand and the cold hand in professional golf. *Journal of Economic Behavior & Organization*, *81*, 172-184. doi:10.1016/j.jebo.2011.10.001

Mace, F. C., Lalli, J. S., Shea, M. C., & Nevin, J. A. (1992). Behavioral momentum in college basketball. *Journal of Applied Behavior Analysis*, *25*, 657-663. doi:10.1901/jaba.1992.25-657

Mack, M. G., Miller, C., Smith, B., Monaghan, B., & German, A. (2008). The development of momentum in a basketball shooting task. *Journal of Sport Behavior*, *31*, 254-263.

Miller, S., & Weinberg, R. (1991). Perceptions of psychological momentum and their relationship to performance. *The Sport Psychologist, 5*, 211-222.

Perreault, S., Vallerand, R. J., Montgomery, D., & Provencher, P. (1998). Coming from behind: On the effect of psychological momentum on sport performance. *Journal of Sport & Exercise Psychology*, *20*, 421-436.

Roane, H. S., Kelley, M. E., Trosclair, N. M., & Hauer, L. S. (2004). Behavioral momentum in sports: A partial replication with women's basketball. *Journal of Applied Behavior Analysis*, *37*, 385–390. doi:10.1901/jaba.2004.37-385

Schwarz, N., Knäuper, B., Hippler, H., Noelle-Neumann, E., & Clark, L. (1991). Rating scales: Numeric values may change the meaning of scale labels. *The Public Opinion Quarterly*, *55*, 570-582.

Silva, J. M., Cornelius, A. E., & Finch, L. M. (1992). Psychological momentum and skill performance: A laboratory study. *Journal of Sport & Exercise Psychology, 14*, 119-133.

Silva, J. M., Hardy, C. J., & Crace, R. (1988). Analysis of psychological momentum in intercollegiate tennis. *Journal of Sport & Exercise Psychology*, *10*, 346-354.

Smith, R., Schutz, R., Smoll, F., & Ptacek, J. T. (1995). Development and validation of a multidimensional measure of sport-specific psychological skills: The athletic coping skills inventory-28. *Journal of Sport & Exercise Psychology, 17,* 379-398.

Stanimirovic, R., & Hanrahan, S. J. (2004). Efficacy, affect, and teams: Is momentum a misnomer? *International Journal of Sport and Exercise Psychology*, *2*, 43-62. doi:10.1080/1612197X.2004.9671732

Taylor, J., & Demick, A. (1994). A multidimensional model of momentum in sports. *Journal of Applied Sport Psychology*, *6*, 51-70. doi;10.1080/10413209408406465

Vallerand, R. J., Colavecchio, P. G., & Pelletier, L. G. (1988). Psychological momentum and performance inferences: A preliminary test of the antecedents-consequences psychological momentum model. *Journal of Sport & Exercise Psychology*, *10*, 92-108.

Vergin, R. C. (2000). Winning streaks in sports and the misperception of momentum. *Journal of Sport Behavior*, *23*, 181-197.

Wanzek, J. S., Houlihan, D. D., & Homan, K. J. (2012). An examination of behavioral momentum in girl's high school volleyball. *Journal of Sport Behavior*, *35*, 94-107.