ABSTRACT

Title of Document: MAKING THE CUT: PSYCHOLOGICAL MOMENTUM ON THE PGA TOUR

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Psychological Momentum on the PGA Tour was investigated. Psychological Momentum is theorized to be a force that arises from early success in an athletic competition that provides an advantage to the participant. It is defined as "an added or gained psychological power that changes a person's view of himself or others." The present research sought to determine whether early success in golf translated into Psychological Momentum and led to further success upon the golf course. This research proposed that differences among golfers at the elite level cannot be explained by customary statistical variables and is theorized to be psychological in nature.

The research was conducted on two levels, in two studies. The first study addressed the presence of Psychological Momentum from week to week, between tournaments, over the course of the PGA Tour season. Cuts made, Top 10, Top 20, and Top 30 finishes were examined to determine if non-random patterns existed. The data supported the construct of Psychological Momentum indicating non-random patterns of successive outcomes for "cuts made," "Top 10 finishes," "Top 20 finishes," and "Top 30

finishes. Discussion focuses on post-hoc analyses of the data grouped into quintiles in order to discern where the differences may exist.

The second study addressed Psychological Momentum within tournaments. Each tournament throughout the season was examined to determine how first round performance affected making the cut. Tournaments also were analyzed from round to round to determine how each round affected subsequent rounds, and within each round to determine how nine-hole totals affected subsequent nine-hole totals. Both gross scores and adjusted scores were analyzed.

The data revealed mixed results regarding the presence of Psychological Momentum within tournaments. There was strong support for the theory evidenced by first round influence (early success) upon subsequent rounds, as well as its influence upon making the cut. The data were mixed when comparing nine-hole totals within rounds and between rounds. Discussion focuses on the evidence supporting the theory and possible explanations for the data that do not.

MAKING THE CUT: PSYCHOLOGICAL MOMENTUM ON THE PGA TOUR

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Table of Contents

List of Tables

Introduction

The word "momentum" is one of the most widely used terms in sport. It is not only used in sport, but is also used in politics, and financial markets, for example. Cutting across many aspects of life, momentum seems to be commonly accepted as some wave of influence that determines what is to come next. If momentum exists, then how is it manifested and what are the factors that bring it about?

A Belief in Psychological Momentum

In sport, it would be almost impossible to find a broadcast of a game or event in which the commentators or analysts don't use the term. Momentum seems to be ubiquitous in sporting contests—even to the extent that it is accepted as an explanation for what happens. Gilovich, Vallone, and Tversky (1985) found strong evidence that people believe in the concept of momentum. One hundred avid basketball fans were queried regarding their belief toward sequences of shots. Their responses indicated that 91 percent believed that a player who had made his or her previous two or three shots was more likely to make his or her next shot than a player who had missed his or her previous two or three shots. Eighty-four percent of these fans believed that "it is important to pass the ball to someone who has just made several shots in a row" (Gilovich, et al., 1985, p. 298.) These numbers indicate a very strong belief, or perception, that what has just occurred is a predictor of what is to occur next.

Markman and Guenther (2007) also found strong support for the perception of momentum. To assess the existence of the perception of momentum, university students watched a basketball game that had been previously played and recorded. An association between what Markman and Guenther describe as "positive velocity" and "positive momentum" was found by 95 percent of participants. This association between positive velocity, or success, and momentum, further revealed that 75 percent of these participants believed that this perceived momentum would even predict the eventual winner.

Markman and Guenther (2007) also found that momentum occurred most strongly in contexts that were most meaningful. In a study comprised of university students, the researchers presented a description of a hypothetical basketball scenario in which a team was competing for a playoff spot and scheduled to play either a team that represented an "intense and long-standing rivalry," or another team in their division, which represented no such rivalry. According to Markman and Guenther, the scenario or situation that produced "psychological mass", such as the presence and significance of a rivalry, yielded the greatest perceived momentum and greatest perceived likelihood of attaining a goal.

To further explore how individuals conceptualize momentum, Markman and Guenther (2007) asked participants to define momentum as it related to sport or athletics. Sample responses included: "Momentum is the force that gives players the mindset of being successful; momentum is the psychological pendulum that swings back and forth between competitors giving one competitor the edge, and is caused by big plays; momentum is a force that is lost or gained that can have considerable positive or negative effect on the players and play of the game.” (p. 804)

One study, in apparent disagreement with the prevailing consensus on the perception of momentum, asked spectators to indicate when they thought momentum occurred in a sporting event. Burke, Edwards, Weigand, and Weinberg (1997) asked spectators or observers to watch a videotaped tennis match or basketball game and indicate when they thought momentum began, and when they thought momentum ended. There was very little agreement by the observers as to the starting point and ending point of momentum, both in the individual sport (tennis) and the team sport (basketball). It may be that the perception of momentum is a highly subjective experience of the individual athlete and, as such, very difficult for observers to accurately, or uniformly detect.

This explanation would suggest that the methodology for studies interested in the perception of momentum must ask the athletes themselves, and not the spectators, as to their individual assessment of the situation. The difficulty in detecting momentum in an athletic event lies in the researcher’s ability, or limitation, to intervene during an event to obtain firsthand information directly from the participating athlete. In summarizing their findings Burke, et al., (1997) suggest: “Given these results, it is plausible to suggest that for spectators momentum is simply a post hoc explanation for events that already have occurred. In essence, it may be that only after seeing the outcome of a particular play or point does the play take on the label of a momentum event.” (p. 91)

Why do we cling to the idea of momentum in sports? What reason do we have to believe that momentum exists and influences those who compete in athletic events? Is there any basis to believe that individuals or teams that have the momentum are more likely to win? There is a prevalent opinion among athletes, analysts, and others that this force exists and impacts athletic outcomes. What is momentum?

Psychological Momentum Defined and the Premise of Early Success

The term Psychological Momentum has been introduced in order to describe the phenomenon believed to exist in athletic performance where a participant or team benefits from early success achieved in a competitive setting (Iso-Ahola & Mobily, 1980). Early success is believed to convey a psychological advantage or power that translates into an increased likelihood for subsequent success.

Iso-Ahola and Mobily (1980) presented the original concept of Psychological Momentum and defined it as "an added or gained psychological power that changes a person's view of himself or of others or others' view of him and of themselves" (p.392). According to them, success in athletic competition modifies perceptions that are held by both competitors. The successful competitor is likely to experience increased self-confidence, improved attention and concentration while increasing their amount of mental and physical effort exerted. The unsuccessful competitor, according to the original conception of Iso-Ahola and Mobily (1980), is likely to experience a concurrent erosion of self-confidence and an undermining of physical and mental effort. Thus, the mechanism by which Psychological Momentum operates is through a process of changed perceptions that the athlete maintains regarding himself, his competitors, and the competitive situation—all based upon early success or lack of early success. That these perceptions change drastically after early success was clearly supported by the data reported by Iso-Ahola and Blanchard (1986). The influence that Psychological Momentum exerts occurs as the athlete makes appraisals of the performance scenario he or she is engaged in, and as those appraisals change and fluctuate along with the performance outcomes.

Athletes in competitive settings often speak of having some positive beliefs or attitudes stemming from their early successes that they believe will carry them to future successes in their endeavors. Early success is the premise upon which Psychological Momentum operates. In sport, early success refers to the desired outcome an athlete is seeking such as taking the first few games in a tennis match, the birdies made by a golfer beginning his round, or the early inning strikeouts a pitcher achieves in a baseball game. All of these outcomes lead the athlete toward his/her ultimate goal of winning. Success, in accomplishing one's objectives early in a sporting scenario, conditions the athlete to believe in future success. It is an associative learning process by which the athlete observes her or his behavior leading to a desired outcome and concludes that this process will be repeated as the match, or round, or game continues and will ultimately lead to victory, triumph or a win. As Iso-Ahola and Mobily (1980) state, "(the athlete) thinks that if his performance is similar to the previous one he will probably beat the opponent." (p. 391)

In short, Psychological Momentum arises from early success and is manifested in the athlete in several ways. It is through psychological effects, or manifestations, that Psychological Momentum is identified and operates.

How Psychological Momentum is Manifested

Iso-Ahola and Blanchard (1986) note that early success in athletic competition yields several important psychological effects to the individuals. In a study with competitive racquetball players, it was found that participants who were queried after having won the first game of a match reported (1) a greater likelihood of winning the second game as well as the entire match, (2) being superior in ability to their defeated opponent, (3) greater confidence in their ability and experience needed to win the subsequent game as compared to those who had lost the first game.

Iso-Ahola and Blanchard (1986) comment that "it is important to stress that success breeds success only if it gives psychological momentum and advantage to the better performer . . . when the early successful performer is able to utilize his success by grasping psychological momentum, he significantly improves the likelihood of winning the contest." (p. 767) The perception of momentum is essential in order to attain any performance advantage. Iso-Ahola and Blanchard (1986) hypothesized that the increased confidence documented in their study improves a competitor's mental performance which, in turn, improves their physical performance: "It is logical to expect that improved mental performance makes it possible for a competitor to augment physical effort and performance with the end result of a significant increase in the likelihood of winning." (p. 767)

Iso-Ahola and Blanchard (1986) suggest an additional mechanism by which Psychological Momentum may exert an influence upon performance. In competition that is "face-to-face," where competitors are in direct and exclusive competition with each other, the competitor who attains Psychological Momentum probably does so at the expense of his or her competitor. According to Iso-Ahola and Blanchard (1986), "early success may have double effects: it gives psychological momentum to the winner and simultaneously puts the loser at a psychological disadvantage. The fact that psychological momentum improves the winner's subsequent performance makes it harder for the loser to 'come back' and take psychological momentum away. It is therefore understandable that the early winner's likelihood of winning the entire contest increases considerably, while that of the early loser declines drastically." (p. 766)

Could Psychological Momentum be an explanation for athletic successes that may be better, or more simply explained, by athletic ability? That is, it would be expected, as some studies have found, that players or competitors who win the first game in a match would go on to win the next game or subsequent games in a match, simply because they are more talented or have greater ability.

Iso-Ahola and Blanchard (1986) discuss the effects of ability on winning. In their study of competitive racquetball players, the competitors were categorized, according to ability, from highest ability (Level A), to medium ability (Level B), and lowest ability (Level C). The researchers hypothesized that the effects of ability would be greatest among the lower ability groups, suggesting that at the higher levels of skill, competitors are often more evenly matched. When competitors are more evenly matched, potential effects of ability decrease while the effects of psychological factors, such as momentum, increase. That is, at the highest level of competition, athletes are very similar in skill and physical capabilities. As such, the difference or discrepancy between competitors, the advantage one athlete attains over another, lies in the psychological and situational factors that exist. As Iso-Ahola and Blanchard (1986) reported that "the effect was as high in the A group as among the C players and even higher in the A than in the B class." (p. 767) This is the opposite effect of what would be expected if ability were the explanatory factor. Accordingly, Psychological Momentum, rather than ability, would explain the differences.

Iso-Ahola and Blanchard (1986) also looked at the data involving tiebreakers. A tiebreaker would be played when one player had won the first game and the other player had won the second game. In this case the authors hypothesized that the players are evenly matched based upon their performance. If ability were used to explain who would win the tiebreaker, one would expect that the game 1 winner would win the tiebreaker half of the time, and the game 2 winner would win the tiebreaker half of the time. The data showed game 1 winners more likely to win the overall match than game 2 winners. Iso-Ahola and Blanchard state, "the results can, to a substantial extent, be explained in psychological terms. . . critical is what the outcome does to the competitors psychologically. Cognitive representation of the outcome plays a critical mediating role and determines whether competitive success is turned into psychological momentum and then into continued success." (p. 768)

The Effects of Psychological Momentum on Performance

Does Psychological Momentum truly affect performance as is popularly believed? Many studies have been conducted that have found support for the effect of Psychological Momentum on performance.

Iso-Ahola and Mobily (1980) looked at archival data from a competitive racquetball tournament and found that players who won their first game were likely to go on to win the entire match. Iso-Ahola and Blanchard (1986) also examined competitive racquetball players and found that in a tournament, more than seventy percent of the players who won the second game, had also won the first game. Silva, Hardy, and Crace (1988) found evidence of Psychological Momentum in intercollegiate tennis. Ransom and Weinberg (1985) found that among elite tennis players, as defined by world ranking, the majority of players who won the first set went on to win the entire match. Perreault, Vallerand, Montgomery, and Provencher (1998) elicited a positive momentum scenario with cyclists, who were provided feedback that informed them that after initially trailing in a race, they had subsequently regained the lead. Given this belief in their success, the cyclists then pedaled faster and outpaced their counterparts in a non-momentum scenario. Recent research by Gray and Beilock (2011) further supports the premise of early success leading to future success. In a study examining hitting in baseball and the common notion that "hitting is contagious," they found a stimulus presented to hitters, an inducing prompt that was a successful hit, had a positive effect on subsequent success.

An extensive and compelling examination of the effect of Psychological Momentum on performance was done by Jackson and Mosurski (1997). The authors employed statistical models using data from the 1987 and 1988 Wimbledon and U. S. Open tennis tournaments. The authors summarized their quest as being "concerned with contests between individuals that are decided not by a single trial but by a series of trials and the dependency structure that may exist between trials in such contests." (p. 27) The authors examined data collected from best-of-five tennis matches in which a competitor needs to win three sets in order to win the overall match. They suggested that this competition structure provides a good opportunity to examine whether the probability of winning each set remains the same throughout a match, that is, whether the sets are independent. Or, whether the probability of winning a set changes as the match progresses. Changing probability, as the match progresses, would indicate the presence of a dependency structure and could suggest the existence of Psychological Momentum.

To investigate the dependency structure that might exist, Jackson and Mosurski (1997) employed four models that could be applied to the data. The authors determined which model or models best fit that data and, as such, provided the best explanation of the outcomes.

The first model introduced was one of simple independence and suggested that the probability of winning a set in a match remained the same throughout the match. Each set had the same probability.

The second model introduced the odds of winning a subsequent set based upon having won the previous set. This model is said to represent Psychological

Momentum since the outcome of the previous set was used in the prediction for the subsequent set.

The third and fourth models incorporated the possibility of random effects. Jackson and Mosurski (1997) noted that the presence of a dependency structure, such as Psychological Momentum, does not exclude the possibility of a random effect that might also indicate a dependency structure and explain the data. The random effect that is introduced into the third and fourth models is player ability as it fluctuates from day to day. World ranking is used to assess overall ability and is noted by the authors to be accepted as “a fair and reasonably accurate guide to the relative merits of the tournament players” (Jackson and Mosurski, 1997, p. 29). As such, an assumption is made regarding overall tennis ability while the fluctuations that may occur, from one day to another day, are addressed.

Jackson and Mosurski (1997) explained that it is plausible that when one opponent triumphs convincingly over another, what they described as a “heavy defeat,” it may be a result of ability rather than momentum. In fact, the authors acknowledged that, in sport, there are often heavy defeats, and even reversals of such heavy defeats (a player winning in straight sets one day only to lose in straight sets the following day) that could be accounted for by fluctuations in ability from day to day, while ability on any given day remains constant.

In order to evaluate the tennis data and account for the possibility of the effect of fluctuating ability, the third model tested was the model of independence with a random effect. To complete the analysis, the fourth model tested was the model of Psychological Momentum with a random effect for fluctuations in player ability from day to day. By adding the possibility of random effects to the analysis, the authors sought to determine whether it was possible to "rescue the concept of independent sets." They asked: "In other words, can we produce an independence model that is comparable to Psychological Momentum as an explanation of these data . . ." (p. 31.)

Jackson and Mosurski (1997) concluded that there exists a dependency structure in the tennis data that is best explained by score or winning, that is, the model incorporating Psychological Momentum. This model, also referred to as the "odds model," provided a far better fit than the model of independence--even the model of independence that accounted for the random effect of ability.

Jackson and Mosurski (1997) stated: "The independence model with a normal random effect is not comparable to the odds model as an explanation of these data. The proposed model for variation in a player's ability contributes little to the overall fit, whereas the effect due to the score is substantial." (p. 32) They continued to explain their findings in support of Psychological Momentum noting that: "We have seen that the independence model with a normal random effect does not rival the odds model (Psychological Momentum) as an explanation of the data . . . It appears then that we must abandon the idea of independence. To abandon independence, however, is not to say that one must reject the common-sense idea that player ability varies from day to day, only that on its own such a model is unlikely to be successful. Whatever the contribution of random variation in a player's ability from day to day may be, our analysis suggests that psychological momentum is certainly a major factor in the outcome of matches at the Wimbledon and U.S. Open tennis tournaments." (p. 33)

The Theory of Psychological Momentum-The Model

The theory of Psychological Momentum can be represented in a model. As mentioned earlier, Psychological Momentum relies on the premise of early success. Early success leads to the manifestation of Psychological Momentum as psychological power and is reflected as increased confidence, perceived superiority over an opponent, and likelihood of winning. Psychological Momentum then leads to increased mental and/or physical effort, which in turn, leads to further success (Iso-Ahola & Mobily, 1980; Iso-Ahola & Blanchard, 1986; Hamberger & Iso-Ahola, 2005).

The Argument Against the Effects of Psychological Momentum

The argument most often made against the concept of Psychological Momentum is that this apparent phenomenon is explained equally well by chance. In other words, that what is perceived by observers as some streak of success, or failure, is really just the randomness of the way things actually occur. The reality may be that trends or patterns of seemingly significant events may only be a meaningful because of our naturally biased perception of the things that we witness.

Gilovich et al., (1985) examined sequences of shots in basketball to determine whether, or not, patterns that were detected were evidence of streak shooting, or if they were simply representative of random sequences. If making a shot increased the likelihood of making the subsequent shot, then there could be said to be evidence of a pattern or streak. If making a shot had no bearing on the outcome of the subsequent shot, then the events could be labeled a random sequence.

Data were examined from the National Basketball Association on two teams, and in one controlled experiment utilizing the men's and women's basketball teams at Cornell University.

The first analysis examined records of field goal shooting of the Philadelphia 76ers for 48 home games during the 1980-1981 season. The proposition addressed was whether a player who had just made a shot, or his last several shots, was more likely to make his next shot, as compared to when a player had missed his last shot or series of shots. Gilovich et al., (1985) found no evidence of streak shooting in these records; in fact, they noted that eight of the nine players analyzed had a lower, but not significantly lower, probability of making a shot following a hit, as compared to following a miss. This analysis would contradict any suggestion of dependency or streak shooting. Gilovich et al., (1985) came to the same conclusion after examining the free throw shooting records of the Boston Celtics during the 1980-1981 and 1981-1982 seasons and suggested that: "These data provide no evidence that the outcome of the second free throw is influenced by the outcome of the first free throw."(p. 304)

Gilovich et al., (1985) acknowledge the widespread belief in the streak, or hot hand phenomenon, among professional athletes, collegiate athletes and even observers, yet, they are unable to provide evidence to support the belief. They state that "the outcomes of both field goal and free throw attempts were largely independent of the outcome of the previous attempt. Moreover, the frequency of streaks in players' records did not exceed the frequency predicted by a binomial model that assumes a constant hit rate." (p. 309) The authors label the belief that people have in this dependency structure, or hot hand, as a "misperception of random sequences." "People not only perceive random sequences as positively correlated, they also perceive negatively correlated sequences as random." (Gilovich et al., 1985, p. 311) They conclude by stating: "If the present results are surprising, it is because of the robustness with which the erroneous belief in the "hot hand" is held by experienced and knowledgeable observers." (Gilovich et al., 1985, p. 313)

While the argument against Psychological Momentum is credible, it would be counterintuitive to deny the value in a process of trial and error that we as humans rely upon in order to survive and prosper. When we succeed, we receive powerful reinforcers that are integral to the process of learning, and we seek to repeat or replicate our success. Similarly, when we fail we encounter powerful consequences that we also evaluate as an integral part of the human learning process. The proposition that success breeds success is not only factual, but essential in describing the manner in which we test and evaluate our courses of action as active learners. Researchers' inability to statistically detect such an effect does not deny its existence.

A study by Mace, Lalli, Shea, and Nevin (1992) presents data that detected such an effect. In a correlational study involving college basketball, the authors looked at rates of reinforcement and how they impact subsequent events. If reinforcement rates correspond to following events, it may suggest that there exists a relationship, and perhaps a mechanism, such as Psychological Momentum, operating.

Mace et al., (1992) outlined how Psychological Momentum, or in their terms, behavioral momentum, may operate according to previous empirically based studies. They suggested that "to generate a high level of momentum for a specified class of behavior, arrange a high rate of reinforcement . . . " (p. 658). Their findings indicated that a high level or reinforcement prior to an adverse event led to an increase in favorable responses following the adverse event. It appears that reinforcing desired behavior led to more favorable subsequent responding. Conversely, Mace et al., (1992) found that interrupting favorable responses in a basketball game led to a reduction in reinforcement rates. According the Mace et al., (1992): "We can speculate that time-out from play may be an effective intervention for decreasing the opponent's momentum in the game." (p. 660)

The findings of Mace et al., suggest that a mechanism, such a Psychological Momentum, cannot be discounted and that it may explain the patterns we observe in human behavior, including sport. As the authors note: "The results reported here appear to disagree with the finding of Gilovich et al., (1985) . . .our data are based on team rather than individual performance, employ a different sampling period. . . and include favorable turnovers as well as points scored in estimating the reinforcer rate for the preceding period. Moreover, our interest centers on performance after the challenge of an adversity. . . They do not report these comparisons. Therefore, there is no necessary contradiction with their data." (Mace et al., 1992, p. 660)

Methodological Issues and Limitations of Existing Research

Compelling and seemingly contradictory evidence exists regarding Psychological Momentum. As referenced by the previous articles, there is both support for, and evidence against the existence of the phenomenon. Adding to the debate regarding the existence and credibility of the construct are the methodologies employed and their limitations.

A study by Albright (1993) examined hitting streaks in baseball. Records for over five hundred Major League Baseball players over the span of four years from 1987-1990 were analyzed. The author employed statistical models to determine if any of the players exhibited "streakiness" in their batting patterns that could not simply be explained by a model of randomness. The author reported that the analysis "failed to find convincing evidence in support of wide-scale streakiness. . . not a single one of these players exhibited significantly streaky behavior over the entire four-year period." (Albright, 1993, p. 1183).

The analysis performed, and conclusions reached, by Albright (1993) indicate a conceptual and methodological problem in examining Psychological Momentum. It would not be expected that Psychological Momentum would be operating over a four-year period, or even a single-year period, such as an entire baseball season. The concept of Psychological Momentum is that a competitor gains a psychological power or advantage over an opponent or situation based upon his or her early success (Iso-Ahola & Mobily, 1980). The foundational premise of early success suggests that Psychological Momentum operates within a certain contextual time frame, whereas early events influence later events. The length of this contextual time frame would be related to the particular competition and also be limited by the nature of that competition. As Hamberger and Iso-Ahola (2005) criticized the Albright study for its methodology and suggested that Psychological Momentum is a short-lived phenomenon, one that may shift from competitor to competitor, or team to team, or that may quickly rise and fall over the course of an athletic competition. By definition, one would not expect Psychological Momentum to operate over long periods of time. This is not to say that Psychological Momentum may not be present for extended periods of time, but rather, that to examine its effect over extended periods of time is beyond its conceptual definition. To examine streakiness over an entire season, or for a period of four years, would require one to establish the lasting effect or capacity of Psychological Momentum to endure throughout that entire time period.

One study has been conducted that examined the tendency of professional golfers to exhibit “streakiness” in their performance. Clark (2004) examined the 1997 and 1998 PGA Tour records and Senior PGA Tour records in order to determine whether scores reflected outcomes that could be attributed to the tendency of individual players to have streaks in their performances.

Clark analyzed 18-hole scores over the course of the entire season for both the PGA and Senior PGA Tour. He categorized scores into two groups: (1) scores of par or better, and (2) scores above par. This categorization allowed a player’s season to be represented by a sequence of 18-hole scores that were coded either as “0” for scores of par or better, or “1” for scores above par. Accordingly, a player would have a sequence, or string, that represented his or her entire season (i.e., 000110111101000111110010 11…). Clark then analyzed whether the scores of par or better, or the scores above par, within these sequences tended to cluster together.

The results supported streakiness among professional golfers. “Whether players were analyzed individually or as a group there was evidence of systematic streaks for players on both the PGA Tour and the Senior PGA Tour. There was a significant tendency for players' par or better rounds to cluster together and for players' above par rounds to cluster together." (Clark, 2004, p. 75)

In addition, Clark analyzed course difficulty, acknowledging that rounds analyzed over the entire season occurred on a variety of courses, comprising a variety of conditions. Clark examined course difficulty by utilizing the winning score for each tournament as the measure of course difficulty. Thus, the higher the winning score in a tournament, the more difficult the course was considered. Conversely, the lower the winning score in a tournament, the easier the course was considered to be.

Upon including course difficulty in his analysis, Clark found that the streakiness demonstrated by many players was related to course difficulty and could not be attributed to an inherent streakiness present in certain players. As Clark (2004) stated: "Whether players are considered individually, or as a group, the easier the course, the greater was the likelihood of a clustering of par or better rounds, and the harder the course, the greater was the likelihood of a clustering of above par rounds." (p. 76) Clark failed to adjust his scoring method as par has a different value on a difficult course than on an easy course. Par, unadjusted, should not be used as a criterion for examining clustering.

In discussing his findings, Clark (2004) noted an important implication of his findings: "If perceivers believe in the hot hand phenomenon because they fail to understand and appreciate what random sequences look like, the results of the present studies place an added burden on the observer. Since the results from Studies 1 and 2 so clearly demonstrated professional golfers to show systematic streaks in their performance, observers would be correct in concluding that the performance of professional golfers is streaky. However, observers would likely be incorrect in determining the cause of the golfers' streakiness. Given the powerful tendency of observers to prefer dispositional causes over situational causes of behavior, observers, when exposed to evidence that players are streaky, would be highly likely to ignore a situational determinant like course difficulty and attribute the cause to some inherent tendency or disposition of players to streak." (p. 76) From a social-psychological viewpoint, this would be an example of committing what is termed the Fundamental Attribution Error (Ross, 1977). This error occurs when an observer, in analyzing a situation, overestimates the impact of a person and her or his disposition, and underestimates the impact of situational variables. This powerful and omnipresent phenomenon offers insight into the process by which Psychological Momentum may be operating and maintained.

In evaluating streakiness in golfers, Clark examined 18-hole scores over two entire seasons. As Psychological Momentum is considered a short-lived phenomenon, it is unlikely that such an analysis would detect a true effect. Evaluating the sequence of scores within an individual round would be a more appropriate measure to address the phenomenon in golf, and would eliminate the confounding factor of course difficulty since the analysis would be conducted on a single 18-hole score upon a single course.

It has been suggested by Hamberger and Iso-Ahola (2005) that the contextual time frame, or "unit of analysis" is problematic in determining the impact of Psychological Momentum on performance outcomes. They point out that there are "immediate" measures of Psychological Momentum that may be chosen, such as the winner of a set in tennis or an inning in baseball. And, that there are possible measures of Psychological Momentum that would not be immediate but, rather, would examine the "end result" of a particular contest, such as winning an entire tennis tournament or a series of games in baseball. Every sport would present its own particular units of analysis. The choices an investigator makes in determining what unit to examine must reflect the conceptual and theoretical framework that defines Psychological Momentum. In order to bolster the credibility of the construct, reference should be made to the logic and process used in arriving at a particular unit of analysis.

Further, it is suggested that the unit of analysis for Psychological Momentum may be difficult to standardize. In order to draw meaningful comparisons among sports, it would be necessary to have a standard unit of measure that could be employed regardless of a sport's specific characteristics. Hamberger and Iso-Ahola (2005) state: "An issue arises when attempting to generalize findings for Psychological Momentum across sports. For instance, it has been shown that winning games in racquetball and tennis predicts match outcome. But is there an equivalent in football or baseball?" (p. 4) The nature of each athletic competition is unique in its rules, time frame, and outcomes. Thus, comparisons among sports are difficult and debatable, and drawing inferences becomes even more problematic. Discussions regarding the existence and effect of Psychological Momentum would be more tenable if a general standard, based on the conceptual definition, was present in all the literature.

Another limitation in the methodologies utilized in researching Psychological Momentum is the external validity that results from providing false feedback to subjects. Psychological Momentum is often measured by providing artificial information to participants in a study, usually information designed to bolster their sense of confidence or competitive advantage over a competitor. Following this feedback, a self-reported assessment of Psychological Momentum is done, and then a subsequent measure of performance is administered.

This was the case involving a study of Psychological Momentum in target shooting done by Kerick, Iso-Ahola and Hatfield (2000). The study evaluated cognitive, affective, and behavioral responses among participants. Perceptions of Psychological Momentum were evaluated to determine whether there was an affective mechanism through which these perceptions operate to influence performance. In order to establish a perception of Psychological Momentum, participants were provided with low, medium, and high feedback conditions regarding their shooting performance.

The researchers were successful in establishing the perception of Psychological Momentum in their participants; however, performance outcomes were not related to these perceptions. It may be that providing individuals with feedback regarding their performance differs in some content or procedural way from evaluation that is done, and arrived at, by the individuals themselves. In other words, in most sporting contexts, the participant himself is responsible for gathering, evaluating, and gauging performance. Providing evaluative feedback to participants may deprive them of an opportunity to self-regulate, which is integral to their performance success. Thus, it would be critical, however challenging, to assess athletes in their natural performance settings without disrupting the physical or cognitive activities in which they are engaged.

Another methodological issue regarding Psychological Momentum is the lack of uniformity among studies in evaluating the construct. Taylor and Demick (1994) proposed the Multidimensional Model of Momentum and argue that the body of work on momentum is plagued by studies that either 1) are not based on well-defined theory and clearly operationalized concepts, or 2) are not supported or empirically validated. They suggest the construct be defined as “a positive or negative change in cognition, affect, physiology, and behavior caused by an event or series of events that will result in a commensurate shift in performance and competitive outcome.” (Taylor & Demick, 1994, p. 54) The adoption of an operational definition of Psychological Momentum, such as this, could be useful in evaluating all research and provide greater credibility to the construct.

Psychological Momentum and Golf

Golf is a sport with unique characteristics that may provide new insight into the concept of Psychological Momentum. One of the most intriguing aspects of golf is its time frame, and the implications and opportunities that this presents to the golfer.

A typical round of competitive golf (a round refers to 18 holes played) is played over a period of approximately four hours. During that four-hour period, the time spent actually executing the golf shots can be measured in seconds. That is, if one was to add together, or sum, the total amount of time that the golfer is in contact with the golf ball, or executing the shots, that total time would amount to a matter of a few seconds. The overwhelming abundance of time that exists during a round of golf is spent on things other than executing the golf shots. This is not to say that this discretionary time is not relevant; in fact, it is this time that is essential to the success of the golfer and must be managed in a deliberate and conscientious manner.

During this discretionary time, or non-execution time, the golfer engages in an evaluative process that informs and directs her or his performance. The golfer gathers information, processes information, and plans his or her performance strategy. In professional golf, this would involve information regarding playing and course conditions, the competitive situation or the competitor's position in the tournament, and the specific, individual assessment made by the player regarding her or his current performance. This performance assessment is made repeatedly throughout the round and is modified and adapted according to the standards, expectations and demands of the golfer.

Another characteristic of tournament golf is the absence of a single, direct opponent. There exists no single adversary, but rather oneself and the golf course that the golfer must engage and manage. Many other sports provide head-to-head competitive scenarios in which the athletes engage one another and are plainly confronted with their successes and failures. The absence of a direct opponent in professional golf, combined with the discretionary time the golfer must manage, presents each competitor with the unique task of determining how successfully he or she is performing and how likely he or she is to reach his or her goals.

The golfer competing in a tournament must make judgments, or appraisals, based upon how he or she believes he or she is doing, as well as, how he or she is told others are performing. Throughout a round of golf, an individual golfer will experience the ebb and flow of the competitive scenario gathering information indirectly (absent of a direct competitor) that will direct his or her efforts. Because Psychological Momentum is established to be a short-lived phenomenon, capitalizing on its effects, perhaps even invoking its influence at a crucial time during the round of golf, would be critical to a golfer's success.

Tournament golf, on the professional level, is usually contested over a four-day period. After the first two days, or rounds of golf, a "cut" is made that reduces the field, or total number of competitors, to roughly half the original number. The players who "make the cut" are those who have performed best over the course of the first and second rounds. That is, the players who have the lowest total score for the first two days of the tournament will compete in the third and fourth rounds, thus completing the 72-hole tournament.

Making the cut is significant for professional golfers because only those who do so will earn a portion of the prize money, or purse, for the tournament. Those who "miss the cut" will have no financial earnings from that specific tournament. Throughout the professional golf season, a "money list" is kept which records total earnings for individual players and ranks them accordingly. The money list is a commonly referenced measure of a professional golfer's success as it indirectly reflects his overall performance for the season. The money list is also important because at the end of the season those golfers who rank in the top 125 on the money list will receive automatic inclusion, or exemption, to play in the following season's schedule of events or tournaments. Those who do not make the top 125 on the money list must pursue other, more limited opportunities, in order to compete the following season.

Overview of the Studies

The general purpose of this research was to increase the current understanding of the conditions under which Psychological Momentum is likely to surface and determine when it is likely to enhance performance. In order to do this, data from the Professional Golf Association Tour were analyzed. The analysis was done on two levels, in two studies, in order to evaluate performance on the macro-level, or from tournament to tournament, and on the micro-level, or within an individual tournament.

The first study looked at PGA Tour data between tournaments, from one week to the next, over the course of the entire season. The goal of this study was to determine how Psychological Momentum was operating over an extended period of time from tournament to tournament. In order to do so, an analysis was done to determine how many cuts players make in a row and whether "making the cut" occurs in sequences.

The first hypothesis was that cuts occur in sequences. Psychological Momentum theory predicts that the probability of making a cut would increase when it follows a successful cut. According to the theory, making a cut would increase the competitor's confidence and belief in his future success, which is expected to lead to a greater likelihood of making subsequent cuts.

Further, the question of how many cuts, on average, players make in a row is determined for all Top 125 players on the money list, and then, for the same players broken down into quintile groups of twenty-five players. Does the number of cuts made by players differ from what would be expected randomly?

The second hypothesis was that performance in a given week predicts performance in the subsequent week. According to Psychological Momentum, success in a given week would provide the competitor with a psychological advantage as reflected by greater confidence, superiority over the task (course), and likelihood of succeeding in the subsequent week. As discussed earlier (p. 12), the theory of Psychological Momentum proposes that a dependency structure exists, such that performance in any given week is not independent of performance in the previous week. Thus, one week's performance may be used to predict the subsequent week's performance.

The third hypothesis was that Top 10, Top 20, and Top 30 performances occur in sequences that would not be predicted by chance. Similar to the first hypothesis, the framework of Psychological Momentum predicts that the probability of success changes (increases) following a successful Top 10, Top 20, or Top 30 performance. The theory also predicts that achieving a Top 10, Top 20, or Top 30 performance increases the likelihood of a subsequent Top 10, 20, or 30 performance(s) when a competitor interprets his first success in a way that gives him confidence.

Finally, from week to week, how many "Top 10" performances (finishing the tournament in a position between 1-10) occur in a row or in sequence? How many "Top 20" performances occur in a row? How many "Top 30" performances occur in a row or sequence? Do the number of Top 10, Top 20, and Top 30 performances differ from what would be expected randomly?

The second study looked at PGA Tour data within a tournament, or within one single contest. The goal of this study was to determine how Psychological Momentum is operating over a short-term period and how it may be influencing performance. In order to investigate the role of Psychological Momentum within an individual tournament a series of analyses was conducted.

The first hypothesis was that the first round score predicts making the cut. If Psychological Momentum were operating, it would be expected that a player's first round score would increase the likelihood of making the cut after the second round. According to the theory, the first round score would be a measure of early success, the premise upon which Psychological Momentum is built. If a player interprets his first round score as a measure of early success and transforms this information into Psychological Momentum, then making the cut could be predicted by using the first round score.

The second hypothesis was that the first round performance predicts second round performance, third round performance, and fourth round performance. Further, this hypothesis stated that the second round performance predicts the third round performance and the third round performance predicts the fourth round performance. If Psychological Momentum is operating, it would be expected that performances between rounds would be correlated. Additionally, if Psychological Momentum is in effect, the correlations between rounds would be positive and significant. In terms of the theory of Psychological Momentum, a dependency structure would exist between rounds such that the probability of success in a subsequent round is dependent upon the success in a previous round. According to the theory, success in one round would provide the competitor the basis for building Psychological Momentum and enable him to succeed in the next round.

Performance was operationalized in two ways in order to account for variations in course difficulty and playing conditions. First, actual score was used to evaluate performance. Second, a rank or a finished position in a tournament was used in order to compare competitors. Utilizing ranking as a measure of performance allows meaningful comparisons to be made despite potential differences in actual score that could result, from one round to the next, due to factors such as variation in weather.

The third hypothesis was that the first round performance predicts the second round performance based upon the median score. According to the framework of Psychological Momentum, those competitors who perform better than the median in the first round (lower scores) would be more likely to perform better than the median in the second round compared to those who perform worse than the median in the first round. Because of their success, the first group would more likely have Psychological Momentum than second group, and consequently, the latter would be less likely to come back and perform better in the second round.

The fourth hypothesis was that the front nine score predicts the back nine score for all rounds, such that those who have established Psychological Momentum during their first nine holes by having early success perform better over their second nine holes than those who have not established Psychological Momentum in their first nine holes of a round. According to the theory, those competitors who achieve early success (i.e., front nine under par) would have the basis for Psychological Momentum, and could turn that early success into an advantage, thus performing better in the second half of their round (back nine) than those players who had not achieved early success.

The fifth hypothesis was that players who establish Psychological Momentum over the second nine holes of the first round perform better in the second round than those who do not establish Psychological Momentum during the second nine of their first round. The same prediction was made for the second nine holes of the third round and the subsequent final round, addressing the common notion that the third round of a tournament "positions" players, or "sets the stage" to enter the final round. Similar to the theoretical premise of the fourth hypothesis, the success achieved during the second nine holes of a round would be a measure of early success and provide the basis for Psychological Momentum to manifest itself and be carried into the next day's round. This hypothesis seeks to answer whether the effects of Psychological Momentum can carry over from one day to the next day.

STUDY 1

Study one examined the role of Psychological Momentum from one tournament to the next over the course of an entire season on the PGA Tour. The aim of this analysis was to determine if the effects of Psychological Momentum might be operating over an extended period of time from tournament to tournament. Psychological Momentum is theorized to be a short-lived phenomenon and, as such, may or may not influence performance over longer periods of time. Whether the week-to-week period is too long for the Psychological Momentum effects is tested in this study.

Psychological Momentum is inferred from non-random patterns of successes occurring within a specific statistical analysis. Several statistical analyses were conducted, each testing the null hypothesis that the outcome can be explained by chance. Each statistical analysis is based upon a specified level of early success that is theorized to lead to increased confidence, a greater belief in the likelihood of winning, and a belief that one's ability is superior to his competitor's (or Psychological Momentum) that, in turn, lead to subsequent success (non-random patterns).

Method

Participants

The data for this study were drawn from the 2008 Shotlink database that is collected by the Professional Golf Association Tour of America. Statistical information is collected on every contestant competing in each weekly event throughout the PGA Tour season. All participants are either members of the PGA Tour, individuals who are not members but have qualified for an event according to PGA Tour guidelines, or have been provided an exemption by the PGA Tour in order to play in an event. Ages of participants range from 18 years to 48 years. All participants are male.

Data Collection Procedures

The PGA Tour of America collects data at each PGA Tour event throughout the season. Data are collected, recorded, and stored under the brand name of Shotlink. Shotlink is a data collection system that was developed jointly by the PGA Tour and IBM. Shotlink was introduced at the Buick Classic in 2001 and went into standard use in 2002. Shotlink data are collected at events on the PGA Tour, as well as, the LPGA Tour and the Champions Tour. Over 100 tournaments each year use the Shotlink system.

Shotlink data exist in text files on a server to which the PGA Tour possesses exclusive rights. There are multiple directories on the server that provide varying levels of data and detail. Data can be made available to researchers and academics at the discretion of the PGA Tour.

Shotlink data are collected by two methods: hand-held devices and laser guns. Hand-held devices are carried by volunteers who walk along with each group of golfers. These walking volunteers record a golfer's every shot from what kind of lie the golfer was playing, and individual scores at the completion of each hole.

Laser guns are positioned on the course to record precise distances between players and their targets. Shotlink employs one laser on each par-3 hole, two lasers on each par-4 hole, and 3 lasers on each par-5 hole. Greenside laser operators are positioned to coordinate with hand-held devices in the fairway or on the tee. Greenside operators communicate with the hand-held operators and then transmit data to a trailer that houses the collection center, or hub.

The data that are collected are highly accurate. For example, the data from the fairway or tee are accurate to within a foot and the data on the greens are accurate to within a centimeter. In certain instances, a ball may be deeply buried within the rough and the laser operator may have difficulty pinpointing the ball. In such cases, the player is targeted by the laser operator and the accuracy is within three feet.

Approximately 250 volunteers are utilized each week, and roughly 10,000 each year, in order to collect the Shotlink data. Shotlink data received from the PGA Tour for this study was extensive. In order to address the research questions of interest, relevant data were selected for the statistical analyses (explained later). Thus, data regarding cuts, Top 10, Top 20, Top 30 performances, week-to-week performance, and 9-hole and 18-hole scores for each round were retrieved from the data set. Data were then transposed into files for SPSS analysis according to each individual hypothesis.

As previously mentioned, Shotlink data exist on a server with multiple directories containing varying dimensions and detail. For example, there exists data for each individual shot a competitor plays, as well as, data from round-to-round, and tournament-to-tournament. Similarly, there are data for a shot’s proximity to the hole, percentage of greens hit in regulation, and driving distance. In order to manage the volume of data, the original Shotlink file was broken into parts and most of the data on the server were discarded and not used for the present analyses.

Statistical Analyses

The first hypothesis of Study 1 required that the data regarding cuts were selected. These data existed for each individual player and contained scores for each round of a tournament for those who made the cut and scores for only the first two rounds of a tournament for those who did not make the cut. Since players do not play every week, it was determined that for purposes of analyzing sequences of cuts a player could not skip, or be idle for more than two weeks. Additionally, there are a few tournaments without a cut. These tournaments were omitted from the formatted data file.

To assess each sequence of outcomes (making a cut--hypothesis 1, and achieving a Top 10, Top 20, or Top 30 performance--hypothesis 3) from week to week across a full season in comparison to chance, the Runs test was employed (Zar, 1998). Since this test implicitly assumes that the overall probability of a given outcome from week to week is constant within a given performance group, it allowed the 125 fully exempt PGA Tour players to also be subdivided into five quintile groups of 25 players each for further analysis. The homogeneity of a given outcome within each group was verified by Chi-Square test of independence of the 25 rows (players) by the two outcomes (achieving or not achieving) within each category (making the cut, Top 10, Top 20, or Top 30 performance). Thus, five different Runs tests were conducted in addition to the overall Runs tests. Each Runs Test tested the null hypothesis that the sequence of each outcome variable overall, and within each quintile performance group, occurs by chance.

Schillings Longest Runs Test (Schilling, 1990) was used to determine if the mean number of cuts, Top 10 performances, Top 20 performances, and Top 30 performances could be explained by chance. The mean number of runs overall, as well as within each quintile group was analyzed.

The second hypothesis of Study 1 examined week-to-week performance. Data were selected and formatted to allow for comparisons from week to week across the season for all tournaments played by each player. The Chi-Square test for sequential independence of outcomes for a specific performance category within each quintile group, called Transition Analysis (Collins and Lanza, 2010), was employed. In this analysis, a two-by-two table of week-one to week-two performances consisting of the following outcomes was created: performance category achieved-week two following performance category achieved-week one; performance category achieved-week two following performance category not achieved-week one; performance category not achieved-week two following performance category achieved-week one; performance category not achieved-week two following performance category not achieved-week one. The data file was formatted so that quintile groups consisting of 25 players could be analyzed. The hypothesis tested by this Chi-square analysis was that the given performance category's outcome in week two is independent of that performance outcome in week one (second hypothesis).

Results

The first hypothesis tested: <u>"Cuts" occur in sequences.</u>

The Runs Test (see Table 1) shows that over the two-year period of the 2007 and 2008 seasons there were 4237 possible "cuts" and 1911 "runs" or sequences of cuts. The null hypothesis tested was that the sequences or "runs" of cuts could be explained by chance. The Runs Test Z (N=1911)=-3.054, p=.002 is significant indicating non-random patterns. Thus, the null hypothesis is rejected and it is concluded that "cuts" do occur in sequences.

The above data were for the combined 2007 and 2008 players with less than three weeks skipped between tournaments. It is noted that 204 players participated in an average of 20.7 events each year over the two-year period.

Schillings Longest Runs Test was employed to answer the question: On average, how many cuts do players make in a row? Schillings' Longest Runs Test determines the mean number of longest runs (it answers "how many") and differs from the Runs Test, which assesses the sequences of runs as compared to chance. On average, players made 5.9 cuts in a row (SD=3.4) over the two-year period (see Table 5).

Additionally, this question was addressed for the players subdivided into quintile groups of 25. Accordingly, there were five quintile groups (Q1, Q2, Q3, Q4 & Q5), each comprised of 25 players. The mean numbers of longest runs for "cuts made" were as follows: Q1=7.3 (SD=3.5), Q2=7.5 (SD=4.3), Q3=5.5 (SD=2.8), Q4=5.1 (SD=2.5), Q5=4.5 (SD=2.7) (See Table 5).

In order to determine if the number of runs for "cuts made" among the quintile groups differs from what would be expected randomly, The Runs Test was employed. Separate Runs Tests were conducted upon each quintile group (see Table 1).

The first quintile group (Q1) was comprised of players 1-25 on the 2007 and 2008 PGA Tour money lists. The Runs Test Z (N= 687)=-1.495 p=.135 indicated runs among the top 25 players for "cuts made" can be explained by chance.

The second quintile group (Q2) was comprised of players 26-50 on the 2007 and 2008 PGA Tour money lists. The Runs Test Z (N= 809)=-1.651 p=.099 indicated runs among Q2 players for "cuts made" can be explained by chance.

The third quintile group (Q3) was comprised of players 51-75 on the money lists. The Runs Test Z (N= 946)=-1.303 p=.193 indicated runs among Q3 players for "cuts made" can be explained by chance.

The fourth quintile group (Q4) was comprised of players 76-100 on the money lists. The Runs Test Z (N=987)=.652 p=.514 indicated runs among Q4 players for "cuts made" can be explained by chance.

Quintile group five (Q5) was comprised of players 101-125 on the money lists. The Runs Test Z (N=808)=-1.346 p=.178 indicated runs among Q5 players for "cuts made" can be explained by chance.

Thus, the number of runs within each quintile group was random. However, the overall test of runs (i.e., the Top 125) was not what would be expected randomly. This suggests that when looking at each quintile group separately, cuts made appear to be random but when examining all the 125 players as a total group, cuts made in sequence are not random. On the basis of this overall finding, the null hypothesis is rejected.

The second hypothesis tested: <u>Performance in a given week predicts performance in the subsequent week.</u>

Transition Analyses were conducted for sequential independence of outcomes for a specific performance category within each quintile group. The null hypothesis tested by these Transition Analyses (chi-square) was that the given performance category's outcome in a given week two is independent of that performance outcome in week one.

Week-to-week, the five quintile groups were analyzed. The resulting values for the chi-square tests of significance for "cut made" week two vs. "cut made" week one were as follows: Q1, χ^2 (1, 455)=1.631, p=.227; Q2, χ^2 (1, 566)=9.055, p=.003; Q3, χ^2 (1, 666)=7.989, p=.006; Q4, χ^2 (1, 714)=1.243, p=.269; Q5, χ^2 (1, 590)=.079, p=.802 (see Table 9). Accordingly, cut made week one does transition to a significant effect on cut made the following week for players in Q2 (players 26-50 on the money list) and Q3 (players 51-75). Cut made week one does not transition to an effect on cut made the following week for Q1 (players 1-25), Q4 (players 76-100), and Q5 (players 101-125).

The quintile groups were also analyzed regarding their Top 10 performances (finishing a tournament in position 1-10). Table 10 presents the values of the chi-square tests for "Top 10 performance" week two vs. "Top 10 performance" week one. They were as follows: Q1, χ^2 (1, 455)=5.816, p=.019; Q2, χ^2 (1, 566)=10.629, p=.003; Q3, χ^2 (1, 666)=.053, p=.846; Q4, χ^2 (1, 714)=1.308, p=.245; Q5, χ^2 (1, 590)=.072, p=.788 . Thus, Top 10 performance of week one does transition to a significant effect on Top 10 performance for the following week for the Q1 (1-25) and Q2 (26-50). A Top 10 performance of week one does not transition to an effect on Top 10 performance for the following week for the Q3, Q4, and Q5 players (51-125).

The quintile groups were analyzed regarding their Top 20 performances. Table 11 presents the values of the chi-square tests for "Top 20 performance" week two vs. "Top 20 performance" week one. They were as follows: Q1, χ^2 (1, 455)=8.303, p=.005; Q2, χ^2 (1, 566)=8.371, p=.005; Q3, χ^2 (1, 666)=.173, p=.729; Q4, χ^2 (1, 714)=1.461, p=.254; Q5, χ^2 (1, 590)=2.963, p=.093. Accordingly, it is concluded that Top 20 performance of week one does transition to a significant effect on Top 20 performance for the following week for the Q1 and Q2 players and to a marginally significant effect for Q5 players. However, Top 20 performance of week one does not transition to an effect on Top 20 performance for the following week for Q3 and Q4 players.

Lastly, the quintile groups were analyzed regarding their Top 30 performances. Table 12 presents the values of the chi-square for "Top 30 performance" week two vs. "Top 30 performance" week one. They were as follows: Q1, χ^2 (1, 455)=.895, p=.349; Q2, χ^2 (1, 566)=8.899, p=.003; Q3, χ^2 (1, 666)=3.819, p=.052; Q4, χ^2 (1, 714)=1.354, p=.267; Q5, χ^2 (1, 590)=10.931, p=.001. Thus, Top 30 performance of week one does transition to a significant effect on Top 30 performance for the following week for the Q2, Q3 and Q5 players. Top 30 performance of week one does not transition to an effect on Top 30 performance for the following week for the Q1 and Q4 players.

Taken together, the Transition Analyses indicate that performance in a given week does predict performance in the subsequent week in terms of "cut made" for Q2 and Q3 players. Similarly, the week one performance predicts Top 10 performance in week two for Q1 and Q2 players. The same was found for Top 20 performance among Q1 and Q2 players. Finally, week one predicts Top 30 performance in week two for Q2, Q3, and Q5 players. As such, these results support the second (alternative) hypothesis and reject the null hypothesis. However, since week one did not predict cuts made or Top 10-30 performances of week two for all the groups, the second (alternative) hypothesis is only partially supported.

The third hypothesis tested: <u>Top 10, Top 20, and Top 30 performances occur in sequences that would not be predicted by chance.</u>

The Runs Test was employed to test the null hypothesis that the sequences of Top 10, Top 20, and Top 30 performances can be explained by chance. Runs of performances will be assessed for non-random patterns. This differs from the previous null hypothesis that Top 10, Top 20, and Top 30 performance in a given week is independent of performance in the previous week.

For Top 10 performances or outcomes, the Runs Test Z (N=835)=-3.967, p=.0001 (see Table 2); for Top 20 performances, the Runs Test Z (N=1349)=-5.787, p=.0001 (see Table 3); for Top 30 performances, the Runs Test Z (N=1657)=-6.932, p=.0001 (see Table 4). Thus, the null hypothesis is rejected, and it is concluded that there are runs in Top 10, Top 20, and Top 30 performances that occur in sequences that cannot be explained by chance.

In order to determine where the non-random runs of Top 10, Top 20, and Top 30 performances occurred, separate Runs Tests were performed upon each quintile group.

The Runs Test conducted for Top 10 performances for quintile groups 1 through 5 (Q1 . . . Q5) yielded the following results: Q1, Z (N=687)=-1.886, p=.059; Q2, Z (N=809)=-3.255, p=.001; Q3, Z (N=946)=-.416, p=.678; Q4, Z (N=987)=-.349, p=.727; Q5, Z (N=808)=-.049, p=.961 (see Table 2).

The Runs Test conducted for Top 20 performances for quintile groups 1 through 5 yielded the following results: Q1, Z (N=687)=-2.366, p=.018; Q2, Z (N=809)=-3.726, p=.0001; Q3, Z (N=946)=-.727, p=.468; Q4, Z (N=987)=-.306, p=.760; Q5, Z (N=808)=-2.595 p=.009 (see Table 3).

The Runs Test conducted for Top 30 performances upon quintile groups 1 through 5 yielded the following results: Q1, Z (N=687)=-3.527, p=.025; Q2, Z (N=809)=-2.113, p=.041; Q3, Z (N=946)=-.971, p=.077; Q4, Z (N=987)=-.998, p=.079; Q5, Z (N=808)=-1.452 p=.064 (see Table 4).

Thus, the test for runs within quintiles for Top 10 performances indicated quintile group two (26-50 players) was non-random and group one (1-25 players) marginally so; the test for Top 20 performances indicated quintiles one, two and five were non-random; and the test for Top 30 performances indicated quintiles one and two were non-random and three, four, and five marginally so. Thus, as indicated earlier, the null hypothesis is rejected by the overall data and these quintile group data, especially the top two quintile group data.

To answer the question of how many Top 10 performances, Top 20 performances, and Top 30 performances occur in a row, Schillings' Longest Runs Test was employed. As previously mentioned, Schillings' Longest Runs Test determines the mean number of longest runs (it answers "how many") and differs from the Runs Test, which assesses the sequences of runs as compared to chance.

The mean numbers of longest runs for Top 10 performances were as follows: Overall = 1.3, (SD=0.9), Q1=1.7, (SD=1.0), Q2=1.6, (SD=1.1), Q3=1.1, (SD=0.8), Q4=1.0, (SD=0.8), Q5=0.9, (SD=0.6) (See Table 6). To test for significance, an analysis of variance was conducted F(4, 203) = 6.220, p=.0001, (*d*=.111) (Table 16), indicating a significant variation among the five quintile groups in their mean number of longest runs for Top 10 performances. The effect size indicates that grouping of players into quintiles explains 11.1% of the total variation in longest runs. Post hoc Tukey HSD revealed quintile group 1 differed significantly from quintile group 5 (see Table 13).

The mean numbers of longest runs for Top 20 performances were as follows: Overall = 2.0, (SD=1.4), Q1=2.8, (SD=1.5), Q2=2.5, (SD=1.4), Q3=1.7, (SD=1.0), Q4=1.6, (SD=1.3), Q5=1.6, (SD=1.1) (See Table 7). An analysis of variance was conducted F(4, 203) = 8.046, p=.0001, (*d*=.139) (Table 17), indicating a significant variation among the five quintile groups in their mean number of longest runs for Top 20 performances. The effect size indicates that grouping of players into quintiles explains 13.9% of the total variation in longest runs. Post hoc Tukey HSD revealed that quintile group 1 differed significantly from quintile groups 3, 4, and 5, and quintile group 2 differed significantly from quintile groups 3, 4, and 5 (see Table 14).

The mean numbers of longest runs for Top 30 performances were as follows: Overall = 2.8, (SD=1.7), Q1=3.8, (SD=2.1), Q2=3.3, (SD=1.8), Q3=2.5, (SD=1.3), Q4=2.4, (SD=1.7), Q5=2.3, (SD=1.3) (See Table 8). An analysis of variance was conducted F(4, 203) = 6.326, p=.0001, (*d*=.113) (Table 18), indicating a significant variation among the five quintile groups in their mean number of longest runs for Top 30 performances. The effect size indicates that grouping of players into quintiles explains 11.3% of the total variation in longest runs. Post hoc Tukey HSD revealed quintile group 1 differed significantly from quintile groups 3, 4, and 5, and quintile group 2 differed significantly from quintile groups 4 and 5 (see Table 15).

Discussion

Over the course of the PGA Tour season, based upon the data analyzed, Psychological Momentum appears to be operating and determining how players perform from week to week. The data showed support for the first and third hypotheses that cuts occur in sequences (hypothesis 1) and that Top 10 performances, Top 20 performances, and Top 30 performances also occur in sequences (hypothesis 3). These findings alone make a reasonable case for the existence of Psychological Momentum.

The second hypothesis that performance in a given week predicts performance in the subsequent week was generally supported by the data. In particular, it was supported by the data pertaining to the top two groups (players 1-25 and players 26-50).

In support of the first hypothesis, when considering all of the players, cuts occur in sequences. Over the course of two seasons, the runs of cuts made by the Top 125 players on the previous year's money list were not consistent with what would be expected by chance. The Runs Test indicated that among the 1911 instances of "runs" over the two seasons, there were patterns that were not random. This finding is at odds with the findings of Gilovich et al's study (1985) in which the authors reported that their data could be explained equally well by chance.

In further tests of the first hypothesis, none of the specific quintile groups (1-25, 26-50, 51-75, 76-100, 101-125) on their own showed any patterns considered non-random. That is, the runs within each specific quintile group could be attributed to chance. This suggests that the players within specific quintile groups were similar in their performances, but between the groups, there were non-random patterns. It is assumed that, at a minimum, the significant overall Runs Test is indicating a non-randomness that distinguishes the upper most quintile players from the lowest quintile players. It would be expected that all golfers in the elite Top 125 would be similar in skill. The question raised is whether there exist psychological factors that distinguish the number 1 player from the number 125 player, for example. The present findings suggest that psychological factors may not be detectable among closely ranked players (1-25 vs. 26-50), but are evident among players whose rankings are farther apart (1-25 vs. 101-125). Thus, the overall Runs Test is significant while the individual Runs Tests upon quintiles are not.

This finding is similar to the findings of Jackson & Mosurski (1997) whose study regarding Wimbledon and U.S. Open tennis showed that players with the higher world ranking in a match produced lopsided victories they referred to as “heavy defeats.” It is surprising that there would be lopsided victories among competitors with equal skill. A plausible explanation for such results is that psychological factors are operating and producing the unexpected results. It is, in fact, common in sports to find a match or game that is expected to be close, but turns out to be lopsided. Thus, it may be that these higher ranked players are capitalizing on Psychological Momentum, turning it into increased physical and mental effort, and accomplishing further successes and ultimately victories.

The number or “cuts made” in a row by the Top 125 players was 5.95, or about 6. This is surprisingly high and suggests that players get on a roll and thus experience Psychological Momentum. The differences in “cuts made” were also observed between quintile groups. For example, the top quintile group (Q1) made, on average, over 7 cuts in a row, whereas the lowest quintile group (Q5) made about 4.5 in a row. Closer inspection reveals that the second quintile (Q2) made, on average, over 7 cuts in a row—a result similar to that of quintile group one. On the other hand, quintile groups three and four (Q3 and Q4) made roughly 5 cuts in a row. It appears that the top two quintile groups are similar to one another and notably different from and better than, quintile groups three, four, and five in terms of the average number of cuts made in a row. This is consistent with the premise that Psychological Momentum is more likely to reveal itself among top competitors (Iso-Ahola & Blanchard, 1986).

Data supported partially the second hypothesis that performance in a given week predicts performance in the subsequent week for some performance criteria but not for others. Week to week performance was evaluated in terms of making the cut, finishing in the Top 10, in the Top 20, and in the Top 30. Each of these was analyzed separately for the five quintile groups of players.

Week one performance predicting week two performance was evident in the top two quintile groups (top 50 players from the previous year's money list) for Top 10 performances and Top 20 performances. Data on "cuts made" indicated week one predicting week two performance for group 2 (players 26-50) and group 3 (51-75). Data on Top 30 performances showed week one predicting week two performance for quintile group 2 (players 26-50), and quintile group Q5 (100-125). While these Transition Analyses were not entirely consistent across all of the performance criteria (cuts, Top 10s, Top 20s and Top 30s) for all quintile groups, they did indicate that for each criterion, quintile group 2's performance in week one predicted their performance in the following week. Additionally, quintile group 1's performance in week one predicted their performance in the following week for Top 10 performances and Top 20 performances. With the exception of quintile group 1 for cuts made and Top 30 performances, these analyses suggest that for the top 50 players, this week's performance is a significant predictor of the next week's performance but not so for the lower three quintile groups of players. This finding is similar to the results of the Runs statistic used in testing the first hypothesis and, again, is consistent with previous findings that the top performers tend to be similar in their physical and technical abilities and skills and therefore distinguishable only by psychological factors (Iso-Ahola & Blanchard, 1986; Jackson and Mosurski, 1997). The analyses point to the top 50 players being largely distinguishable by psychological factors-a claim that cannot be made for the lower ranked golfers. The top players seem to be able to take advantage of early success and subsequent Psychological Momentum and turn it, with increased mental and/or physical effort, into continued success (Hamberger & Iso-Ahola, 2005).

The case for Psychological Momentum was less compelling when looking at one given week and the following week. If Psychological Momentum were operating, it would be expected that success in one week would increase the likelihood for success in the following week; however, it appears that this is not always the case. According to theory, Psychological Momentum provides a competitor with a psychological advantage that increases his likelihood of success (Iso-Ahola & Mobily, 1980). It does not guarantee success. What is important is how the competitor interprets the early success and represents it psychologically. Increased mental and/or physical effort may or may not follow. Thus, it is not surprising that detecting an effect on any given week from the previous week might not be possible for it might not be present. However, over the course of a season, or two seasons, it is expected, as the data showed, that an effect would be found. It would be expected that the most successful elite players would be those players who most often turn their early success into continued success.

Consistent with the third hypothesis, Top 10 performances, Top 20 performances, and Top 30 performances occurred in non-random patterns. For each of these outcomes, the Runs Test produced statistically significant results. Thus, for the top 125 ranked players (according to the previous year's money list) there were sequences that would not be predicted by chance for Top 10 performances, Top 20 performances, and Top 30 performances. Similar to the findings obtained by the Runs Test conducted for the first hypothesis, these results contradict the findings of Gilovich et al., (1985) who concluded that the sequences observed in their basketball data were consistent with chance. Interestingly, both the current study and the Gilovich et al study employed the Runs Test and used archival data. The findings of the two studies, however, differ considerably in other respects and suggest different conclusions about Psychological Momentum and its effect on performance.

The conflicting findings may be partially attributed to the different sports studied. In one analysis in the Gilovich et al study, researchers utilized field goal percentages of basketball players during home games over the course of a season. Field goal percentage refers to the number of successful shots versus the number of attempted shots during a game. Assessing field goal percentage is difficult as all shots would be different, from different places on the floor and with or without the presence of a defender, for example. Making a short range, wide-open shot and then missing the subsequent long-range, well-defended shot may not indicate the presence or absence of a streak but may be more circumstantially determined. Basketball is also played with time constraints whereas golf is not. The golfer initiates each golf shot at his own discretion while the basketball player must react to opposing players.

Gilovich et al., (1985) also examined free throw percentages in a second analysis of archival data. Free throw percentage would not involve opposing players and could arguably be said to be a better basketball statistic to analyze in order to assess a dependency structure. The free throw process consists of, at best , a series of two trials: one attempt, possibly followed by a second attempt. Analyzing runs for such a small set of trials is questionable. Additionally, analyzing free throws from one set of attempts to another does not account for what occurs in between the attempted free throws. The game goes on in between free throw attempts. A player may make or miss many shots between free throw attempts confounding the notion of independence between trials. While Gilovich et al., (1985) found no sequences that a random model could not predict equally well, the present study found patterns of non-randomness in all the performance criteria investigated.

The present findings more closely parallel those of Jackson and Mosurski (1997) who used archival data from U.S. Open and Wimbledon tennis matches. Their analyses indicated that of the four models they tested to fit their data, the “odds model,” or the model that incorporated Psychological Momentum, was the best. Like the present study which utilized world ranking as a covariate, they controlled for fluctuations in player ability from day-to-day. They found player ability fluctuating from day-to-day was not a strong predictor of winning—not nearly as strong as Psychological Momentum. These two studies are noted as similar because of their use of archival data that spanned long periods of time. The Jackson and Mosurski study utilized two years of data from tennis matches that span more than two weeks each. The present study utilized data from two seasons comprised of golf tournaments lasting one week each upon the professional golf tour. Having extensive data over a long period of time should allow for the detection of an effect of Psychological Momentum.

Additionally, Jackson and Mosurski (1997) found the effects of Psychological Momentum to be operating among the highest ranked tennis players, in what they termed “heavy defeats” (players winning a match by a margin of 3 sets to none). These heavy defeats occurred far more frequently by the player of higher world ranking over the lower ranked player. However, introducing the random effect of ability did not significantly improve their model. Psychological Momentum, as introduced in their “odds model”, did greatly improve their prediction. Among these highest ranked players, ability did not identify heavy defeats—Psychological Momentum did. Similarly, the present research found players of the highest ranking, generally, more likely to exhibit runs that would not occur randomly. These runs would be attributed to psychological factors rather than ability. It is possible that these highest ranked players are the most psychologically skilled performers that capitalize most often on Psychological Momentum. Together, these two studies, derived from extensive data sets, suggest the existence of Psychological Momentum and its influence on performance.

The third hypothesis was further tested to determine where among the Top 125 golfers the sequences occurred (Runs Test), and how many Top 10, Top 20, and Top 30 performances occurred in a row (Shillings Longest Runs). It was found that the overall support for the third hypothesis stems primarily from the data on quintile groups one and two (Top 50 players), suggesting that these top performers were more capable of capitalizing upon the effects of Psychological Momentum than other groups.

The greater success of the top elite golfers may relate to their ability to maintain their high level of performance in demanding competitive situations, more often than even the elite golfers ranked just below them. Even at the elite level there are lapses or deteriorations in performance that occur very regularly. Current literature on "choking" suggests that choking is not merely performing poorly, as all athletes do from time to time, but a deterioration in performance from a particular level that is expected from a particular athlete in a high-pressure situation (Beilock & Gray, 2007). The ability to perform in high-pressure situations would be a characteristic of the most elite performers. Research suggests that highly skilled or experienced performers are less likely to choke (Beilock & Carr, 2001; Beilock et al., 2002; Gray, 2004; Beilock & DeCaro, 2007; Beilock & Gray, 2007). If these performers are less likely to choke then they may be able to capture Psychological Momentum more readily and, most importantly, hang onto it in order to achieve subsequent successes.

Recent research has shown that among experienced athletes the choking process can be alleviated by specific psychological training in pre-performance routines (Mesagno & Mullane-Grant, 2010). The findings of this study indicated that those skilled athletes who received psychological training improved their performance in stressful situations while those who did not receive training had performance decreases. This finding is drawn exclusively from elite athletes. Thus, the influence of psychological factors (such as the psychological training vs. no psychological training) exists among the most elite performers and is consistent with the original framework of Psychological Momentum as it pertains to the most evenly matched competitors (elite athletes) and the increasing effect of psychological factors (Iso-Ahola & Mobily, 1980).

The superior performance by the top two quintile groups of golfers is also reflected by how many successful performances players achieve in a row. Shillings Longest Runs Test revealed trends regarding the average number of cuts, Top 10, Top 20, and Top 30 performances players make in a row. Given the significant overall test for runs for each of these outcomes, the question of "how many" cuts, Top10s, Top 20s and Top 30s were made and whether these numbers differed from what would be expected randomly was addressed.

As reported earlier, the analyses of mean number of longest runs indicated that the top 50 ranked golfers perform better (in these analyses in terms of mean number of Top 10, 20 and 30 finishes in a row) than the golfers ranked 51-125. These analyses are meaningful because they reflect the same pattern shown by the Transition Analyses utilized to test the second hypothesis. The longest runs differ from the sequence of runs. The sequence of runs tested by the Runs Test in the first hypothesis confirmed the non-randomness of outcomes. The longest runs answered the question of "how many" occurred in a row and the subsequent analysis of variance answered whether the differences in numbers of "how many" were significant.

In terms of human performance, the differences in the number of runs in a row between the top 50 and next 75 ranked golfers may represent psychological rather than physical factors. The data repeatedly showed differences between the quintile groups in terms of sequences of runs and average number of longest runs. These differences most often distinguished the first and second quintile groups collectively from the third, fourth, and fifth quintile groups collectively. Thus, it can be argued that psychological factors influencing golfers are most prevalent among the top 50 golfers. As Iso-Ahola and Blanchard (1986) point out, when competitors are more evenly matched, potential effects of ability decrease while the effects of psychological factors, such as momentum, increase.

It seems that optimal performance is linked with Psychological Momentum. The optimal experience identified by Csikszentmihalyi (1990) is what athletes refer to as "in the zone" or "in a groove" such that they feel completely immersed in their task. Characteristics identified by Jackson and Csikszentmihalyi (1999) included a balance of challenge and skill, complete immersion in the activity, clear goals, a merging of action and awareness, focused concentration, a loss of self-consciousness, and a sense of control. It may be that Psychological Momentum is attained more readily by athletes who are high on many of the characteristics of the flow experience, which make them more capable of sustaining optimal performance and achieving future successes. For example, elite athletes are known to be able to focus on the task at hand and present moment. Complete immersion in the activity and focused attention are characteristic of flow.

Research by Keller and Bless (2008) supports the premise that complete immersion in an activity is linked to intrinsic motivation and more successful performance. Their work done in two studies employed experimental techniques involving video games and was designed to establish a causal relationship between the variables. Their first study found that participants in an "adaptive playing mode" (one designed to change in order to continually adjust demands to match a player's skill) were more immersed in the activity, as measured by "perception of time" and "involvement and enjoyment," and performed better on the video game task. The present data may be taken to suggest that the Top 50 golfers are able to get into flow more readily and therefore benefit from the ensuing Psychological Momentum in their enhanced performance. It should be noted, however, that these conclusions are speculative as neither Psychological Momentum nor Flow were measured directly in the present study.

Further evidence that distinguished the top ranked golfers were the Transition analyses that were conducted to assess one week affecting the subsequent week's performance. These analyses demonstrated the consistency of performance of the top ranked golfers. Congruent with the theoretical framework of Psychological Momentum, results showed an effect from week to week for the top ranked golfers but not for the lower ranked golfers, as the performance criterion became more stringent. That is, the highest performance criterion or standard of success/analysis is a Top 10 performance, the next highest is a Top 20 performance, the next highest is a Top 30 performance, and the lowest performance criterion analyzed for the study is a cut made. Overall, the data trended toward the top quintile groups distinguishing themselves from the bottom quintile groups.

For example, the top 50 ranked players (quintile 1 and quintile 2) showed patterns or streaks for finishing in the Top 10 that the lower ranked players did not. However, the top ranked players did not show patterns or streaks for "cuts made" whereas the lower ranked players did. This suggests that as the performance criterion increases, Psychological Momentum becomes more influential (Iso-Ahola & Blanchard, 1986). As one might expect, "cuts made" does not distinguish the top ranked players from the lower ranked players, as the former make the great majority of their cuts. Finishing in the Top 10, however, is a more relevant criterion for the top ranked golfers. Again, it seems that at the highest levels of competition the role of psychological factors such as Psychological Momentum may best explain the differences in success among competitors.

Although the data are not unequivocal, they are consistent with the theoretical framework of Psychological Momentum. Ideally, the data would be predictive of performance from week to week for quintile group one at the Top 10 level, quintile group two at the Top 20 level, quintile group three at the Top 30 level and quintile groups four and five at the "cuts" level—or something to this effect. While the data were not as clear-cut, they did show a trend in this direction—the direction Psychological Momentum would predict. It is suggested that as the performance criterion increases, Psychological Momentum further reveals itself.

For this study the Top 125 players of the PGA Tour were divided into five groups consisting of 25 golfers each. Originally, the data were not collected with such groupings in mind and, although the data are very revealing and informative, they present challenges for the researcher. In reality, the Top 125 golfers on the PGA Tour could arguably be divided into more representative groupings according to successes. For example, a group of roughly the top 10 golfers, followed by a group of some 50 golfers, followed by everyone else. Taking a retrospective view of the Tour over the past decade or so would support such groupings. However, this clearly is not viable from the standpoint of statistical analyses. Grouping and analyzing the Top 125 golfers in such a way might yield results different from the current analyses but might also show more support for the idea about the influence of Psychological Momentum among the very top performers. This remains to be investigated in the future.

Overall, there exists considerable support for Psychological Momentum as evidenced by the streaks that occur by players across all the different performance categories examined. The most compelling evidence is that making the cut, finishing in the Top 10, finishing in the Top 20, and finishing in the Top 30 all occurred in streaks or non-random patterns over the course of two seasons. These findings suggest that the theory of Psychological Momentum is a plausible explanation for the findings obtained. That is, if an elite golfer makes a cut, for example, Psychological Momentum would explain that such a success would lead to a psychological power or advantage that would produce greater physical and mental effort and increase the likelihood of making a cut in the next tournament. Further, among the more interesting findings of the present research was the consistent indication that the very top players are different, and better, than their fellow competitors in terms of capitalizing on Psychological Momentum and turning it into further success. Future examination of these top performers would be a meaningful way to extend the present research. These findings may offer direction to players who wish to maximize their success and minimize their failure by selecting events and scheduling their season according to the theory of Psychological Momentum.

STUDY 2

Study 2 examined the role of Psychological Momentum within an individual tournament or single contest on the PGA Tour. An individual tournament consists of 72 holes played over a four-day period—18 holes each day. The aim of this study was to determine how Psychological Momentum is operating over a short-term period and how it influences or enhances performance. Psychological Momentum has been observed as a short-term phenomenon (Iso-Ahola & Mobily, 1980; Iso-Ahola & Blanchard, 1986) and, as such, should be operating in a single event such as a golf tournament and reflected in data collected from the tournament. Data were analyzed within a tournament in two ways. First, there were analyses of data to examine the effects from day to day within a single contest. Second, there were analyses of data to examine the effects within a single round, or one day of a tournament.

Study 2 investigated whether the first round of a tournament predicts making the cut, as well as, second round, third round, and fourth round performance. Further, Study 2 sought to answer how 9-hole scores influence the subsequent 9-hole score both within each round and from one day to the next.

Five hypotheses were tested: 1) The first round score predicts making the cut. 2) The first round performance predicts the second round performance, as well as, third round performance, and also, fourth round performance. The second round performance predicts the third round performance. And, the third round performance predicts the fourth round performance. 3) The first round performance predicts the second round performance based upon the median score. 4) The front nine score for each round predicts the back nine score for that round. 5) Players who establish

Psychological Momentum over the second nine holes of the first round (as defined in *Statistical Analyses, Within tournament/within rounds analyses*) perform better in the second round than those who do not establish Psychological Momentum during the second nine holes of their first round. The same prediction was made for the second nine holes of the third round and the subsequent final, or fourth round.

Method

Participants

The data for this study were drawn from the 2008 Shotlink database that is collected by the Professional Golf Association Tour of America. Statistical information is collected on every contestant competing in each weekly event throughout the PGA Tour season. All participants are either members of the PGA Tour, or have qualified, or have been provided an exemption by the PGA Tour in order to play in an event. Ages of participants ranged from 18 years to 48 years.

Data Collection Procedures

The same data set was utilized in Study 2 that was utilized in Study 1. The protocol for data collection, recording, and storage is identical to that described earlier for Study 1.

Statistical Analyses

In order to determine whether the first round score predicts making the cut (Hypothesis 1), all first round scores, for all players, for all tournaments were included in the analysis. Excluded from this analysis were tournaments where players competed on different courses for the first round. Also excluded from the formatted data file were tournaments in which no cut is made.

The analysis to address this question employed the logistic regression procedure (Kleinbaum, 1994). This procedure establishes a regression relationship between the dependent variable (i.e., "making the cut"), which is binary, and the predictor variable (i.e., "first round 18 hole total score"). The regression coefficient associated with the predictor variable indicates its contribution regarding whether a player will make the cut for a given first round score. Since data employed for the logistic regression analysis constitute the first round scores across the full PGA Tour season, players' first round score was expressed as plus, zero, or minus the ultimate cut score relative to par.

To further investigate the within-tournament performance, Pearson correlation coefficients were computed to show the magnitude of relationships between the first, second, third, and fourth round total scores (hypothesis 2). Among these twelve correlations, special attention was paid to those describing the relationship between the first and second round scores, first and third round scores, first and fourth round scores, second and third round scores, and third and fourth round scores. Tournaments that did not consist of four rounds, such as those shortened by inclement weather and those that consisted of more than four rounds, were excluded from the analyses.

Further investigation of the potential role of Psychological Momentum in the within-tournament performance was addressed by relating a player's performance from round one to round two relative to the impending cut line (hypothesis 3). For this analysis, players' first round scores were classified into two groups: above and below the median total score. Similarly, two groups based on the tournament's median score for the second round were determined. Thus, the Chi-Square test of a two by two contingency table was completed to determine if performance, relative to the potential cut line following round one, predicted players' position relative to the second round's official cut line. Again, tournaments that utilized multiple courses for first round play were excluded from analysis.

The following analyses are based on the premise that early successful performance establishes Psychological Momentum and subsequently leads to additional successful performance. Operationally, the establishment of Psychological Momentum was defined as a player's cumulative score recorded as under par, either for the number of holes played (e.g., nine holes) or for the total round. Not having Psychological Momentum was operationally defined as a player's cumulative score that is over par for the referenced round or within round duration. Finally, a neutral group was operationally defined as cumulative scores at par for the referenced duration. Then, the following analyses were performed.

For the Psychological Momentum group established by the first nine-hole scores, was there a significant difference between their second nine-hole score and if so, did that difference favor the Psychological Momentum group over the non-Psychological Momentum group and the neutral group? (hypothesis 4) The statistical analyses to address these questions were conducted using a between-groups means analysis of covariance, co-variates were strength of the field (stable measure) and conditions/difficulty (variable measure), and followed, if necessary, by appropriate post hoc tests of individual group mean differences. The independent variable was Psychological Momentum (either having, not having it, or neutral) and the dependent variable was the second nine-hole score. Identical analyses were completed when comparing the front nine scores to the back nine scores for all of the four rounds.

The analyses described in the preceding paragraph were completed for two different scores. First, the analyses as described with no adjustments made from tournament to tournament across the full PGA Tour season were completed. Then, the between-tournament performances were adjusted for the strength of the field and conditions/difficulty. For the former (strength of field), players' within-tournament scores were adjusted by tournament participants' world ranking. For the latter (conditions/difficulty), the official PGA Tour scores, which are continuously adjusted from tournament to tournament, were applied to achieve players' ongoing scoring average across the full PGA Tour season (this would account for course condition and difficulty). Thus, Psychological Momentum groups were based on players' adjusted scores relative to the covariance analysis's adjusted par score. That is, par at a tournament with a strong field and/or difficult conditions was adjusted up or down to reflect the specific tournament's strength of field and/or specific conditions/difficulty.

Additionally, the above analyses were completed to determine differences in the back nine scores between the three Psychological Momentum groups defined by the second round's first nine hole actual scores and adjusted scores; the same group comparisons were done for the third round's actual and adjusted scores and, finally for the fourth round's actual and adjusted scores.

Continuing the investigation of the possible effect of Psychological Momentum within tournament performance, the final two analyses were completed to address the fifth hypothesis that those who establish Psychological Momentum in the second half of the first round (last nine holes) perform better in the second round than those who did not establish Psychological Momentum during the last nine holes of the first round. This same analysis was completed for the fourth or final round addressing the common notion that the third round of a tournament "positions" players, or "sets the stage" to enter the final round. Thus, do those players who establish Psychological Momentum in the second half of the third round perform better in the final round than those who do not establish Psychological Momentum during the last nine holes of the third round? This question was answered by analyses of covariance (co-variates were strength of field and conditions/difficulty) followed by post hoc Tukey HSD where necessary.

Results

Five hypotheses were tested to see if evidence supports the effect of Psychological Momentum on the Tour players' performance.

The first hypothesis tested: <u>First round score predicts making the cut.</u>

The top 125 players from the 2007 money list were evaluated across the full 2008 season. In any given week, a player in the full field of around 150 players would have a 50% chance of making the cut. For players ranked in the top 125, 64.9% made the cut while 35.1% failed to make the cut in any given week. Thus, the odds that a top 125 ranked player made the cut in any given week was about 2 to 1.

Knowing a top 125 player's first round score (adjusted for tournament conditions and strength of field) strengthened the prediction as compared to not knowing a player's first round score. If the first round score was above the average, the chance of making the cut dropped from 64.9% to 53%. The chi-square value testing the null hypothesis that making the cut is independent of the first round score was significant χ^2 =(1, N=2216) = 518.487, p=.0001, see Table 19). Thus, the null hypothesis is rejected, and it is concluded that the first round score predicts making the cut.

It should be noted that logistic regression uses the lowest code score as the reference group. In this case, "0" means missing the cut, while "1" means making the cut. Thus, "odds" are expressed relative to increasing or decreasing the odds of missing the cut. The odds ratio of 0.688 (see Table 20) describes the chance of making the cut when shooting over par relative to the group that shoots under par. Therefore, golfers' chance of making the cut following an over par first round score was 0.69 as compared to 1.0 for those golfers with an under par first round score.

The second hypothesis tested: <u>First round performance predicts second round performance, as well as, third round performance and fourth round performance. This hypothesis was also extended to second round performance predicting third round performance and third round performance predicting fourth round performance.</u>

Pearson correlations were performed among first (Day 1), second (Day 2), third (Day 3), and fourth (Day 4) round 18-hole scores—each adjusted for tournament conditions and strength of field. The null hypothesis tested was that score for a particular round was independent of the previous round's score.

Each day's score correlates with the next day's score (see Table 21). Day 1 correlates with Day 2 ($r=.078$, $p<.01$), Day 2 correlates with Day 3, ($r=.052$, $p<.05$), and Day 3 correlates with Day 4, ($r=.748$, $p<.01$). Day 1 does not correlate with Day 3 ($r=.019$) nor does it correlate with Day 4 ($r=.024$). Day 2 does not correlate with Day 4 ($r=.003$). It is concluded that each round's performance predicts the next round's performance but not beyond that. Thus, the hypothesis is partially supported.

The third hypothesis tested: <u>First round performance predicts second round performance based upon the median score.</u>

Day 1 scores were classified as either above or below the median (potential cut line). Day 2 scores were also classified as either above or below the median (actual cut line). The chi-square testing the null hypothesis that the potential cut line (predictor variable) does not predict the actual cut line (outcome variable) was significant: $\chi^2 =(1, N=4511) = 1019.996$, $p=.0001$ (see Table 22). Thus, the null hypothesis is rejected and it is concluded that first round performance predicts second round performance based upon the median score. This analysis is meaningful because the median divides the field in half and represents the "potential cut line" after Day 1, providing the players with a point of reference.

The fourth hypothesis tested: <u>Front nine score predicts back nine score, such that those who have established positive Psychological Momentum (i.e., below par) during their first nine holes perform better over their second nine holes than those who have not established Psychological Momentum (i.e., even par), or those who have negative Psychological Momentum (i.e., above par).</u>

Front nine versus back nine comparisons of rank scores were done adjusting for the strength of the field and course difficulty. A player's rank score represents his position relative to the field and can be compared to any other tournament field regardless of actual scores. A rank score of 0.50 is the median score. The rank scores of players were classified into three groups: below par, even par, and above par (coded -1, 0, and 1). A between-groups means analysis of covariance (co-variates were strength of field and conditions/difficulty) was conducted to test the null hypothesis that establishing Psychological Momentum on the front nine had no impact upon performance on the back nine. The Psychological Momentum group (below par, even par, or above par) was the independent variable and the back nine-hole score was the dependent variable.

A first round comparison of the means between the three Psychological Momentum groups yielded a marginally significant $F(2, 4499) = 2.215$, $p=.109$ ($d=.001$) (see Table 23). It is therefore concluded that the Psychological Momentum grouping based on the front nine score did not predict the back nine score for round one.

A second round comparison of the means between the three groups yielded a significant $F(2, 4499) = 5.852$, $p=.003$ ($d=.003$) (see Table 24). Thus, significant differences among the three front nine groups existed. Post hoc Tukey HSD revealed that the below-par group did not differ from the even-par group, but did differ from the above-par group (see Table 29). The even-par group did not differ from the above-par group. Thus, it is concluded that the front nine score did predict the back nine score for round two.

A third round comparison of the means between the three groups yielded a nonsignificant F(2, 2767) = .502, p=.606 (*d*=.0001) (see Table 25). Therefore, it is concluded the front nine score did not predict the back nine score for the third round.

A fourth round comparison of the means between the three groups yielded a nonsignificant F(2, 2511) = .384 p=.681 (*d*=.0001) (see Table 26). Thus, it is concluded that the front nine score did not predict the back nine score for the fourth round.

Overall, the hypothesis that the front nine score predicts the back nine score, by those who have established Psychological Momentum during their first nine holes, is only supported by the second round scores. For the first, third, and fourth round scores, the null hypothesis cannot be rejected.

The fifth hypothesis tested: Players who establish Psychological Momentum over the second nine holes of the first round (Day 1 back nine) perform better in the second round (Day 2 18-hole score) than those who do not establish Psychological Momentum during the second nine of their first round. The same prediction is made for the second nine holes of the third round (Day 3 back nine) and the subsequent final round (Day 4 18-hole score).

Comparisons of back nine versus the next day 18-hole score were done adjusting for the strength of field and conditions/difficulty (co-variates). Rank scores were established, classified, and coded as in the previous analysis. The Psychological Momentum group (below par, even par, or above par) was the independent variable and the next day 18-hole score was the dependent variable. A between-groups means analysis of covariance was performed to test the null hypothesis that back nine score had no influence upon the next day's 18-hole score.

Day two 18-hole score means were compared between the three groups, yielding a significant $F(2, 4499) = 17.253$, $p=.0001$ ($d=.008$) (see Table 27). Post hoc Tukey HSD tests revealed that the below-par group differed significantly from the even-par group and the over-par group for the following day's 18-hole score. But the even-par group did not differ from the above-par group (see Table 30). It is concluded that those players who established Psychological Momentum over the second nine holes of the first round performed better in the second round than those who did not establish Psychological Momentum. The null hypothesis is therefore rejected.

Day four 18-hole score means were compared between the three groups, yielding a nonsignificant $F(2, 2511) = 1.661$, $p=.190$ ($d=.001$) (see Table 28). It is concluded that players who established Psychological Momentum over the second nine holes of the third round did not perform better in the fourth round than those who did not establish Psychological Momentum. Thus, the null hypothesis is accepted and it is concluded that the Day 3 back nine performance does not influence the Day 4 18-hole score.

Discussion

The data indicated that Psychological Momentum is operating within tournaments on the PGA Tour. The first hypothesis, first round scores predicting making the cut, was supported. This indicates the critical importance of the first round in achieving early success and establishing Psychological Momentum. The data further indicated the importance of the first round score in relation to the median score of the first round (the third hypothesis). Those players who scored lower than the median in their first round (a “good” first round score) performed better in the second round than those who scored higher than the median in their first round (a “poor” first round score). Previous research has shown the positive effect of a first game upon a second game (Iso-Ahola & Blanchard, 1986) in terms of greater confidence in one’s ability and perceived likelihood of winning the subsequent game as compared to those who had lost the first game. In theory, it would be more difficult for the golfers who performed worse than the median in their first round to recover in their second round than those who performed better than the median in the first round.

These findings regarding the two hypotheses are consistent with the framework of Psychological Momentum that early success leads to psychological power manifested as increased confidence, perceived superiority over an opponent, and likelihood of winning which, in turn, increases mental and/or physical effort and leads to subsequent success. A good first round in a tournament increases the likelihood a player will make the cut. A good first round in comparison to the median informs the player about his position relative to his competitors. A player knowing that he is better than the median affords psychological power that he is better than half of his competitors, and that a similar performance in the subsequent round would lead to his making the cut. Additionally, a double-effect may occur, in that those golfers scoring better than the median gain an advantage, while those golfers scoring worse than the median are put at a psychological disadvantage. The median is important because like the cut after the second round, it creates a stressful situation or demand upon the players.

The median is the potential or hypothetical cut line after one round of play. Relating one's score to the median provides the player with relevant information or feedback. Feedback provided to individuals has been shown to affect perceptions of Psychological Momentum although it may not affect performance (Kerick et al., 2000). The potential cut line is a marker or milestone occurring within a tournament that serves to give feedback to competitors leading into the critical second round. The present research suggests that this milestone creates Psychological Momentum and that, in turn, affects subsequent performance.

The Odds Ratio describes the likelihood of making the cut given a particular first round score. As mentioned, a good first round score increases the likelihood of making the cut. Conversely, a poor first round score decreases the likelihood of making the cut. The obtained Odds Ratio of 0.69 indicates the chance of making the cut when shooting over par relative to the group who shot under par (1.0). These two values can be related by dividing 1 by .69. The resultant value of 1.45 indicates that for every 100 players who made the cut scoring over par in their first round, there were 145 players who made the cut after scoring under par in their first round. These findings indicate the importance of getting off to a good start, establishing Psychological Momentum and having subsequent success in the second round. Support for the first and third hypotheses indicates how important the first round score is, the finding which is consistent with the theory of Psychological Momentum and the premise that success breeds success. With regard to these results, there exists strong evidence that Psychological Momentum is operating within tournaments on the PGA Tour.

The second hypothesis that first round performance predicts second round, third round and fourth round performance, and that second round performance predicts third round performance and third round performance predicts fourth round performance, was for the most part supported. There were clear patterns and significant correlations between performances from one day to the next. The correlations between successive rounds were positive and significant, supporting the hypothesis and indicating that each day's performance was a good predictor of the next day's performance. This finding has clear implications for Psychological Momentum. The achievement of early success is critical to the establishment of Psychological Momentum (Iso-Ahola & Mobily, 1980). The correlations suggest that competitors are gaining a psychological advantage from the first day's performance that is translated into successful subsequent performances. It appears that this effect occurs between each successive round, implying that Psychological Momentum could be increasing in influence as the competitor builds upon his successes.

The correlations between the first and third round and the first and fourth rounds were not significant, suggesting that Psychological Momentum was not operating between these non-consecutive rounds and reinforcing the notion that it is a short-lived phenomenon. Regarding the nonsignificant correlations between the first round and the third and fourth rounds, it may also be that Psychological Momentum is interrupted by what occurs between non-consecutive rounds. In fact, there is evidence that Psychological Momentum can be significantly interrupted, for example, by the opposing team's coach (Mace et al., 1992). Also, Markman & Guenther (2007, p. 807) hypothesized and found support for the idea that "people would perceive that it is harder to achieve a goal following an unwanted interruption of a higher degree of positive momentum than it is to achieve a goal following an interruption of a lower degree of positive momentum." The present research suggests that Psychological Momentum created by round one carried to round two but not to round three, possibly because the effect is short-term or because of some interrupting events between rounds two and three. Since round four is further removed from round one, it is not therefore expected to be affected by Psychological Momentum created by round one. Accordingly, the present research suggests that the effect of Psychological Momentum can only be established among the consecutive rounds of golf in a tournament.

The fourth hypothesis stated that the front nine score predicts the back nine score but was only supported by the second round scores. Rounds one, three, and four did not show a statistically significant effect of the front nine score on the back nine score. It may be that the second round possesses a special significance due to its position immediately prior to the cut. The second round is critical to making the cut. The cut may be looked at as a "life or death" situation in which players either continue to compete in the tournament or are eliminated and do not earn any money. The demands of the second round create a pressure situation for the golfer. Research has shown that while such situations elicit a stress response, highly skilled or elite athletes have the ability to perform well under these kinds conditions (Hill, Hanton, Fleming, & Matthews 2009). Performing well under stressful conditions would enable golfers to turn front nine success into back nine success via Psychological Momentum.

For elite athletes it may be that high-pressure situations enhance or facilitate successful performance. Social facilitation (Zajonc, 1965) is a well-documented social-psychological phenomenon according to which performance improves in the presence of others (Guerin, 1986; Schmitt et al., 1986). Similar to the role that the presence of others plays, it may be that high-pressure situations provide elite athletes with the necessary stimulus needed to challenge them and bring out their best. If performance is facilitated or enhanced by favorable social influences such effects would allow the athlete to more readily achieve early success--the necessary foundation for Psychological Momentum. It is likely that the second round, specifically making or missing the cut, challenges the golfer, rather than makes him fear the consequences and therefore leads to improved performance and early success.

The notion that high-level performance is characterized by certain criteria is also supported by the literature on the concept of “flow” and optimal performance (Csikszentmihalyi, 1990; Hodge, Lonsdale & Jackson, 2009; Jackson & Csikszentmihalyi, 1999). Paramount to achieving flow is the balance between challenge and skills. An athlete must possess the necessary skills and must also be met with equal or appropriate levels of challenge. Balancing challenge and skill at the elite level requires the athlete to manage high-pressure situations such as making the cut in a tournament. The second round of a PGA Tour golf tournament would seem to provide considerable challenge to these athletes, spurring them to perform at their best. As this balance of skill and challenge is met, conditions are then conducive to Psychological Momentum and its influence. It may be that successful elite athletes more readily achieve a state of flow by having acquired other flow characteristics, such as an enhanced sense of control and concentration. (Jackson & Csikszentmihalyi, 1999), which in turn allow them to capitalize on Psychological Momentum and put together subsequent successful performances. However, it is equally plausible that Psychological Momentum leads to flow experiences, suggesting a reciprocal relationship between the two.

There was no effect found from front nine to back nine for rounds one, three or four. Perhaps, Psychological Momentum operates more readily in critical situations. It can be argued that the second round is more critical to players than the third or fourth rounds where players know they will earn a paycheck. If so, it would be expected that those individuals performing well during the front nine of their second round would then continue to do well during the back nine of their second round. This is similar to what Jackson & Mosurski (1997) had previously found when investigating critical competitive situations. They had found that at the highest level of competition, Psychological Momentum was likely to be the most influential factor in determining outcomes. Their examination of McEnroe/Borg tennis matches, in particular fifth and final sets, revealed that Psychological Momentum was a plausible, even compelling, explanation for victory.

The data for the fifth hypothesis were mixed. This hypothesis stated that players who establish Psychological Momentum during the second nine holes of their first round would perform better in the second round than those players who did not establish Psychological Momentum over the second nine holes of their first round. The same prediction was made for the second nine holes of the third round predicting the fourth and final round. The data supported the hypothesis that the second round score is reliably predicted from the first day's back nine-hole score. Consistent with Psychological Momentum theory (Iso-Ahola & Mobily, 1980; Iso-Ahola & Blanchard, 1986; Hamberger & Iso-Ahola, 2005), golfers who were under par on their back nine holes in the first round achieved early success, then experienced increased confidence, perceived superiority, and a belief in their likelihood of success that then enabled them to perform well the next day during the critical second round.

Once again, the second round appears to play a unique role. The importance of the second round may be described as having "psychological mass" (Markman & Guenther, 2007). Psychological mass refers to situations that possess importance and value and are therefore expected to provide competitors with greater Psychological Momentum and a greater likelihood to attain a goal or succeed. The research of Markman and Guenther (2007) suggests that those situations with greater psychological mass enhance a competitor's perceived momentum and increase the likelihood of subsequent success. The present research is consistent with this premise in that the second round may be considered a context of greater psychological mass than other rounds, thus producing greater perceived momentum and success. In this sense the present research extends the empirical body of evidence that suggests situations of importance, value, or challenge provide the best scenario for Psychological Momentum and subsequent success.

The data did not support the hypothesis that the final round performance can be predicted from the third day's back nine-hole score. One possible explanation is that this comparison was made after the cut in the tournament. Because the number of players involved was reduced by half, the variability of scores was lowered, creating more homogeneity, meaning that detecting the effect of Psychological Momentum may be more difficult. It could also be argued that the back nine third round scores only influenced the front nine scores of the fourth round. Since the entire18-hole score was utilized in this analysis an effect on the individual nine-hole score would not have been detected. It is also possible that the fourth round of a tournament is a special situation entirely, given its criticalness and finality. Because of the huge stakes, maybe Psychological Momentum is created only within the fourth round and is therefore short-lived within it. One birdie might ignite Psychological Momentum in the fourth round but would not do so in other rounds as easily. If so, the third round does not carry-over to the fourth round.

It is also worth noting that mixed results that were obtained for the final two hypotheses suggest Psychological Momentum is present and operating but not always detectable. Psychological Momentum may occur within tournaments and within rounds of tournaments at intervals that our present research did not capture. Within tournaments the point at which Psychological Momentum begins and ends may vary considerably. Further analyses that look at each individual hole of a round of golf might detect an effect that the present research did not.

Overall, it appears that Psychological Momentum is operating within tournaments on the PGA Tour in many powerful ways. The first round itself had profound implications for making the cut. A player's performance in the first round allowed for a significantly greater predictive power in regard to making the cut. Whether a player performed better or worse than the median in his initial round was a strong predictor of his second round performance. These findings all support the premise of the effect of early success that is the foundation for building Psychological Momentum (Iso-Ahola & Mobily, 1980). Together they suggest that players at the highest level are interpreting their early successes in ways that allow them to gain a psychological advantage or power and thereby extend their successes to subsequent events.

Further, there exists a clear pattern regarding one day's score predicting the next day's score. The previous day's score correlates with the next day's score for all rounds. These correlations are simple, yet positive and significant, suggesting that Psychological Momentum may be operating.

Partial support for the fourth and fifth hypotheses suggests that players are subject to the effects of Psychological Momentum most clearly under conditions of importance or, of particular significance. The data revealed an effect on performance in the second round (the determining point as to who makes the cut and who does not) in accord with both hypotheses. Consistent with the theoretical framework of Psychological Momentum, the effect on performance under critical conditions, involving players of equal abilities, suggests that a psychological factor such as Psychological Momentum is a compelling explanation.

General Discussion

The purpose of the present research was to investigate the conditions under which Psychological Momentum is likely to surface and determine when it is likely to enhance performance. In order to do this, data from the Professional Golf Association Tour were analyzed. The analyses were done on two levels, in two studies, in order to evaluate performance on the macro-level, or from tournament to tournament, and on the micro-level, or within an individual tournament.

Study 1 analyzed PGA Tour data between tournaments, from one week to the next, over the course of an entire season. The goal of this study was to determine how Psychological Momentum was operating over an extended period of time such as the PGA Tour season. Considering the evidence of the presence of Psychological Momentum over the long-term found in Study 1, it was logical to examine its role more closely. Study 2 examined the role of Psychological Momentum over the short-term, namely within individual tournaments on the PGA Tour. Data were analyzed to examine the effects from day to day within a single contest. Further, data were examined to determine the effects within a single round of a tournament. Evaluating the results from all analyses of Study 1 and Study 2 as a single piece of research regarding Psychological Momentum on the PGA Tour, it is clear that there exists extensive support for the construct as a plausible explanation for the data.

Psychological Momentum- Does Success Breed Success?

A primary question asked by the present research was whether making the cut on the PGA Tour occurs in sequences. This question is central to the entirety of the research as it establishes whether making the cut in one week changes the likelihood of making the cut in the following week or whether each week is independent of one another. Is there a "dependency structure?" (Jackson & Mosurski, 1997). An affirmative answer to this question was supported by the large amount of data—data that spanned across two full seasons on the PGA Tour. There was strong evidence that the patterns observed in the data, the individual player sequences for making or missing the cut, did not occur randomly. This finding was true for the most elite golfers, the best of the best in the world. Finding a dependency structure within the data provides empirical evidence that directly contradicts the findings of Gilovich et al., (1985) who found "chance" to be a reasonable explanation for their data.

Extending the research regarding whether success breeds success and a dependency structure exists, sequences of Top 10, Top 20, and Top 30 performances were also examined for non-random patterns. Considering these top performances separately, there was strong evidence that the patterns observed in these data also did not occur randomly--that a dependency structure exists (i.e., Psychological Momentum). These findings represent further evidence contradicting the findings of Gilovich et al., (1985).

If making a cut, or finishing in the Top 10, Top 20, or Top 30, provides the golfer with confidence, a sense of superiority, and a belief in his likelihood of winning, then Psychological Momentum would follow and provide for greater mental effort (e.g., concentration) and a greater potential for further success (Iso-Ahola & Blanchard, 1986). It is important to mention that psychological factors influence physiological ones. That is, the psychological experience of the competitor is translated into his or her physiological responses. The model of Psychological

Momentum itself states that the advantage or psychological power that occurs from early success leads to increased effort both mental and physical. Additionally, one of the manifestations of psychological power is confidence, and variations in one's level of confidence may translate into profound performance differences involving fine motor skills.

Recent research regarding hitting in baseball has also found success breeds success, hitting is contagious (Gray & Beilock, 2011). Results showed that expert players who viewed successful batting attempts prior to their at bat were themselves more successful than those who did not view successful attempts (referred to as "action induction.") This is consistent with the present findings that success is contagious and leads to Psychological Momentum.

If success breeds success over the long-term from week to week, does it similarly operate over the short-term, within individual tournaments? For example, does the first round score in a tournament predict whether a player will make the cut? The premise of early success was the rationale for this question. Early success is fundamental to the theory of Psychological Momentum and is similar to the concept of reinforcement found in the behavioral psychology literature. Reinforcement occurs within the framework of operant conditioning (Skinner, 1968) in which a behavior is followed by either a reinforcer that increases the likelihood of the behavior being repeated, or a punisher that decreases the likelihood of the behavior occurring again. This is worth mentioning because Psychological Momentum is a cognitive-behavioral construct incorporating elements that can be traced to established psychological theory.

Mace et al., (1992) conducted a study that put Psychological Momentum in a reinforcement context. Their study with collegiate basketball found a connection between reinforcement rates or behavioral momentum and how a team responded to adversity. Specifically, an increase in rate of reinforcement or having behavioral momentum increased a team's favorable responses to an adverse event suggesting that momentum has a positive impact upon how players respond to adversity. That is, when setbacks occur in a sporting event, a team or individual that has established momentum prior to the setback will follow that setback with more positive or desired responses than those without momentum. This indicates that when good things happen or desired outcomes occur prior to a setback, there is an increase in good things that happen following the setback--success breeding success. Thus, reinforcing a behavior and creating behavioral momentum leads to positive or favorable responses to adversity and subsequent success. This implies that creating a high level of reinforcement rate will create momentum that will carry over to subsequent performance. For example, early success in a golf tournament, such as a good first round, provides reinforcement to the golfer and increases the likelihood of that same behavior or successful performance occurring, that is, making the cut.

If success truly breeds success, interrupting success may breed failure. Markman and Guenther (2007) suggested "targets that have positive momentum when they are interrupted should experience greater difficulty resuming goal progress than should targets that have less positive momentum when they are interrupted" (p. 807). Correlations between rounds within tournaments provided evidence that there is a relationship between consecutive rounds. Performances in consecutive rounds were positively correlated while those in non-consecutive rounds were not. If Psychological Momentum is operating, one event must lead directly to the next event; otherwise, the competitor may not interpret the success as psychologically useful. For example, rounds of golf that are non-consecutive (such as round 1 and round 3) may be interrupted by many events, thereby negating the psychological advantage established by the early success of round one. The findings showed this to be true. Accordingly, Psychological Momentum may be a fleeting phenomenon and once a competitor loses it, it is difficult for him to regain.

Consistent with the above, Mace et al., (1992) found that a “time-out” utilized by a coach was an effective way to reduce an opponent’s rate of reinforcement, or behavioral momentum. That is, interrupting a series of successes by an opponent by calling “time-out” led to less subsequent success by that opponent. In golf, inconsistent play from round to round may inhibit the formation of Psychological Momentum and can also be understood in terms of an interruption of progress toward a goal. Although calling a “time-out” is not an option in tournament golf, there exist countless possible events that could disrupt a player’s success and destroy his Psychological Momentum. Events such as delays in play due to course characteristics, slow play, or weather are just a few examples of interruptions that impact players’ success.

Psychological Momentum--A Social-Cognitive Process

The theory of Psychological Momentum is based upon the idea that early success has social-cognitive effects, which underpin the likelihood of subsequent success. According to social learning theory (Bandura, 1977, 1986), behavior is mediated by cognitive processes and social influences. Thus, behavior is not simply the result of a strict stimulus-response relationship as conceptualized by behaviorism. The social and cognitive elements are processed following the stimulus and prior to the subsequent behavior. Psychological Momentum closely follows this social learning model as early success is transformed into Psychological Momentum if the athlete interprets early success in a way that imbues him with confidence, a sense of superiority over his opponent, and a belief in his likelihood of winning (Iso-Ahola & Blanchard, 1986).

Confidence is a key element in the theoretical framework of Psychological Momentum; in fact, it is central to the processes that bring it about. According to the theory, early success is likely to lead to the manifestation of confidence that, along with other elements, is the cognitive mediating component that is necessary to achieve Psychological Momentum and lead to a greater likelihood of subsequent success. One of the key benefits of increased confidence is that it leads to increases in both physical and mental effort (Iso-Ahola & Blanchard, 1986). Social psychologists have documented that confidence contributes significantly to how much effort an individual expends and how long he/she persists toward a goal (Gill, 2000; Duda & Hall, 2001; Nicholls, 1984; Dweck, 1986). Thus, the findings of both Study 1 and Study 2 regarding the most highly ranked golfers (Top 50) can in part be explained in terms of the mediating effect of confidence on mental (concentration) and physical (perseverance) effort and the resultant Psychological Momentum.

Confidence in the framework of Psychological Momentum would be labeled as “state” confidence, as opposed to “trait” confidence. Such situation-specific confidence may be best thought of as self-efficacy (Bandura, 1977, 1986). Self-efficacy refers to one's estimate of his/her capabilities regarding a particular situation or task. More specifically, self-efficacy refers to the perceived capabilities to perform a behavior that will lead to a certain outcome. Bandura's model of self-efficacy proposes there are many sources for the development of self-efficacy that, in turn, create expectations and then lead to behavior. One source of building self-efficacy is previous experience or in terms of sport, previous performance. Psychological Momentum closely parallels Bandura's model and social-cognitive theories in general. Psychological Momentum proposes early success that leads to increased self-confidence and self-efficacy. Both models posit that the individual processes information from previous behavior and uses it as a basis for subsequent behavior and performance. Research has shown that previous experience or accomplishments increase self-efficacy, which, in turn, positively affects subsequent performance (Bandura, 1977, 1986, 1997).

Bandura's (1997) social-cognitive theory also proposes the individual has expectations for the desired outcome (outcome expectations). According to Bandura, an outcome expectation is an estimate by the individual as to how likely his/her behavior is to bring about the desired outcome. This differs from the self-efficacy expectation that refers to the individual's estimate of his/her capabilities to execute the desired behavior. Similarly, a belief in a positive outcome (e.g., increased likelihood of winning) is an important part of the Psychological Momentum Theory (Iso-Ahola & Blanchard, 1986). The present findings are consistent with these theoretical ideas and suggest that previous performance or accomplishment provides the golfer with a strong belief that his present performance would result in future success. Thus, the golfer who achieves early success increases his outcome expectations on one hand and his self-confidence and self-efficacy on the other, and thereby provides himself with an important psychological foundation for achieving future success. It should be noted, however, that these cognitions were not directly measured in the present study.

Self-efficacy could also explain the lack of support for week-to-week performance observed in some of the data in Study 1 and within-tournament performance observed in Study 2. Succeeding in making the cut, or finishing in the Top 10, 20, or 30, may not always provide the golfer the outcome expectation necessary to achieve further success. Self-efficacy is what would be analogous to self-confidence that is part of the Psychological Momentum model. If a golfer fully believes he is capable of performing to a certain standard but does not believe that it will result in the desired outcome, then subsequent performance may not be influenced by the situation-specific confidence or self-efficacy. For example, it may be that a golfer who performs well on the back nine holes of his third round and achieves Psychological Momentum finds himself too many strokes behind going into the fourth and final round, and thus, determines that no matter what his score is in the final round it will not be good enough. Consequently, performance in the final round does not benefit from the Psychological Momentum that was established the previous day. The present findings regarding back nine performance affecting the next day's round showed this to be the case.

Among other psychological processes that the framework for Psychological Momentum parallels is the social-cognitive process of attribution. Attribution theory (Heider, 1958; Weiner et al., 1972) addresses how people explain the causes of their behavior and their successes and failures. Attributions have been shown to affect expectations of future success and failure (Biddle, Hanrahan, & Sellars, 2001; McAuley, 1993; Iso-Ahola, 1977). Where Psychological Momentum proposes the manifestation of psychological advantage or power, attribution theory proposes how the cognitions are likely to influence subsequent behavior, or in sport, subsequent performance. Within the model of Psychological Momentum, attributions would be operating as the individual processes and assigns causality to early success and then transforms it to psychological power.

The present research may in part be viewed in the context of attributions. Early success may or may not be transformed into psychological power as evidenced by the mixed results pertaining to the second hypothesis in Study 1 and the fourth and fifth hypotheses in Study 2. For example, golfers who believe their performance is under their control are more likely to attribute their success to personal skills and abilities than those golfers who believe their performance is not under their control. A sense that performance outcomes are not under one's control would lead to decreased motivation, or in the Psychological Momentum terms, a decrease in physical and/or psychological effort, with the net result of the reduced likelihood of subsequent success. According to the theory of Psychological Momentum, it is the individual's interpretation of early success (i.e., causal attributions) that leads to psychological power and subsequent success, and it is this process that can be related to existing cognitive theories such as attribution theory in order to help understand discrepant findings. This suggestion, however, should be viewed with caution, as the present study did not directly measure relevant social-cognitive variables.

The Cut, The Median, and The Top 50

In golf, as in other sports, getting off to a good start has its advantages. But, what constitutes a good start? How is early success defined? The present research looked at both long-term and short-term criteria for early success and consequent Psychological Momentum. Making the cut and the median are criteria that allow golfers to evaluate their position relative to other golfers. The median represents what can be called the "potential cut line." The "actual cut line", or cut, occurs following the second round and roughly divides the entire field in half with those below the cut line (better performance) continuing to play two more rounds of golf and complete the tournament. One critical element of the first round is that it provides the competitors an initial indication for determining whether they will make the actual cut. Actual or raw scores are only meaningful when related to the raw scores of other golfers competing in an event. Thus, the median and the cut become markers for players to determine their success and for researchers to evaluate early success. According to the present research golfers who find themselves performing better than the median following their first round would have achieved early success and would therefore have the basis for Psychological Momentum going into the second round.

Additionally, the framework of Psychological Momentum suggests that those individuals who have performed above the median (poor performance) would have difficulty recovering and “coming back” during the critical second. This additional aspect, or “double effect” of Psychological Momentum, is noted by Iso-Ahola and Blanchard (1986) in regard to head-to-head competition where one competitor benefits from Psychological Momentum while the other simultaneously suffers. Knowing one’s position in relation to the median creates the “winner/loser” dichotomy, such that those below the potential cut line benefit from their position, while those above the potential cut line suffer. The median provides additional, meaningful, information that the raw score alone cannot. Indeed, the analysis of first round scores by grouping players either above or below the median provided strong support for the hypothesis that the first round score predicts the second round performance.

An intriguing finding that emerged from both Study 1 and Study 2 was that the top 50 golfers (players ranked from 1-50 on the previous year’s money list) were better at achieving and retaining Psychological Momentum than their lower ranked counterparts. It may be that these players achieve a performance state that allows them to more readily achieve Psychological Momentum, and as a result, they have many successes in a row. For example, the present research asked the question, “How many cuts do players make in a row?” Having established that the sequences observed were not random events, the question then became how many occurred in a sequence. The average number of cuts made in a row was surprisingly high (5.9). Additionally, it is worth noting that there was a meaningful difference in the average number of consecutive cuts made (7.3) between the top golfers (players 1-25) and the lowest ranked golfers (4.5) (players 101-125). This finding further supports the idea that Psychological Momentum as the phenomenon becomes more influential as competitors become more evenly matched (Iso-Ahola & Blanchard, 1986). It appears that the influence of Psychological Momentum increases with the ranking of a professional golfer. It may be generalized the Psychological Momentum is more likely to reveal itself in high-skill players than low-skill players. The present data provide support for this assertion. It may be that low-skill players engage in more processes related to the execution of the task--processes that are more procedural and physical and less automatic and psychological. If so, low-skill players would need to automatize their performance in order to gain the benefits of Psychological Momentum.

Related Constructs: Flow and Choking

The prevalence of Psychological Momentum among the top ranked players suggests that they are able to achieve a high-level of performance and maintain it even as performance demands upon them increase. In this way, the psychological constructs of flow and choking are related to Psychological Momentum and they may provide additional understanding regarding elite performance and the present research.

Research by Csikszentmihalyi (1990) and Jackson & Csikszentmihalyi (1999) describes a state of optimal performance as “flow” and identifies its characteristics. The ability to reach the state of flow may be important in order to achieve and sustain Psychological Momentum. According to the flow theory, one of the hallmarks of performing in a state of flow is the balance or matching of skill and challenge (Jackson & Csikszentmihalyi, 1999). If there is no balance the competitor may be overwhelmed when the challenge is greater than his skill, or, conversely, the competitor may become bored when his skill exceeds the challenge. This is relevant to the golfers evaluated in the present research and in particular, to the highest ranked golfers. That is, while all pro golfers have the requisite physical skills and abilities, the highest ranked golfers distinguished themselves as better, more consistent performers from week to week in Study 1 (this also holds true for round to round as found in Study 2). The flow theory suggests that those competitors, who more readily achieve the flow characteristics such as the balance of challenge and skill, especially as their challenges increase, as would be the case in tournament golf, may achieve optimal performance.

Research by Keller and Bless (2008) has established a causal relationship between the regulatory compatibility (balance of demand and skill) and the experience of flow. Their two experiments together demonstrated the critical role that the compatibility or matching of skill and challenge plays in an intrinsically motivating experience, or flow. They additionally found that individuals high on a personality measure of “action orientation” were more susceptible to the adaptive playing mode or manipulation of skill and challenge and consequently were more likely to experience flow. Likewise, top ranked golfers may more readily achieve this characteristic of flow that allows them to perform at an optimal level. Performing at an optimal level would be critical during times of special challenge (such as making the cut in the second round) when golfers must summon their physical and psychological skills to meet the challenge. If they are able to achieve a state of flow relatively readily, they are more likely to experience Psychological Momentum and therefore continue to succeed.

A sense of control is another characteristic of “flow” that is relevant for understanding a top-level performance. A sense of control means that an athlete has high confidence in himself as a performer. Confidence has been linked to performance such that increases in confidence lead to better performances (Feltz, 1984, Vealey, 2001). Confidence is also one of the manifestations of early success that leads to Psychological Momentum and subsequent success (Iso-Ahola & Blanchard, 1986). Athletes in a state of flow have a sense of control, or in other words, they do not fear a lack of control in their performance (Jackson & Csikszentmihalyi, 1999). Accordingly, the top golfers in the present research would have achieved a sense of control (flow) and built confidence (Psychological Momentum) as their successes multiplied, as seen in the Runs data for cuts, Top 10, Top 20, and Top 30 performances. It may be that there is a mechanism of feedback that flow enables athletes to utilize to sustain Psychological Momentum, and in turn, sequences of successes (Psychological Momentum) help maintain the state of flow.

Also important to the success of these elite golfers in achieving Psychological Momentum is the ability to maintain their high level of performance as demands upon them increase. Choking is a documented phenomenon in sport when performance deteriorates under conditions of stress (Hill et al., 2009). Poor performance is considered choking when that performance is below one’s actual abilities (Beilock & Gray, 2007). Choking is explained by researchers in terms of attention being consumed by irrelevant tasks (distraction) or, alternatively, by attention being focused on the step-by-step process of performing (explicit monitoring). The majority of empirical evidence on choking has supported the theoretical position of self-focus and explicit monitoring (Gray, 2004; Lewis & Linder, 1997; Beilock, 2001). However, recent findings indicate that "both distraction and explicit monitoring theories of choking under pressure seem to be correct. Whether attention is diverted from and/or directed toward the task at hand depends in large part on characteristics of the performance situation one is facing. Moreover, whether performance fails because of this situation depends also on the attentional demands of the task being performed" (DeCaro, et al., 2011, p. 12).

How do elite athletes perform successfully in high-pressure situations? The most frequently cited mechanism for this is that high-level expert performance is governed by procedural knowledge that does not impose demands upon working memory, as compared to the declarative knowledge used by non-experts. Thus, experts' performance is largely automatic (Beilock & Carr, 2001; Gray 2004). Regarding the present research, it may be that the top golfers have better psychological skills in terms of handling these situations due to their experience. Clearly, the Top 50 players have achieved their ranking by succeeding more often than the lower ranked golfers. Repeated exposure to high-pressure situations would allow the top performers to "procedurelize" or automate their "high-level skills" and the way in which they manage themselves in pressure situations (Beilock et al., 2002; Gray, 2004). Automating skills renders them less vulnerable to extraneous influences, and even if they are exposed to such influences they have cognitive resources to handle them. If so, they should be able to use Psychological Momentum to their advantage. Lower ranked golfers, on the other hand, may find that when they are in high-pressure situations, such as leading a golf tournament, they are not prepared to perform at their potential since they have been in these situations less often. As a result, they may more quickly revert to skill-focused attention, which would prevent higher-level performance and Psychological Momentum.

There exists evidence that highly skilled or experienced athletes are less likely to choke or suffer performance decrements in high-pressure situations (Beilock & Carr, 2001; Beilock et al., 2002; Gray, 2004; Beilock & DeCaro, 2007; Beilock & Gray, 2007). If the skilled and experienced athletes perform better under pressure, they would be able to capture Psychological Momentum and turn it into further success. Research has shown that experienced golfers perform better under pressure in a condition in which they are given dual tasks to perform versus a condition in which they are asked to monitor performance in a step-by step manner (Beilock et al., 2002). This suggests that the most experienced golfers do not undermine their abilities by over-analysis, but rather, that they perform better as additional demands are placed upon them (dual tasks). Moreover, research by Beilock et al., (2008) indicates skilled performers benefit from added pressure in terms of “speed instructions” or taking less time. This would be a plausible explanation for the results of Study 1 in terms of runs of success in cuts, Top 10, Top 20, and Top 30 performances, and for the results obtained in Study 2 that pertain to round 2 and making the cut. The second round of a tournament, which requires players to not only attend to the task at hand but to monitor their overall position with respect to making the cut, showed an effect from the front nine to the back nine performances.

It appears the very best players (Top 50 players) thrive when pressure is added to situations while their lesser-ranked counterparts' performance declines under the same conditions. The former are able to focus on the performance itself whereas the latter are likely to become self-focused and self-aware under pressure. The ability to perform successfully as demands increase (not to choke) allows the athlete to build success upon success and benefit from the advantages of Psychological Momentum. These ideas and possibilities, however, need to be tested empirically.

Summary

By and large, the findings of Study 1 and Study 2 supported the theory of Psychological Momentum. Study 1 found non-random patterns in the data for making the cut, finishing in the Top 10, Top 20, and Top 30. Study 2 found early success was critical in the formation of Psychological Momentum that led to making the cut. Success in the first round was crucial to making the cut, predicting the subsequent round's performance, and additionally, predicting making the cut when the first round score was evaluated according to the median. All of these findings point to the critical importance of getting off to a good start. As a whole, the present research supports the premise of early success and suggests that the phenomenon of Psychological Momentum functions both on a long-term and a short-term basis on the PGA Tour.

Limitations and Future Directions

Study 1 is limited by the exclusion of available data due to the fact that some players did not play week-to-week—the optimal scenario in which to allow runs or "streaks" to be determined. Players competing on the PGA Tour operate as individual contractors in that they determine in which tournaments they will compete. There are very few rules dictating which events, or how many events, a player will play. A typical player may play 25 events in a season. Some play as few as 14 or 15 while others play as many as 30 or more. In order to compare players who have different playing schedules it was established that "runs" would be assessed on players who had missed or "skipped" no more than two consecutive weeks. Future investigations could define "runs" differently. For example, Psychological Momentum could be investigated among the Top 50 golfers or Top 100 golfers who all play the "Major" events and select other marquee tournaments. Such an analysis would provide a stronger methodology and further insight by capturing all of the same players in the same events. However, this approach would exclude many players and also introduce extended periods of time between certain events played.

Both Study 1 and Study 2 were limited by the data set utilized. Extensive data are collected by the PGA Tour every year and archived for their specific goals and purposes. These data are collected primarily to report basic statistical information such as driving distance, percentages of greens reached in regulation, percentages of fairways hit, putts per round, and so on. No straight psychological data are collected. Measures and instruments to collect data that pertain directly to aspects of Psychological Momentum, such as measures of self-confidence or outcome expectations, were not available. Thus, the use of these archival data only allows the presence of Psychological Momentum to be inferred. Despite the abundance of evidence supporting the construct as a plausible, theoretically sound explanation for the data, the ability to directly and unobtrusively measure the phenomenon must be addressed.

A delimitation of the two studies is that only the Top 125 players were examined. Selecting the Top 125 was a decision that was made because this threshold is used by the PGA Tour in determining which players retain their Tour card, or privileges, and right to compete on the PGA Tour the following year. This also is a limitation of the two studies as the Top 125 players are constantly changing throughout the season, from week to week. It is only after the final event that the Top 125 players can be determined.

From the standpoint of cause-effect conclusions, the study has a limitation because Psychological Momentum was not directly measured or manipulated. Experimental research, of course, is the only way to provide causal conclusions. Psychological Momentum exists if a performer's confidence, perceived competence, and perceived likelihood of doing well have increased (Iso-Ahola & Blanchard, 1986). On the PGA Tour, there is, however, no way of observing this cognitively occurring phenomenon, much less manipulating it in an experimental sense. Therefore, data must be collected by asking the athlete directly. Interrupting an athletic event to assess Psychological Momentum might undermine the phenomenon itself. The mechanism for building Psychological Momentum, the cognitive processes in which an athlete engages, might be disrupted by attempts, such as questionnaires, to measure the phenomenon. On the other hand, false feedback has been effectively employed to manipulate Psychological Momentum (Kerick, et al., 2000) in experimental laboratory settings, but not in real life competitive situations.

Direct measurements of specific elements of the theory would provide greater confidence in drawing conclusions. Creative methodologies need to be developed that would enable researchers to observe and measure this phenomenon as it presents itself naturally.

For example, collecting data regarding self-confidence after each hole of a round would provide researchers a direct measure of the golfer's confidence throughout the round. In order to do so, golfers would need to record a self-confidence score along with their actual score for each hole. Typically golfers record, in writing, their score following each hole. If players were instructed to record another numeric value for self-confidence (according to a simple scale) along with each actual score, such data could be collected with minimal disruption of their round. Alternatively, a "scorer" for self-confidence could be present on each tee to ask for a simple number from each player as he arrives at the tee box. Golf is a sport well suited for collection of such data as there exists time between each hole (in fact, between each shot) to allow golfers to report selected cognitions or feelings. Collecting similar data in a sport such as tennis would be impossible.

This methodology could also be employed to capture players' belief in their perceived likelihood of winning or scoring well and sense of superiority over their opponent (in match play). These data would help enlighten the cognitive processes that have been theorized to be occurring in the development of Psychological Momentum. A minimally intrusive method, such as this, to directly measure players' psychological state during the actual competition would constitute a good test of the theory of Psychological Momentum. Additionally, multiple instruments could be used in order to determine the robustness of Psychological Momentum as a uniting, encompassing construct. It would be useful to have the momentum construct manifested in several ways to better understand its effect on athletic performance.

Measuring the phenomenon on a short-term basis, such as each shot, would be recommended in order to assure the greatest potential for capturing an effect. It may be that Psychological Momentum is a transient state that influences other states such a confidence, either negatively or positively, in the future. Psychological Momentum has been shown to be a short-lived phenomenon (Hamberger & Iso-Ahola, 2005). In sporting events (e.g., golf) that last for several hours, Psychological Momentum is likely to emerge and then disappear several times throughout the competition. A performance, such as a single shot in golf, may be a trigger for a change in Psychological Momentum. Having extensive data that pertain to Psychological Momentum on each individual shot would allow researchers to determine if small time frames in performance would better help them to understand the conditions under which Psychological Momentum emerges.

Is Psychological Momentum a cause or an effect? As mentioned, the presence of Psychological Momentum was inferred, not directly measured, and as such, the role of Psychological Momentum cannot be stated conclusively. In theory, early success would provide a competitor with psychological power, which in turn, would enable greater effort both mental and physical. The result of this sequence would be further success. In this theoretical "chain of command" Psychological Momentum would be a cause of subsequent success and lead to the non-random patterns observed in the current data. There is experimental data reported in the literature that confirms the idea that Psychological Momentum is actually causing improved performance (e.g., Perreault et al., 1998).

The present research was done in two studies in order to assess the effects of Psychological Momentum both in the short-term and the long-term. Previous studies have examined either short-term or long-term effects and thus, present challenges when comparing and interpreting results. Hamberger and Iso-Ahola (2005) have identified the "unit of analysis," or "immediate" measures and "end result" measures, as a methodological problem when attempting to prove the effects of Psychological Momentum on performance. Future research should attempt to incorporate measures both in the short-term and long-term in order to make meaningful comparisons with a broad range of other studies.

The issue of differences in player ability confounding the momentum effect is often raised. This question was thoroughly examined by Jackson and Mosurski (1997) who tested several models, including the random effects to account for differences in performance from day to day, and even incorporated the world rankings of the players in order to control for the effects of ability. The findings clearly indicated that Psychological Momentum is the most convincing explanation for their data, leading the authors to conclude: "To abandon independence, however, is not to say that one must reject the common-sense idea that player ability varies from day to day, only that on its own such a model is unlikely to be successful." (p. 33) Likewise, the present research found Psychological Momentum, not ability, to be the explanation for the findings.

Appendices

Table 1

Number of runs for "cuts made" by PGA Tour players, overall,
and by quintile group, for the 2007 and 2008 seasons combined.
Runs Test Z-score tests whether the number of runs could be explained by chance.

	total	**runs-Cuts**	Z-score	p-value
Overall	4237	**1911**	-3.054	0.002
Q1	687	**276**	-1.495	0.135
Q2	809	**325**	-1.651	0.099
Q3	946	**439**	-1.303	0.193
Q4	987	**491**	0.652	0.514
Q5	808	**383**	-1.346	0.178

Table 2

Number of runs for "Top 10 performances" by PGA Tour players, overall,
and by quintile group, for the 2007 and 2008 seasons combined.
Runs Test Z-score tests whether the number of runs could be explained by chance.

	total	**runs-Top 10s**	Z-score	p-value
Overall	4237	**835**	-3.967	0.000
Q1	687	**192**	-1.886	0.059
Q2	809	**187**	-3.255	0.001
Q3	946	**179**	-0.416	0.678
Q4	987	**153**	-0.349	0.727
Q5	808	**127**	-0.049	0.961

Table 3

Number of runs for "Top 20 performances" by PGA Tour players, overall,
and by quintile group, for the 2007 and 2008 seasons combined.
Runs Test Z-score tests whether the number of runs could be explained by chance.

	total	**runs-Top 20s**	Z-score	p-value
Overall	4237	**1349**	-5.787	0.000
Q1	687	**280**	-2.366	0.018
Q2	809	**281**	-3.726	0.000
Q3	946	**301**	-0.727	0.468
Q4	987	**281**	-0.306	0.760
Q5	808	**209**	-2.595	0.009

Table 4

Number of runs for "Top 30 performances" by PGA Tour players, overall, and by quintile group, for the 2007 and 2008 seasons combined.
Runs Test Z-score tests whether the number of runs could be explained by chance.

	total	**runs-Top 30s**	Z-score	p-value
Overall	4237	**1657**	-6.932	0.000
Q1	687	**393**	-3.527	0.025
Q2	809	**389**	-2.113	0.041
Q3	946	**312**	-0.971	0.077
Q4	987	**293**	-0.998	0.079
Q5	808	**287**	-1.452	0.064

Table 5

Mean number of longest runs for "cuts made" by PGA Tour players overall, and by quintile group, for the 2007 and 2008 seasons combined.

	N	**Mean**	Std. Deviation
Overall	204	**5.9510**	3.3934
Q1	38	**7.2632**	3.4772
Q2	40	**7.5250**	4.3382
Q3	42	**5.4762**	2.7783
Q4	43	**5.1395**	2.5409
Q5	41	**4.5366**	2.6655

Table 6

Mean number of longest runs for "Top 10 performances" by PGA Tour players overall, and by quintile group, for the 2007 and 2008 seasons combined.

	N	**Mean**	Std. Deviation
Overall	204	**1.2549**	0.9488
Q1	38	**1.6579**	1.0208
Q2	40	**1.6250**	1.1477
Q3	42	**1.1429**	0.8431
Q4	43	**1.0233**	0.8306
Q5	41	**0.8780**	0.5998

Table 7

Mean number of longest runs for "Top 20 performances" by PGA Tour players overall, and by quintile group, for the 2007 and 2008 seasons combined.

	N	**Mean**	Std. Deviation
Overall	204	**2.0098**	1.3537
Q1	38	**2.7632**	1.5323
Q2	40	**2.5250**	1.4140
Q3	42	**1.6905**	0.9750
Q4	43	**1.6047**	1.2562
Q5	41	**1.5610**	1.1191

Table 8

Mean number of longest runs for "Top 30 performances" by PGA Tour players overall, and by quintile group, for the 2007 and 2008 seasons combined.

	N	**Mean**	Std. Deviation
Overall	204	**2.8480**	1.7339
Q1	38	**3.8158**	2.1163
Q2	40	**3.3000**	1.8003
Q3	42	**2.5476**	1.2726
Q4	43	**2.3721**	1.6765
Q5	41	**2.3171**	1.2736

Table 9

Chi-square test for "cut made" week two being independent of "cut made" week one, by quintile group, for PGA Tour players over the 2007 and 2008 seasons combined.

	N	χ^2	p-value
Q1	455	**1.631**	0.227
Q2	566	**9.005**	0.003
Q3	666	**7.989**	0.006
Q4	714	**1.234**	0.269
Q5	590	**0.079**	0.802

Table 10

Chi-square test for "Top 10 performance" week two being independent of "Top 10 performance" week one, by quintile group, for PGA Tour players over the 2007 and 2008 seasons combined.

	N	χ2	p-value
Q1	455	**5.816**	0.019
Q2	566	**10.629**	0.003
Q3	666	**0.053**	0.846
Q4	714	**1.308**	0.245
Q5	590	**0.072**	0.788

Table 11

Chi-square test for "Top 20 performance" week two being independent of "Top 20 performance" week one, by quintile group, for PGA Tour players over the 2007 and 2008 seasons combined.

	N	χ2	p-value
Q1	455	**8.303**	0.005
Q2	566	**8.371**	0.005
Q3	666	**0.173**	0.729
Q4	714	**1.461**	0.254
Q5	590	**2.963**	0.093

Table 12

Chi-square test for "Top 30 performance" week two being independent of "Top 30 performance" week one, by quintile group, for PGA Tour players over the 2007 and 2008 seasons combined.

	N	χ2	p-value
Q1	455	**0.895**	0.349
Q2	566	**8.899**	0.003
Q3	666	**3.819**	0.052
Q4	714	**1.354**	0.267
Q5	590	**10.931**	0.001

Table 13
Post hoc Tukey HSD examining all pair-wise differences among quintile groups for number of longest runs for "Top 10 performances" by PGA Tour players for the 2007 and 2008 seasons combined.

TOP10LRUN	Quintile Groups						
Quintile Groups	1	2	3	4	5	Means	N
1		0.0329	0.515	0.6346	0.7799*	1.6579	38
2			0.4821	0.6017	0.747	1.6250	40
3				0.1196	0.2649	1.1429	42
4					0.1453	1.0233	43
5						0.8780	41

Q(5,dferror)	3.9
Number of Groups(k)	5
Harmonic sample size	40.72611
Error	0.816
Tukey HSD	**0.552043**

*indicates the difference in number of longest runs for the respective groups is significant at the .05 level.

Table 14
Post hoc Tukey HSD examining all pair-wise differences among quintile groups for number of longest runs for "Top 20 performances" by PGA Tour players for the 2007 and 2008 seasons combined.

TOP20LRUN	Quintile Groups						
Quintile Groups	1	2	3	4	5	Means	N
1		0.2382	1.0727*	1.1585*	1.2022*	2.7632	38
2			0.8345*	0.9203*	0.964*	2.5250	40
3				0.0858	0.1295	1.6905	42
4					0.0437	1.6047	43
5						1.5610	41

Q(5,dferror)	3.9
Number of Groups(k)	5
Harmonic sample size	40.72611
Error	1.609
Tukey HSD	**0.775186**

*indicates the difference in number of longest runs for the respective groups is significant at the .05 level.

Table 15

Post hoc Tukey HSD examining all pair-wise differences among quintile groups for number of longest runs for "Top 30 performances" by PGA Tour players for the 2007 and 2008 seasons combined.

TOP30LRUN	Quintile Groups						
Quintile Groups	1	2	3	4	5	Means	N
1		0.5158	1.2682*	1.4437*	1.4987*	3.8158	38
2			0.7524	0.9279*	0.9829*	3.3000	40
3				0.1755	0.2305	2.5476	42
4					0.055	2.3721	43
5						2.3171	41

Q(5,dferror)	3.9
Number of Groups(k)	5
Harmonic sample size	40.72611
Error	2.721
Tukey HSD	**1.008074**

*indicates the difference in number of longest runs for the respective groups is significant at the .05 level.

Table 16

Analysis of Variance for mean number of longests runs among the five quintile groups for Top 10 performances for the tournaments from the 2007 and 2008 PGA Tour seasons.

Tests of Between-Subjects Effects
Dependent Variable: "Top 10 Longest Runs"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**20.308**	**4**	**5.077**	**6.220**	**0.0001**
Intercept	326.067	1	326.067	399.460	0.0001
TOP125Q	20.308	4	5.077	6.220	0.0001
Error	162.437	199	8.16E-01		
Total	504	204			
Corrected Total	182.745	203			
R Squared=.111 (Adjusted R Squared=.093)					

Table 17

Analysis of Variance for mean number of longest runs among the five quintile groups for Top 20 performances for the tournaments from the 2007 and 2008 PGA Tour seasons.

Tests of Between-Subjects Effects
Dependent Variable: "Top 20 Longest Runs"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**51.784**	**4**	**12.946**	**8.046**	**0.0001**
Intercept	838.192	1	838.192	520.931	0.0001
TOP125Q	51.784	4	12.946	8.046	0.0001
Error	320.196	199	1.61E+00		
Total	1196	204			
Corrected Total	371.98	203			
R Squared=.139 (Adjusted R Squared=.122)					

Table 18

Analysis of Variance for mean number of longest runs among the five quintile groups for Top 30 performances for the tournaments from the 2007 and 2008 PGA Tour seasons.

Tests of Between-Subjects Effects
Dependent Variable: "Top 30 Longest Runs"

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**68.849**	**4**	**17.212**	**6.326**	**0.0001**
Intercept	1677.886	1	1677.886	616.688	0.0001
TOP125Q	68.849	4	17.212	6.326	0.0001
Error	541.44	199	2.72E+00		
Total	2265	204			
Corrected Total	610.289	203			
R Squared=.113 (Adjusted R Squared=.095)					

Table 19

Chi-Square test that making the cut is independent of first round score for PGA Tour events from the 2007 and 2008 seasons.

Omnibus Tests of Model Coefficients

	Chi-squ	df	Sig.
Step 1	**518.49**	**1**	**0.0001**

Table 20

The Odds Ratio describing the relative chance of making the cut when shooting an over-par first round score as compared to shooting an under-par first round score.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	**Odds Ratio**
Step 1(a)	Score(over par)	-0.374	0.019	372.779	1	0.0001	**0.688***
	Constant	0.764	0.052	216.273	1	0.0001	2.147
a Variable(s) entered on step 1: SCORE1A							

*Chance of making the cut if first round score is over-par versus chance of 1.0 if first round score is under-par.

Table 21
Pearson product-moment correlations for first, second, third, and fourth round scores, each adjusted for tournament conditions and strength of field, for PGA Tour events from the 2007 and 2008 seasons.

		First round	Second round	Third round	Fourth round
First round	**Pearson Correlation**				
	Sig. (2-tailed)				
	N	1438			
Second round	**Pearson Correlation**	0.078			
	Sig. (2-tailed)	0.003			
	N	1438			
Third round	**Pearson Correlation**	0.019	0.052		
	Sig. (2-tailed)	0.483	0.050		
	N	1438	1438		
Fourth round	**Pearson Correlation**	0.024	0.003	0.748	
	Sig. (2-tailed)	0.354	0.904	0.0001	
	N	1438	1438	1438	

Table 22

Chi-Square analysis of the first round scores classified as either above or below the median (potential cut line) as compared to second round scores classified as either above or below the median (actual cut line) for the tournaments from the 2007 and 2008 PGA Tour seasons.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Chi-Square	**1019.996(b)**	1	**0.0001**		
Continuity Corrections(a)	1018.054	1	0.000		
Likelihood Ratio	1054.554	1	0.000		
Fisher's Exact Test				0.000	0.000
Linear-by-Linear Association	1019.77	1	0.000		
N of Valid Cases	4511				

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minmum expected count is 831.89

Table 23

Analysis of Covariance for back nine scores for Round 1 as a function of Psychological Momentum ("below par," "even par," and "above par") for the tournaments from the 2007 and 2008 PGA Tour season. (Co-variates were strength of field and course condition/difficulty)

Between-Subjects Factors

		N
Front nine (Round 1)	-1 (below par)	1676
	0 (even par)	941
	1 (above par)	1883

Descriptive Statistics

Dependent Variable: Back nine score (Round 1)

Front nine	Mean	Std. Dev.	N
-1.00	0.493319	0.278593	1676
0.00	0.516399	0.283576	941
1.00	0.507576	0.291345	1883
Total	0.504111	0.285105	4500

Tests of Between-Subjects Effects

Dependent Variable: Back nine score (Round 1)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**.360(a)**	**2**	**0.180**	**2.215**	**0.109**
Intercept	1051.02	1	1051.02	12937.060	0.000
Front nine(Rd.1)	0.360	2	0.180	2.215	0.109
Error	365.341	4497	8.12E-02		
Total	1509.277	4500			
Corrected Total	365.701	4499			
a R Squared=.001 (Adjusted R Squared = .001)					

Table 24

Analysis of Covariance for back nine scores for Round 2 as a function of Psychological Momentum ("below par," "even par," and "above par") for the tournaments from the 2007 and 2008 PGA Tour seasons. (Co-variates were strength of field and course condition/difficulty)

Between-Subjects Factors

		N
Front nine (Round 2)	-1 (below par)	1794
	0 (even par)	940
	1 (above par)	1766

Descriptive Statistics

Dependent Variable: Back nine score (Round 2)

Front nine	Mean	Std. Dev.	N
-1.00	0.487274	0.279971	1794
0.00	0.506855	0.278549	940
1.00	0.519755	0.292300	1766
Total	0.504111	0.284889	4500

Tests of Between-Subjects Effects

Dependent Variable: Back nine score (Round 2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**.948(a)**	**2**	**0.474**	**5.852**	**0.003**
Intercept	1047.703	1	1047.703	12936.643	0.000
Front nine(Rd. 2)	0.948	2	0.474	5.852	0.003
Error	364.199	4497	8.10E-02		
Total	1508.723	4500			
Corrected Total	365.147	4499			
a R Squared = .003 (Adjusted R Squared = .002)					

Table 25

Analysis of Covariance for back nine score for Round 3 as a function of Psychological Momentum ("below par," "even par," and "above par") for the tournaments from the 2007 and 2008 PGA Tour seasons. (Co-variates were strength of field and course condition/difficulty)

Between-Subjects Factors

		N
Front nine (Round 3)	-1 (below par)	970
	0 (even par)	539
	1 (above par)	1259

Descriptive Statistics

Dependent Variable: Back nine score (Round 3)

Front nine	Mean	Std. Dev.	N
-1.00	0.500471	0.282788	970
0.00	0.504511	0.271804	539
1.00	0.512400	0.290669	1259
Total	0.506684	0.284273	4500

Tests of Between-Subjects Effects
Dependent Variable: Back nine score (Round 3)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**8.112E-02**	**2**	**4.056E**	**0.502**	**0.606**
Intercept	625.581	1	625.581	7738.498	0.000
Front nine (Rd.3)	8.112E	2	4.056E	0.502	0.606
Error	223.523	2765	8.08E-02		
Total	934.228	2768			
Corrected Total	223.604	2767			
R Squared = .000 (Adjusted R Squared = .000)					

Table 26

Analysis of Covariance for back nine scores for Round 4 as a function of Psychological Momentum ("below par," "even par," and "above par") for the tournaments from the 2007 and 2008 PGA Tour seasons. (Co-variates were strength of field and course condition/difficulty)

Between-Subjects Factors

		N
Front nine (Round 4)	-1 (below par)	810
	0 (even par)	496
	1 (above par)	1206

Descriptive Statistics

Dependent Variable: Back nine score (Round 4)

Front nine	Mean	Std Dev.	N
-1.00	0.514130	0.283063	810
0.00	0.500872	0.280874	496
1.00	0.505491	0.286922	1206
Total	0.507365	0.284426	2512

Tests of Between-Subjects Effects
Dependent Variable: Back nine score (Round 4)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**6.221E-02**	**2**	**3.111E'-02**	**0.384**	**0.681**
Intercept	566.658	1	566.658	7001.174	0.000
Front nine (Rd.4)	6.221E'-02	2	3.111E'-02	0.384	0.681
Error	203.072	2509	8.094E-02		
Total	849.771	2512			
Corrected Total	203.135	2511			
R Squared = .000 (Adjusted R Squared = .000)					

Table 27

Analysis of Covariance for the next day 18-hole score (Round 2) as a function of Psychological Momentum ("below par," "even par," and "above par") for the tournaments from the 2007 and 2008 PGA Tour seasons. (Co-variates were strength of field and course condition/difficulty)

Between-Subjects Factors

		N
Back nine (Round 1)	-1 (below par)	1741
	0 (even par)	883
	1 (above par)	1876

Descriptive Statistics

Dependent Variable: "Next day score" (Round 2)

Back nine	Mean	Std. Dev.	N
-1.00	0.474920	0.278385	1741
0.00	0.505009	0.287639	883
1.00	0.530779	0.291666	1876
Total	0.504111	0.286831	4500

Tests of Between-Subjects Effects

Dependent Variable: "Next day score" (Round 2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**2.818**	**2**	**1.409**	**17.253**	**0.0001**
Intercept	1018.886	1	1018.886	12473.822	0.0001
Back nine (Rd.1)	2.818	2	1.409	17.253	0.0001
Error	367.324	4497	8.168E-02		
Total	1513.718	4500			
Corrected Total	370.142	4499			
R Squared = .008 (Adjusted R Squared = .007					

Table 28

Analysis of Covariance for the next day 18-hole score (Round 4) as a function of Psychological Momentum ("below par," "even par," and "above par") for the tournaments from the 2007 and 2008 PGA Tour seasons. (Co-variates were strength of field and course condition/difficulty)

Between-Subjects Factors

		N
Back nine, (Round 3)	-1 (below par)	1030
	0 (even par)	501
	1 (above par)	981

Descriptive Statistics

Dependent Variable: "Next day score" (Round 4)

Back nine	Mean	Std. Dev.	N
-1.00	0.499205	0.284946	1030
0.00	0.498690	0.284277	501
1.00	0.520362	0.288456	981
Total	0.507365	0.286265	2512

Tests of Between-Subjects Effects

Dependent Variable: "Next day score" (Round 4)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	**.272(a)**	**2**	**0.136**	**1.661**	**0.190**
Intercept	578.264	1	578.264	7060.233	0.000
Back nine(Rd.3)	0.272	2	0.136	1.661	0.190
Error	205.498	2509	8.190E-02		
Total	852.406	2512			
Corrected Total	205.77	2511			
a R Squared = .001 (Adjusted R Squared = .001)					

Table 29

Post hoc Tukey HSD for testing differences in back nine scores (of Round 2) between Psychological Momentum groups: below par (-1.0), even par (0.0), and above par (1.0) for the 2007 and 2008 PGA Tour seasons.

Multiple Comparisons
Dependent Variable: Back nine score (Round 2)
Tukey HSD

(I) Front nine performance group	**(J)**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
-1.00	0.00	-1.958152E-02	1.14586E-02	0.202	-4.643710E-02	7.27406E-03
	1.00	-3.248153E-02(*)	9.53952E-03	0.002	-5.483932E-02	-1.012374E-02
0.00	-1.00	1.95815E-02	1.14586E-02	0.202	-7.274060E-03	4.64371E-02
	1.00	-1.290001E-02	1.14898E-02	0.500	-3.982869E-02	1.40287E-02
1.00	-1.00	3.24815E-02(*)	9.53952E-03	0.002	1.01237E-02	5.48393E-02
	0.00	1.29000E-02	1.14898E-02	0.500	-1.402867E-02	3.98287E-02

Based on observed means.
* The mean difference is significant at the .05 level.

Table 30

Post hoc Tukey HSD for testing differences in the Round 2 18-hole scores between Psychological Momentum groups: below par (-1.0), even par (0.0), and above par (1.0) for the 2007 and 2008 PGA Tour seasons.

Multiple Comparisons
Dependent Variable: "Next day score" (Round 2)
Tukey HSD

(I) Back nine performance group	(J)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
-1.00	0.00	-3.008870E-02(*)	1.18077E-02	0.029	-5.776241E-02	-2.414983E-03
	1.00	-5.585935E-02(*)	9.51090E-03	0.000	-7.815005E-02	-3.356865E-02
0.00	-1.00	3.00887E-02(*)	1.18077E-02	0.029	2.41498E-03	5.77624E-02
	1.00	-2.577065E-02	1.16639E-02	0.070	-5.310724E-02	1.56593E-03
1.00	-1.00	5.58593E-02(*)	9.51090E-03	0.000	3.35687E-02	7.81500E-02
	0.00	2.57707E-02	1.16639E-02	0.070	-1.565935E-03	5.31072E-02

Based on observed means.

* The mean difference is significant at the .05 level.

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