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Psychological Momentum: Why Success Breeds Success

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Whether trying to win Presidential primaries, trading stocks, or playing sports, performance-enhancing effects of psychological momentum (PM) are widely accepted. But, does initial success ($\mathbf{S_1}$) lead to subsequent success ($\mathbf{S_2}$) in and of itself due to increased know-how on one's and opponents' performance or because it creates psychological force (momentum) that mediates this relationship? We review research on the phenomenon and show its strong empirical foundations in various domains of human performance. To advance research, we present an organizing theoretical framework that proposes both mediating and moderating effects of PM as mechanisms to explain why success breeds success in general. Initial success is critical for PM and has 3 types of effects: intensity, frequency, and duration. Whether performing alone (trader) or against an opponent (tennis player), perceptions of self as a performer ($\mathbf{S_p}$) and of opponent as a performer ($\mathbf{O_p}$) are at the center of PM. The theory posits that the more the initial success separates the two ($\mathbf{O_p}/\mathbf{S_p}$), the greater the PM. These and associated perceptions, however, have to turn into an increased subjective probability of winning or succeeding before PM becomes a psychological force. Evidence supports the mediating mechanism since initial success increases PM, which in turn enhances subsequent success. When initial success with PM leads to a greater likelihood of subsequent success than without PM, PM then modifies ("moderates") the $\mathbf{S_1}$–$\mathbf{S_2}$ relationship without PM's independent effect on $\mathbf{S_2}$. There is also tentative evidence for a moderated mediation effect as the influence of PM seems to be greater for male than female performers. Areas of future research are highlighted.

Keywords: momentum, hot hand, success-failure, choking, mediation–moderation

If I got something going, I would somehow find a way to stop the momentum.

—Tiger Woods

If one were to ask people on the street, "What is cognitive dissonance?" most likely 99% would have no clue. But if they were asked, "What is momentum?" probably 99% would have a general understanding. They would not answer according to Newtonian physics but rather, in psychological terms. Indeed, psychological momentum (PM) is one of the most frequently discussed phenomena among sports fans and stock traders. This is especially evident when listening to sports commentators, reading sports pages, or when following commentaries about stock markets' daily behaviors. Similarly, in the 2012 Presidential primaries, candidates were frequently gaining and losing momentum, according to pundits. It is, then, no wonder that over 90% of sports fans (Markman & Guenther, 2007), 92% of coaches (Raab, Gula, & Gigerenzer, 2012), and 76% of NBA basketball players themselves (Gilovich, Vallone, & Tversky, 1985) *believe* that their performance is crucially determined by momentum, to the point that they "almost can't miss" their next shot (Gilovich et al., 1985; Markman & Guenther, 2007). Thus, the public at large and athletes themselves are convinced about the performance-enhancing effects of psychological momentum.

It is, therefore, not surprising that even a single successful shot is sufficient to increase NBA players' likelihood of taking the next team shot (Attali, 2013). They even change their behavior after a single field goal attempt and tend to "overgeneralize" to future actions (Neiman & Loewenstein, 2011). Such a behavioral change suggests that athletes are quick to embrace psychological momentum and operate on the basis of these perceptions. This is to be expected given that belief in oneself as performer constitutes one's "psychological core" and is at the heart of athletic performance in general (Iso-Ahola, 1995) and psychological momentum in particular (Iso-Ahola & Blanchard, 1986). Prior success gives rise to perceptions of momentum and an increased sense of confidence and efficacy, as will be shown later. Athletes seek confidence because, with it, they know they are better performers. Consequently, they are continuously trying to create momentum for their performance, and the only way to do it is to make successful performances happen.

Common Phenomenon

Psychological momentum is not just a sports phenomenon. The tendency to detect short-term sequential dependencies can be seen in most, if not all, human activities, from births (is the next child

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also a girl?) to weather events to horse race betting to financial markets' ups and downs (Arkes, 2011; Hendricks, Patel, & Zeckhauser, 1993; Oskarsson, VanBoven, McClelland, & Hastie, 2009). It has even been suggested that individual competence in detecting streaks serves evolutionary function and helps people to cognitively adapt to the environment (Wilke & Barrett, 2009). In the economic context, the importance of momentum perceptions is quite clear. For example, it is widely believed that since the 2008 Great Recession, companies have been slow to make capital investments and hire new employees because they are waiting to see if the economy is "gaining momentum" and therefore truly recovering. Momentum also gets to the heart of the debate on how the economy works and financial markets function, and whether people make rational financial choices (Tetlock & Mellers, 2002). There is a school of economists who believe that the markets are "efficient" and consequently always correctly price products (e.g., stocks) at a given time. This is based upon an assumption that all the relevant information is available and that people make rational decisions and choices about investments. "Behavioral economists" (e.g., pioneers like Kahneman and Thaler), however, have challenged this assumption and shown that people actually make irrational financial decisions during risk taking (Kahneman & Tversky, 1979). As was seen in the dot.com era, many people blindly followed the market momentum and frequently bought stocks high (i.e., near their peak) only to sell them low when the markets crashed. "Smart" or rational investors, on the other hand, did the opposite: bought low and sold high. The financial markets frequently overshoot (positive momentum) and undershoot (negative momentum) because investors' and traders' decisions are largely emotionally based (Kahneman, 2011; Lerner, Small, & Loewenstein, 2004). Stock prices over the short term are frequently driven by investor sentiment rather than companies' performance ("fundamentals"). High-momentum stocks are heavily traded, often have unjustified price-to-earnings ratios, and exhibit wild swings based on fluctuating momentums. Investors, however, can benefit from psychological momentum as shown by Hendricks et al. (1993). In their classic study of mutual funds' performance over 13 years, these researchers sought to determine if steering money to funds that have performed well recently is justified. Their data showed that such a strategy can lead to superior performance with returns up to 10% per annum as long as the evaluation period does not exceed one year. There was a statistically significant relationship between performance in one period and the next. The authors concluded that "substantial gains are available from investing in the mutual fund equivalents of the last year's pennant winners" (p. 122).

Psychological Foundations

In the first study of the phenomenon, Iso-Ahola and Mobily (1980) defined psychological momentum "as an added or gained psychological power that changes a person's view of him/herself or of others, or others' views of him/her and themselves" (p. 392). Accordingly, psychological momentum changes not only a performer's own perceptions but concurrently his or her opponent's perceptions as well. This definition is important because it posits that one gains psychological advantage by his or her own successful performance *and* by an opponent's simultaneous unsuccessful or reduced performance. True to the fundamental nature of a zero-sum game, one's gain in momentum is another's loss. A performer who has momentum blocks his or her opponent from having one. Both cannot have momentum simultaneously, but they, of course, can alternate momentums. In this alternation, a person can create momentum by his or her own successful performance (e.g., a "birdie" in golf), but can also build on it or maintain it by an opponent's unsuccessful performance (e.g., a "bogey" in golf), thereby feeding off of the opponent's lowered performance. Creating frequent, intense, and lasting momentums in such competitive duels is critical for the final success. Three predictions follow from these considerations: An individual or team that has (a) more momentums during the entire contest is more likely to win or be successful (*frequency effect*); (b) the one whose momentums last longer (*duration effect*) is more likely to win or be successful; and (c) momentums with higher intensity increase the likelihood of success and winning (*intensity effect*). Intensity here refers to momentum that has been created by a powerful performance, such as a ferocious dunk in basketball. All of these three effects will be elaborated on later.

Psychological momentum is an altered and felt state of mind in which a performer senses things going unstoppably his or her way. It is experienced as a psychological force in which several factors or qualities converge in a synergistic way to enable one to perform at a level not ordinarily possible. Notably, it is accompanied by perceived superiority over an opponent, attribution of success to oneself, increased sense of confidence (self-efficacy), control, and competence. PM is directly reflected in a heightened subjective probability of success, and this increased probability signals the birth of PM and its growing magnitude. Because PM critically depends on initial success, the above-mentioned qualities are only contributing factors that alone cannot make PM possible. For example, most athletes enter competition with confidence, but it is only when this confidence significantly increases due to initial success that it further fuels a sense of momentum and thus contributes to subsequent success (Feather, 1968). That is why initial success is critical for momentum building. These considerations are further elaborated on in the basic model and its mathematical development, as well as in the mediating and moderating effects of PM on subsequent success.

The underlying tenet of the theory of psychological momentum is that previous performance significantly affects subsequent performance (Iso-Ahola & Mobily, 1980). Thus, there is a dependency structure between two consecutive performances, such that success leads to further success and failure to further failure. However, this relationship is crucially mediated or moderated by PM. In other words, PM explains *why* success often seems to lead to success. In and of itself, however, success does not result in success, as will be explained later. Nevertheless, the dependency structure is fundamental to the PM effect. Of course, failure does not always lead to failure, nor success always to success, but when it occurs, we posit, it is critically due to the PM effect.

Consistent with the above theoretical ideas, recent experimental evidence has indicated that successful hitting in baseball is contagious (Gray & Beilock, 2011). However, as Mace, Lalli, Shea, and Nevin (1992) demonstrated, this dependency can be easily broken by external events or agents. They showed that taking a "time out" disrupted the opposing basketball team's PM and consequently reduced its performance success by 56% relative to the pre time-out level. Consistent with this, Berry and Wood (2004) reported

that "icing" NFL field goal kickers (e.g., the opposing team forcing a time-out) in critical situations had strong negative effects on performance. These findings, therefore, support Hamberger and Iso-Ahola's (2004) proposition that PM is basically short-lived and temporary in nature. In short, although the fundamental tenet posits the dependency structure between consecutive performances, the theory further postulates that success leads to success primarily because it is mediated or moderated by psychological momentum (Iso-Ahola & Blanchard, 1986), as described later. Before examining these mechanisms, however, a closer look at the literature on the veracity of the basic tenet of the theory is in order.

Does "Hot Hand" Exist?

Sport Contexts

Although the Gilovich et al. (1985) study was not the first one on PM, it has garnered more attention than any other study presumably because it has been invariably, albeit erroneously, said to have started research on the phenomenon and perhaps because it provocatively declared that "hot hand" is nothing but a cognitive illusion and a myth. The conclusion that the present success is independent of previous performance outcomes was mainly based upon one professional basketball team's nine individual players' probability of making a successful "field goal" given their success or failure on prior shots over the season. The researchers also looked at another pro team's nine players' probability of making a "free throw" given a miss or a hit on the prior free throw. Because the serial correlations for individual players were nonsignificant, it was concluded that "hot hand" does not exist. These findings, however, were soon challenged, and it was shown that "hot hand" indeed exists at the professional (Forthofer, 1991; Larkey, Smith, & Kadane, 1989) and intercollegiate basketball level (Mace et al., 1992). Wadrop (1995) reanalyzed Gilovich et al.'s free throw data and showed that fans' perceptions of hot hand are justified. To illustrate the existence of the phenomenon anecdotally, and to highlight the major conceptual problem in previous studies reporting no effect, the following example is informative. In a recent ACC match-up, Maryland Terps lost their 10-point lead over Miami Hurricanes, but managed to win the game by a 3-point field goal by Dez Wells with 3.5 s left. What is remarkable about this is that Wells had no points in the first half but was a perfect seven for seven from the field for 21 points during the second half. Needless to say, this individual momentum-based performance was decisive for the team's victory. His performance clearly illustrates the nature of psychological momentum: it is temporary and short-lived, infrequent and occasional, individual, yet critical for the overall team performance. Such individual performance momentums can be very beneficial and "adaptive" for teams, especially if coaches are astute in first detecting and then capitalizing on them (Burns, 2004).

Several recent well-designed studies based on large data sets from basketball have lent strong support for the "hot hand" hypothesis. Yaari and Eisenmann's (2011) analysis of five NBA regular season's free throw data (constructed from over 300,00 attempts) revealed that the second free throw's success rate was significantly higher when it was preceded by success than failure in the first attempt, and this held true at both individual and aggregated levels. Arkes (2013) performed an illuminating analysis and comparison of a small data set (2,160 observations, thereby approximating the largest sample employed in prior studies finding no effect) and a large sample (28,800 observations and 32,000 total shots).The findings indicated that the prior studies claiming no effect have had a low chance of detecting "hot hand" because of two major reasons: (a) small samples and lack of adequate statistical power and (b) failure to consider the frequency of the "hot hand." Results showed that the probability of detecting the "hot hand" increases with its frequency, but even with large samples this probability can be low if the frequency of "hot hand" is low. Given that psychological momentum is short-lived (Hamberger & Iso-Ahola, 2004), it is an infrequent event and difficult to detect, but prior results (e.g., Arkes, 2010), when using large samples, "are indicative of a fairly large but infrequent hot hand effect" (Arkes, 2013, p. 408). Also critical is the appropriateness of the statistical analysis to represent the underlying probability model (e.g., incorrectly employing analyses based on normal probability theory when one based on a Poisson even may be called for). Finally, Stone (2012) provides strong (mathematical) evidence for "hot hand" if measurement error bias is removed from the previous studies finding no effect. He used an autocorrelation model and simulation to show that measurement error is "severe in the basketball context" when shot result data are employed to calculate shot probabilities. Stone demonstrated that because "shots made" measure the probabilities with error, the autocorrelation between shots (i.e., the autocorrelation of shot probabilities) is underestimated substantially. The net result, as argued by Stone, is that evidence for "hot hand" is artificially prevented from being observed, especially for relatively small samples (e.g., as used by Gilovich et al., 1985).

Besides basketball, the PM or "hot hand" phenomenon has been investigated in many other sport contexts, from team sports (e.g., baseball and volleyball) to individual sports (e.g., bowling, billiards, darts, golf putting, and tennis). It has been suggested that "hot hand" is more likely to emerge in individually performed sports as opposed to team sports (Bar-Eli, Avugos, & Raab, 2006). This generalization, however, does not seem warranted in light of the above evidence showing that "hot hand" can reliably be detected even in such complex activities as basketball, provided that appropriate methodological and statistical steps and measures are taken. Further, a recent well-designed study (Raab et al., 2012) on volleyball players provided strong evidence for "hot hand" indicating that half of the contestants exhibited streakiness in their performance. Volleyball is a good field laboratory for testing the phenomenon because the net separates opposing players and teams, meaning that opponents are less able to use counterstrategies against a hot player, unlike in a basketball game where opponents can guard the "hot" player closely. Consistent with this, Oskarsson et al. (2009) suggested that "hot hand" more likely emerges in situations where performance trials are more uniform (billiards, bowling, darts, horseshoes, darts, putting). According to these authors, uniformity translates into an increased sense of control: golf putting is more controllable than basketball field goal shooting, which in turn is more controllable than baseball batting (p. 276). Therefore, the more control performers feel over outcomes in certain sports, the more conducive are such situations to psychological momentum effects. Bowling is a good example of this relative uniformity of performance trials as every roll is taken from the same distance and made at a regular, brief interval. It is

therefore not surprising that strong support for "hot hand" has been reported in bowling studies (e.g., Dorsey-Palmateer & Smith, 2004; Yaari & David, 2012).

Tennis does not provide the same uniformity of performance trials as other individual sports (e.g., bowling) do. Yet, arguably, the best study and the strongest evidence for psychological momentum comes from a study conducted by Jackson & Mosurski (1997) on U.S. Open and Wimbledon tennis contestants. Curiously, this study has almost completely been overlooked in the literature, even in research reviews. The authors set out to test four different and competing models to explain competitors' performance success: (a) simple independence; (b) psychological momentum; (c) independence with a normal random effect (daily fluctuations in players' ability); and (d) psychological momentum with a normal random effect. Based upon two years of data from both venues (752 matches and 2,765 sets in total), results showed that the independence model was the worst of the four and provided a "very poor" fit to explain performance success from set to set within a match. Although the addition of the random effect model to the independence model somewhat improved the combined model's explanatory power, it still was significantly worse than the PM model, which in turn was not improved by the addition of the fluctuation in player ability (random effect). In other words, day-to-day variation in player ability contributed very little to the overall explanation, whereas the PM model explained the data "extremely well" and therefore, "the impact of PM cannot be ignored" (Jackson & Mosurski, 1997, p. 31). They concluded that "the idea of independence must be abandoned" (p. 33).

Jackson and Mosurski's findings are also important, in that they refute the notion of ability (vs. PM) as an explanation for performance outcomes. Naturally, when low- and high-skilled players are compared no psychological factors are needed to account for the final result. But, when ability and skill are held constant (i.e., competitors are homogeneous in this regard), as it is the case at the elite level of competition, for instance in the U.S. Open tennis tournament or a PGA tour event, then it is the psychological factors that differentiate winners from losers. This, of course, has been demonstrated in countless psychological studies that have shown the effects of emotions and cognitions on human performance in general. One study illustrates the point clearly. Marsh and Perry (2005) tested the relative contribution of ability ("personal performance best") and self-concept to championship performance among 257 elite swimmers in Pan Pacific Championships. Although the personal best time in swimming prior to the event explained most of the variance in championship performance, self-concept strikingly accounted for more than 10% of the total variance. In other words, when the effect of prior "personal best" (ability) was statistically controlled, this psychological factor still made a significant and meaningful contribution to championship performance. Which performer in any sport at the elite level would not embrace a 10% advantage over competitors? Having even a 1% psychological superiority would be enough for a competitor to handily beat his or her opponent at the elite level. Although ability is a relatively fixed entity, it nevertheless fluctuates somewhat from day to day, but this random fluctuation does not make a significant contribution to performance outcome when compared with PM effects (Jackson & Mosurski, 1997).

Taken together, the PM or "hot hand" phenomenon has been extensively tested in various sport contexts. Unfortunately, an overwhelming majority of the studies has used unobtrusive methodologies (archival data, e.g., Albright, 1993), which make it difficult for researchers to control for confounding influences (e.g., Dorsey-Palmateer & Smith, 2004). They are further limited by methodological and statistical problems, including, but not limited to, measurement error, small samples, and lack of statistical power (Arkes, 2013; Stone, 2012). The phenomenon has most often been tested on basketball players and teams, but this sport is not a clean setting for testing it because of many situational factors related to opponents' counterstrategic behaviors against a "hot" player (Raab et al., 2012). The methodological problems in basketball studies have further been compounded by the calculation of simple serial correlations between consecutive shot results and averaging them over the entire season (Stone, 2012). Such methodologies and crude statistics mask short-lived and infrequent but potent PM effects (Hamberger & Iso-Ahola, 2004), as the earlier example of a Maryland basketball player so clearly demonstrated. By its nature, the phenomenon is temporary and occasional yet powerful when it occurs. As recent studies have shown, the frequency of the phenomenon is directly related to researchers' ability to statistically detect its existence (Arkes, 2013). But, because the frequency has not been considered in previous studies, it is no wonder why "hot hand" has not emerged in many statistical analyses and has therefore been declared cognitive illusion. It is also worth noting that a meta-analysis does not rescue these poorly designed and executed studies. Throwing "apples and oranges" into one meta-analysis and treating different studies as equals, even after subjectively excluding some studies, does not salvage the problem (Avugos, Koppen, Csienskowski, Raab, & Bar-Eli, 2013).

What can be concluded? First, when conceptual, methodological, and statistical problems are considered, the phenomenon is reliably demonstrated even in basketball (Forthofer, 1991; Mace et al., 1992; Wadrop, 1995). Second, when the PM or "hot hand" phenomenon is given a fair chance to emerge (e.g., its frequency taken into account), it shows up as a strong effect (Arkes, 2010, 2013). Third, in those sports (e.g., putting, billiards, bowling) where performance trials are relatively uniform, thus giving performers a sense of control over outcomes, the phenomenon is likely to surface (Oskarsson et al., 2009). As a whole, this reluctant phenomenon indeed exists and can be flushed out by tight methodologies and statistical analyses.

Clearly, experimental studies are needed but at the present, they are rare. Two reported experiments used a staged cycling race to investigate the phenomenon. The first (Perreault, Vallerand, Montgomery, & Provencher, 1998) showed that when competitors ostensibly caught up with their cocompetitor (i.e., succeeded), their perceptions of momentum shot up and performance increased. The second (Briki, Hartigh, Markman, Micallef, & Gernigon, 2013) complemented these findings, in that when leaders suddenly kept falling behind their competitor, they naturally felt they have less momentum but used the situation to increase their energy output in efforts to catch up, as any competitor would do in such predicament. In other words, they were trying to create momentum for themselves by pedaling more furiously to catch up. Research has shown that in such situations goal commitment protects against the adverse effects of negative feedback by helping a performer to focus on the task at hand rather than on the implications for the self (Kappes, Oettingen, & Pak, 2012). It is therefore reasonable to assume that if the competitors had succeed in narrowing the

opponent's lead, their perceived momentum would have increased and as a result, would have further increased their performance output; but had they failed to narrow the gap, PM would have likely started to wane again and so would have their performance output. The study underscores the earlier point that psychological momentum is a dynamic phenomenon that fluctuates as a function of competitive situations. PM goes up and down and changes hands many times during competition as it is a zero-sum game. It is therefore natural that competitors try to recapture the lost momentum and use it to motivate themselves. However, as our model predicts, the winner is the one who is able to accumulate more positive momentums (frequency effect) and make them last for longer periods of time (duration effect).

PM or "Hot Hand" in Nonsport Contexts

Although sport settings seem to dominate the empirical testing of the phenomenon, researchers have investigated it in nonsport contexts as well, most notably in relation to investing in mutual funds or stocks and pricing momentum in betting markets (e.g., Arkes, 2011; Brown & Sauer, 1993; Camerer, 1989; Hendricks et al., 1993; Jegadeesh & Titman, 1993).It is one of the best known and most adhered axioms among the active Wall Street investors and traders that "trend is your friend," meaning that investors buy stocks in the up-trending (momentum) market and stay in them until the momentum stalls. They can also do the reverse by "selling short" in the down-trending momentum and ride the momentum as long as it continues. In this kind of investing and trading, all the decisions are based on momentum rather than companies' financial performance ("fundamentals"). Belief in the momentum effect is so strong that virtually all stock-charting and software programs include various momentum indicators. It has been shown empirically that in a relatively short period (i.e.,3–12 months), investors can capitalize on the PM phenomenon by buying past winners and selling past losers; this strategy has generated annual compounded returns of 10%–12%, but the effect dissipates after 12 months (Hendricks et al., 1993; Jegadeesh & Titman, 1993). The vanishing effect may be due to "gamblers'" (i.e., investors') tendency to overestimate the importance of momentum (Arkes, 2011) and the resultant proclivity to stay too long in their momentum-based investments or to make too risky bets. In capitalizing on the momentum effect, be it on basketball courts or Wall Street, timing is everything.

Feedback Effects

The basic tenet of the PM hypothesis posits the dependency structure between consecutive performances such that success leads to further success and failure to further failure. As the above review of research indicates, empirical studies, especially recent better-designed ones, provide strong support for the hypothesis. Thus, in the words of Jackson and Mosurski (1997), it is time to abandon the idea of independence between consecutive performances. This conclusion is bolstered by an extensive psychological literature on the effects of prior success and failure on subsequent performance on one hand and the effects of feedback on human performance on the other. Although studies in these areas have not been designed to test the PM or "hot hand" hypothesis as such, they nevertheless are highly relevant for evaluating its empirical foundations. Already in the 60s, Feather and colleagues reported several well-designed and controlled *experiments* on the effects of success and failure on subsequent performance (e.g., Feather, 1966, 1968; Feather & Saville, 1967). All of his laboratory experiments produced the same finding: initial success led to better subsequent performance than did initial failure, and this result holds true for both cognitive and motor tasks (Iso-Ahola & Hatfield, 1986).It is curious that this well-replicated finding has been completely overlooked in the "hot hand" literature (e.g., Bar-Eli, 2006; Reifman, 2012).

There is also a rich literature in psychology on the effects of feedback on human performance. Although feedback can be expressed and received in many different ways, performance success represents a powerful form of feedback. In general, people readily process positive feedback because it affirms their self-views, whereas they refrain from negative feedback because it threatens their self-perceptions (Sedikides & Green, 2009).Moreover, positive feedback is more accessible mentally and better remembered than negative feedback (Kappes et al., 2012). Bandura (1997) contends that mastery experiences (i.e., performance successes) constitute the most important method to increase one's self-efficacy. Feedback on goal progress also increases self-efficacy, and elevated efficacy in turn sustains motivation and promotes performance (Bandura & Cervone, 1983; Schunk, 1989). Furthermore, it is well established in social psychology that competence feedback (i.e., success) enhances intrinsic motivation (Deci, Koestner, & Ryan, 1999). All of this evidence speaks strongly for the effects of positive feedback on human affect and cognition.

As for feedback and performance more specifically, an extensive review and meta-analysis of research indicated that feedback interventions improve performance on average by about 0.40 of a *SD* (Kluger & DeNisi, 1996). This review also revealed that when feedback cues direct attention to task motivation, they augment feedback effects on performance. Kluger and DeNisi's review also disclosed that if feedback provides the correct solution, such feedback has stronger effects on performance. Clearly, success informs the performer that he or she is not only doing things correctly but also, that success is due to his or her skills and effort. The tendency to attribute success to internal factors (i.e., ability and effort) is well established (e.g., Sedikides & Gregg, 2008; Weiner, 1985) and suggests that such attributions are likely to solidify self-confidence and self-efficacy and thus sustain motivation (e.g., Schunk, 1989).On the other hand, if success is attributed to luck and other external factors, such attributions would not provide any psychological basis for building momentum, yet internal attributions would. It then follows that attributions of feedback and performance outcomes play an important role in the process of creating and enhancing psychological momentum. Finally, although it is beyond the scope of this article, it should not be forgotten that the effects of positive reinforcement on human cognition, affect, and behavior comprise one of the most robust findings in all of psychology. Success reinforces one's perception of him/herself as a capable performer and motivates for greater achievement, thereby providing strong psychological foundations for momentum effects.

A New Model Needed

When considering the previous research as a whole, it is clear that success indeed breeds success. In an effort to advance and stimulate future research, we build on this fundamental finding and propose a basic model that explains how present success is linked to future success via PM. This model goes beyond any previous theoretical and empirical research by distinguishing intensity, frequency, and duration effects of initial success (or any sequential combination of these effects) on PM and subsequent success. In this basic model, we delineate PM psychologically and mathematically for situations where performers are directly facing opponents (e.g., tennis) and where there are no face-to-face opponents (e.g., trading). We also draw attention to PM and its effects to be observed in "between" and "within" performances, such as tournament performance from day to day (between) and during one day (within). Theory and research lead us to explain the success-breeds-success phenomenon in terms of PM's "mediation" and "moderation" (and possibly even "moderated mediation") effects. Such theory- and model-building has been called for in the literature (e.g., Bar-Eli et al., 2006; Wadrop, 1998) as previous attempts have been too general in scope and have thus failed to generate much empirical work. For example, PM has been proposed to represent a positive or negative change in cognition, affect, physiology, and behavior caused by an event (Taylor & Demick, 1994), or to refer to a perception of progress toward one's goals, resulting in increased levels of motivation, control, and optimism (Vallerand, Colevacchio, & Pelletier, 1988). Needless to say, such general suggestions are not particularly useful for a theoretical explanation of neither the phenomenon nor its empirical validation. Although statisticians have done a great deal of research on "hot hand," their work, understandably, has also lacked in psychological depth. It should not be forgotten, however, that first and foremost, PM is a psychological, not statistical, phenomenon. Therefore, our model-building is based upon elucidating the psychological foundations of PM effects.

Basic Model

In general, psychological momentum is grounded and manifested in two altered perceptions: (a) oneself as a performer (without any social or competitive comparison); and (b) oneself as a performer relative to an opponent (i.e., perceived superiority over the opponent). As combined, these two perceptions determine (or manifest in) the third perceptual component of PM: perceived likelihood of winning or being successful in achieving a future goal. This perceptual foundation of psychological momentum has been validated by empirical data (Iso-Ahola & Blanchard, 1986). In a racquetball tournament, these perceptions were measured between sets and were found to increase or decrease significantly as a function of the outcome of a previous game. Taken together, psychological momentum is felt and experienced when (a) one has a high sense of competence, confidence, efficacy and control in him/herself as a performer, and attributes success to him/herself; (b) perceives him/herself as superior to his or her opponent; and (c) perceives an increased likelihood of winning or being successful. Simply stated, a competitor who has gained momentum believes he or she is the cause of his or her success, is highly confident, thinks he or she is better than the opponent, and consequently senses a good probability of winning the contest or achieving his or her stated goal(s). These perceptions combine to form momentum that becomes a psychological force or wave that carries the competitor to further success. Like ocean waves, psychological momentum lasts only a limited time, but can also be strung together with other waves into a series of consecutive momentums, so that a performer can benefit from the frequency, intensity, and duration effects of psychological momentum.

Although necessary, these perceptions, however, are not sufficient without initial success, nor do they occur without a preceding success. That is, a person can generally be highly confident, and perceive that he or she is better than others, and yet have little or no PM. It is only when these perceptions have been created by a recent or sudden success that they combine into a psychological momentum. As Iso-Ahola and Mobily (1980) and Iso-Ahola and Blanchard (1986) have demonstrated, these perceptions do not come from thin air but rather, directly from a recent success. Thus, the basic model (Model 1) is:

$$\text{SUCCESS} \rightarrow \text{PSYCHOLOGICAL MOMENTUM} \rightarrow \text{SUCCESS}$$

Intensity Effect

Accordingly, initial success creates or leads to psychological momentum, which then leads to further success. In this model, PM has either a mediating or moderating effect on future success, as will be discussed later in detail. The nature of initial success plays an important role. More specifically, the greater the perceived initial success, the greater the psychological momentum and the greater the likelihood of subsequent success. If the initial success occurs with a big bang, or has a "wow" factor associated with it, the more likely it is to lead to PM, and PM is likely to be strong ("intensity effect").When a basketball player makes a ferocious dunk or a boxer makes a devastating hit or a football team beats the season's leading team, the "wow" factor is obvious and thus enhances the value, meaning, and power of the success. In this way, mass and velocity (Markman & Guenther, 2007) are either additively or multiplicatively combined, thereby increasing the likelihood of PM and its strength.

Frequency Effect

An alternative model (Model 2) for occurrence of PM is as follows:

$$\text{SUCCESS}_1 + \text{SUCCESS}_2 \rightarrow \text{PSYCHOLOGICAL MOMENTUM} \rightarrow \text{SUCCESS}_3$$

Accordingly, psychological momentum occurs because of the perceived linkage between two sequential episodes of success. When performers realize and perceive this linkage between the two consecutive successes, their aforementioned perceptions are enhanced and as a result, PM is created and felt, with the net result of enhanced success in the future. In this scenario, there is no single "wow" factor necessarily involved but instead, emphasis is on the *perceived* connection between two instances of success. However, the realization or perception of the connection between two successes can become a powerful "wow"-like experience or feeling. An example would be a golfer who makes two "birdies" in a row, which then creates momentum, increases confidence in

him/herself as a performer and elevates the perception of having an ability to beat most of the "field." The net result is an improved probability of making a "cut" (i.e., qualifying for the final rounds; Iso-Ahola & Dotson, 2014).

Isolated successes here and there during a contest, especially without the intensity effect, are insufficient for creation of PM. A "birdie" on the second and 13th hole, with pars and bogeys in between, or a winning trade followed by several break-even and small-loss trades before another winning trade, do not allow a performer to see a connection between two successful performances, and thus, no PM is manifested. The closer in proximity in time the two successful performances are, the more likely is the perceived link between the two, and thus, the more likely is PM. Further, the more successful performances that are achieved in a row, the stronger PM is. The "frequency effect" postulates that the more momentums there are during the entire contest or performance, whether they are created by high-intensity successes or the perceived connections between two or more successes, the more likely is success or winning. As noted earlier, the frequency of an event is positively related to its perceived streakiness and researchers' ability to statistically detect the phenomenon (Arkes, 2013; Carlson & Shu, 2007).

The two successes (Model 2) can differ in their intensity or impact and are therefore likely to have a differing effect on the formation of PM. For example, if both are high in intensity, it is then easier for a performer to see the connection between the two than if they are low in intensity. Thus, in the former case, PM is more likely. Nevertheless, simply stringing two successes together can be powerful for creation of PM because it suggests, to a competitor, a continuity of successful performance. Even if a trader did not make a lot of money by his or her two consecutive trades, these trades nonetheless were successful, which then validates the trader's "system" and him/herself as a successful trader, which in turn enhances the likelihood of PM.

When contrasting the effects on PM of one single high-intensity success (home run) versus the perceived link between two successes (single hits by two consecutive players), it remains to be determined which one is more effective and under what conditions. It should also be noted that although the general theoretical derivation is based upon the perceived link between two consecutive successes, it is possible that in certain situations, more than two instances of success are required before PM is manifested. In baseball, for example, it may take three to four players to hit "singles" before PM is felt by the team. Nevertheless, theoretically, the key point is the perceived linkage between successes, however many may be required for creation of PM. Whether it is the first (a single high-intensity success) or second scenario (the perceived link between two), PM's existence is tentatively demonstrated by a significant empirical relationship between two successful performances ($\mathbf{S_2}$ and $\mathbf{S_3}$) and its nonexistence by a lack of correlation between the two. However, although success seems to breed success in such a situation, this relationship does not exist without PM's mediating or moderating effect. Establishment of the significant correlation between $\mathbf{S_2}$ and $\mathbf{S_3}$ is an indirect way of demonstrating PM's influence and calls for a direct measurement of the three perceptions discussed earlier to ultimately validate PM's effect.

Duration Effect

PM has been observed in both short- and long-term time frames (Iso-Ahola & Dotson, 2014). In general, however, longer PMs lead to a greater likelihood of success and winning. If a basketball team has two separate intervals of PM lasting altogether, say, 10 min during each half, such long PMs allow the team to dominate the game and therefore all but guarantee the final victory. Both frequency and intensity contribute to PM's duration. Obviously, the more frequent instances of PM a team has, the longer the duration of PM overall. Similarly, more intense PMs tend to be more enduring in time. It then follows that to maximize PM and its effect, a performer or team strives to extend PM by creating as many PMs and as powerful PMs as possible.

Figure 1 organizes the overall manifestation sequences through which PM may be felt as a result of the three distinct effects of intensity, frequency and duration.

For organizational purposes, Figure 1 displays sequential intensity and frequency effects in separate columns. However, in reality, PM can be manifested and felt following recent success through any sequential combination of the three effects of intensity, frequency, and duration. For example, a set of frequent recent successes building PM could be enhanced by one or more intensity-based successes supporting a stronger felt PM. Or, PM might be built from two or more intensity-based successes leading to an overall high-impact duration effect. A still third example might include multiple sets of frequent recent successes, each sufficient to manifest PM, thereby leading to multiple waves of PM felt for a significantly longer duration mediating and/or moderating subsequent and enhanced successes. Consistent with this, a recent experiment (Hunt, Rietschel, Hatfield, & Iso-Ahola, 2013) showed that winners' early success not only increased their confidence over losers, but this difference got larger with the continued competitive success. By combining and building PM in sequences such as these, enhanced subsequent successes can be maintained for extended periods or durations. Otherwise, isolated PMs, like physical momentum as described by Newton, will dissipate.

In general, PM is terminated in two ways: (a) a stoppage in performance in time and (b) a performer's own unsuccessful or an opponent's successful performance. As for the first, simply stopping performance will interrupt momentum and thus hinder performance. Mace et al. (1992) showed that "timeouts" in collegiate basketball reduced momentum and subsequent performance by 56%. As to the second, it is well documented that losing or "falling behind" in competition dampens confidence, perceptions of momentum, and even efficiency in neural networking (Hunt et al., 2013; Kerick, Iso-Ahola, & Hatfield, 2000). However, PM can be maintained by a "neutral" performance. For example, after creating PM by two consecutive "birdies," a golfer can keep PM operational even if he or she makes several pars in a row after the birdies. However, as soon as he or she "bogeys" or "double-bogeys" a hole, PM is lost. Similarly, a stock trader, after creating PM by consecutive successful trades, can maintain PM as long as he or she breaks even with subsequent trades ("at least I didn't lose money"). Such nonlosing trades suggest to him/her that his or her trading "system" still works and that he or she is a successful trader, therefore keeping PM alive. But, once he or she has a losing trade, PM is lost.

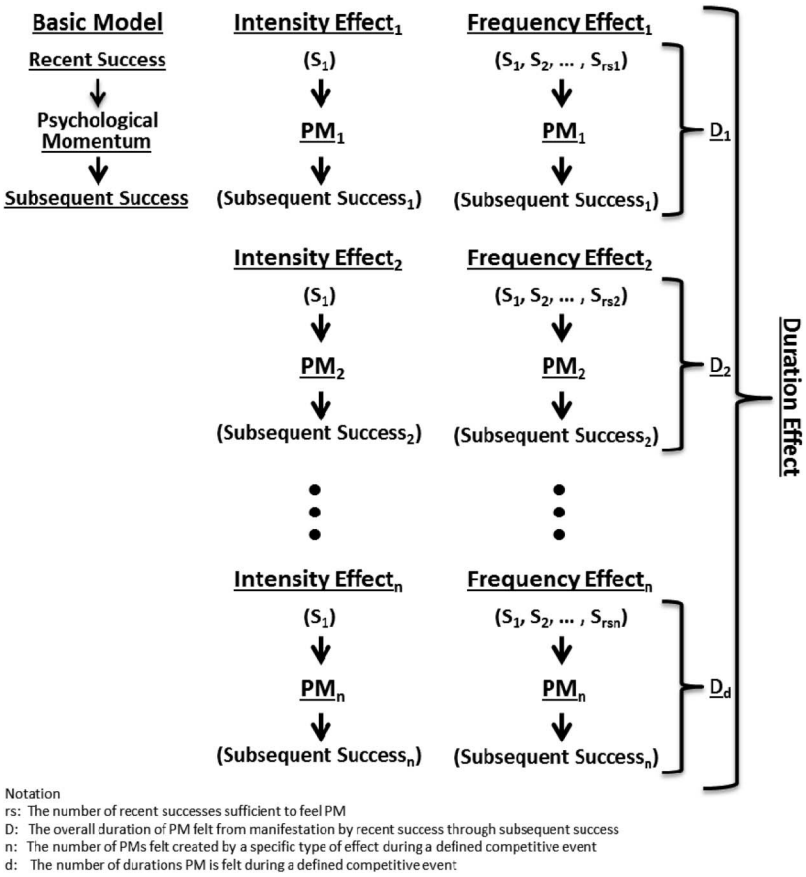

Figure 1. Frequency, intensity and duration effects of PM.

Whether in direct competition (tennis) or performing without face-to-face opponents (trader), it is impossible to avoid errors in human performance. Thus, termination of PM is unavoidable. However, the longer an individual or the team is able to ride momentum, the more likely is success or victory. It follows that successful performers not only seek to create momentums for themselves but also, to prevent the opponent from building them. A major strategy for accomplishing this is to force opponents to make errors. While it is easy to see why errors abound in such sports as basketball because of opponents' constant attempts to force them, errors are frequent also in solo performances (e.g., trading, golf). The reasons for this are both neurological and psychological. Neurologically, one is never again able to repeat the exact same motor movement because of the "context-conditioned variability" and "degrees of freedom" problems (Turvey, Fitch, & Tuller, 1982). Both internal (e.g., muscles) and external (e.g., uphill vs. downhill lies in golf) conditions vary significantly from situation to situation and therefore make errors common in motor performance. Psychologically, there are many factors that make people "choke" and underperform, such as anxiety (Baumeister & Showers, 1986) and self-focus (Lewis & Linder, 1997). The result of all of this is the frequency of errors in human performance even at elite levels (Gray, 2004), making extended periods of PM hard to come by.

PM When Performing Directly Against Opponents

In many competitive situations, there are direct opponents (e.g., boxing, tennis, basketball). As indicated, in such situations two perceptions are critical for PM: perception of self as a performer ($\mathbf{S_p}$) and perception of opponent ($\mathbf{O_p}$) as a performer. Conceived broadly, these perceptions can be qualitatively described as follows: self as performer (high, low) and opponent as performer (high, low). Summarized in this way, four combinations of perceptions are possible as depicted in the following 2 × 2 table.

If initial success leads a competitor to perceive Self as the superior performer (e.g., higher competence) and concurrently Opponent as the inferior performer, positive PM is likely to occur and success to ensue (Cell 2). In general, people have a tendency to self-servingly compare themselves with others (Sedikides & Gregg, 2008), especially if they have had recent success (e.g., Weiner, 1985). On the other hand, if the Self–Opponent perceptions are reversed following initial performance, negative PM is experienced and downward spiraling performance is likely to follow (Cell 3). Experimental research has shown that performers experiencing positive momentum report higher levels of self-efficacy or self-confidence than those having negative momentum (Mack & Stephens, 2000). Finally, when the perceptions are closely matched (Cells 1 & 4), neither competitor achieves PM.

Alternatively, these perceptions of Self and Opponent as a performer can be more specifically quantified across the range of 0 to 1. For all of these situations, PM can be mathematically calculated as follows:

$$PM_f = 1 - \frac{O_P}{S_P} \text{ or } PM_f = \frac{S_P - O_P}{S_P} \quad (1)$$

where $\mathbf{PM_f}$ = psychological momentum felt or experienced; $\mathbf{S_p}$ = perception of self as a performer; and $\mathbf{O_p}$ = perception of opponent as a performer. A graph of $\mathbf{PM_f}$ for representative values of $\mathbf{S_p}$ and $\mathbf{O_p}$ is presented in Figure 2.

Figure 2 reflects only positive values for PM felt by Self, because, by the tenets of PM theory, perception of PM arises only when the competitor experiences high competence (and efficacy) as a performer, perceives superiority over the opponent and expects to win or succeed (Iso-Ahola & Blanchard, 1986). Other observations implied by Figure 2 may be deduced. For any given perception of an opponent as a performer, recent success by a competitor sufficient to boost perception of self ($\mathbf{S_p}$) will exponentially increase PM felt by the competitor. If simultaneously this recent or initial success results in a reduction of Self's perception of the opponent ($\mathbf{O_p}$), PM felt will be further increased. Alternatively, the formula also clearly demonstrates PM felt by a competitor can be negatively impacted by success experienced by his or her opponent. Finally, regardless of the level of perception Self holds for him/herself, a corresponding equal perception of opponent will neutralize any potential for a recent success to produce a positive PM. A negative $\mathbf{PM_f}$ results when $\mathbf{S_p} < \mathbf{O_p}$. $\mathbf{PM_f}$ becomes negative when Opponent ($\mathbf{O_p}$) is perceived as the superior performer by Self ($\mathbf{S_p}$). It should be noted that neither $\mathbf{S_p}$ nor $\mathbf{O_p}$ can be zero in mathematical or practical terms. Even if a competitor perceives the opponent as inferior to him/herself, the opponent would never be seen as zero as such a mismatch would not make a competitive sense. Although Formula 1 allows for all possible perceptions of Self and Opponent over the range of zero to one, in reality, large differences between $\mathbf{S_p}$ and $\mathbf{O_p}$ also make no competitive sense. In a real direct competition between performers, perceptions of self or opponent would not be expected to be less than about 0.25 and therefore no significant PM would be expected to materialize at such low levels of perceptions.

The final consideration in computation of PM is the perceived likelihood of winning or succeeding ($\mathbf{W_l}$). While $\mathbf{S_p} > \mathbf{O_p}$ is necessary for PM's occurrence, it is not a sufficient nor entirely accurate indicator of PM because the perception of superiority over an opponent has to translate in a performer's mind into an increased likelihood of winning or succeeding. If it does not, then the earlier Formula 1 gives an inflated or overestimated value for PM, and therefore, has to be corrected by the inclusion of $\mathbf{W_l}$. When $\mathbf{W_l}$ is introduced into the formula it reduces the previous value of PM and in doing so, corrects for the overestimation of PM without $\mathbf{W_l}$. In many performance and competitive situations, $\mathbf{S_p}$ can be considerably greater than $\mathbf{O_p}$ and thereby suggest a large PM. The resultant large PM would be inflated if it were not adjusted for a performer's perceived likelihood of winning or succeeding in a particular performance situation. A tennis player may feel that he or she is much better than his or her opponent in every respect, but if he or she does not sense a great likelihood of winning their match, even a large $\mathbf{S_p}$ over $\mathbf{O_p}$ would not guarantee an equally large PM, and would yield an inflated PM. Because of his or her vast experience, a competitor knows that there are factors other than perceived ability that can have a significant influence on the outcome. He or she knows that an opponent can get "lucky breaks" and unexplainably find a "second wind;" the audience can motivate and emotionally lift the opponent to higher levels of performance; referees can become biased against him/her; he or she also knows one can become emotionally drained, fall "out of sync" and make mistakes that the opponent may then exploit. As a result, a smart competitor is on guard against the "underdog effect" and therefore does not automatically equate even a large $\mathbf{S_p}$ over $\mathbf{O_p}$ with a high probability of winning. But when he or she does, the likelihood of PM increases substantially.

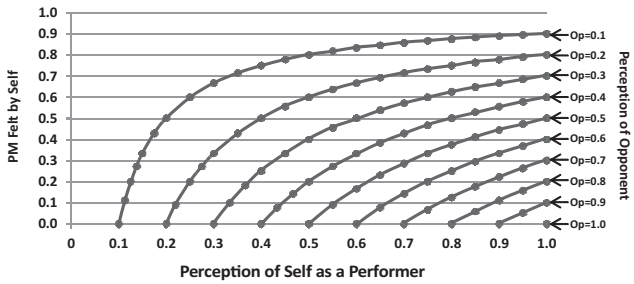

Figure 2. PM felt as a function of Self and Opponent perceptions.

These considerations, and empirical findings indicating the dominant influence of success and failure in affecting judgments of probabilities and expectations of success (e.g.,Feather, 1966), suggest the following adjustment for the earlier Formula 1

$$PM_f = \left(1 - \frac{O_p}{S_p}\right) \times W_l. \quad (2)$$

If the perceived probability is measured on .00–1.0 scale, and if $\mathbf{W_l}$, for example, is 0.90 in Cell 2, then the final $\mathbf{PM_f}$ would be 0.63 (0.70 × 0.90), assuming 0.30 for $\mathbf{O_p}$ and 1.0 for $\mathbf{S_p}$. In Cell 3, if $\mathbf{W_l}$ were only 0.10, the resultant $\mathbf{PM_f}$ would be a low of −.20 (−2 × 0.10), assuming 0.90 for $\mathbf{O_p}$ and 0.30 for $\mathbf{S_p}$. In this way, all three key perceptions are taken into account, and their effect on PM can objectively be calculated for the four fundamental conditions presented in Table 1. Moreover, the four conditions or cells in the 2 × 2 model (Table 1) can be experimentally manipulated and created, thereby allowing researchers to determine the relative contributions of the Self–Opponent perceptions on PM following various manipulated conditions of initial success.

PM When No Direct Opponent

There are many performance situations where no direct competition exists. For example, when golfers compete in "stroke" play, they are not directly competing one against another but instead, against the entire field or against par for the course. Similarly, when buying and selling stocks, a trader seeks to ride a momentum and in doing so, is not directly competing against another trader, but rather against the other traders as a crowd. In such situations, the above Formula 2 still applies and the three perceptions ($\mathbf{S_p}$, $\mathbf{O_p}$,

Table 1
PM in Relation Self and Opponent Perceptions

	Opponent as a performer	
	High	Low
Self as a performer		
High	NO PM (1)	POSITIVE PM (2)
Low	NEGATIVE PM (3)	NO PM (4)

W_1) determine **PM_f** if initial success has been experienced. The only difference is that **O_p** is not here as specific as in situations where a face-to-face competition exists. In case of golf, **O_p** could be one's perception of par for the course, which would vary as a function of the perceived difficulty of a golf course. In fact, then, **O_p** essentially becomes the perceived difficulty of the golf course. In trading a particular stock, **O_p** becomes the perceived difficulty in predicting the stock's movements. What would initial success be in these situations? In the case of golf, it would be making a "birdie" or an "eagle," or making a par on a difficult hole. In the case of trading, it would be a jump in the stock price on a given day (or significant movements up in day trading). In general, such initial successes enhance the value of **S_p** and lower the value of **O_p**, thereby separating the two. The bigger the difference between the two in favour of **S_p**, the greater the **PM_f**. In effect, **O_p** amounts to "noise" in the system or "error variance" in statistical terms, with the general goal being to reduce the value of **O_p** in relation to **S_p**. Mathematically (Formula 2), as **S_p** grows (and **O_p** reduces) so does psychological momentum. Continual climb of a stock (repeated success) builds a trader's **S_p** and **W_1** and thus **PM_f**. As a result, a trader perceives him/herself having momentum and is likely to stay in the stock as long as he or she has PM. A likelihood of his or her selling the stock increases in a direct proportion to a reduction in PM. In this way, a trader's buying and selling behavior can be analyzed as a function of PM.

Between and Within Situations

The impact of PM can be investigated and determined on the basis of both "between" and "within" performances. Theoretically, the PM phenomenon may more readily surface in "within" than "between" situations because of its temporary and short-lived nature. Failure to differentiate between these two types of performance situations may have contributed to conflicting conclusions in previous reviews of research. In stock market trading, the difference refers to PM, the effect of which is assessed from day-to-day performances (between) or from performances during one single session of trading or "day trading" (within). In golf, it refers to examination of PM's influence from tournament to tournament (between) or within a single tournament. Iso-Ahola and Dotson (2014) analyzed PGA Tour players' between and within performance and found support for PM in both contexts. When players' performance was analyzed from tournament to tournament, results showed that not only were "cuts" made but also achievement of top 10, 20, and 30 performances occurred in sequence, and more so for higher ranked players. When players' performance was analyzed within tournaments, results revealed that each round's performance was dependent on a previous round's performance within a tournament (there are four rounds in a typical professional tournament). PM can further be analyzed within a single round of a tournament. Similarly, Jackson and Mosurski (1997) analyzed the U.S. Open and Wimbledon tennis players' performance within matches and found that only the PM model could explain the outcome of matches in these tournaments.

As a whole, these findings are consistent with the earlier review of research on "hot hand" and lend credence to Jackson and Mosurski's conclusion that it is time to abandon the idea of independence between consecutive performances. More research, however, remains to be done to discover the conditions in both types of situations (between vs. within) that facilitate the emergence of PM effects.

PM as a Mediational Link Between Consecutive Successes

According to the mediational model (see Figure 3), the significant relationship between **S_1** and **S_2** is mediated by **PM**. **S_1** contributes significantly to **PM** (a), which in turn has a significant effect on **S_2** (b). Finally, the magnitude of the original **S_1**–**S_2** (c) relationship is significantly reduced when **PM** is taken into account. Although no study has directly tested this mediational model, several studies have reported empirical support for each link (a, b, c) of the model, which therefore deductively justifies the proposed hypothesis that **PM** is likely to mediate the **S_1**–**S_2** link.

Based on their experimental work, Feather and Simon (1971) reported that task performance is a dominant factor influencing performers' confidence ratings. Success reliably improves confidence while failure dampens it (Feather, 1968). Iso-Ahola and Blanchard (1986) administered a three-item questionnaire to competitors during a 2-min rest period between the first and second and between the second and third games in a state-wide racquetball tournament. Results revealed that winners rated themselves as better performers ability-wise than losers ($p < .0001$), were more confident in their abilities ($p < .03$), and believed that they were more likely to win the next game ($p < .004$). Similarly, Feather (1966) and Feather and Saville (1967) demonstrated experimentally that success and failure play the dominant role in shaping judgments of probability and expectations of success, with prior success increasing and failure decreasing them. Based on an experimentally manipulated free-throw competition, Shaw, Dzewaltowski, and McElroy (1992) showed that defeating an opponent increased self-efficacy (measured as self-confidence) and perceived psychological momentum; these effects were also observed when one's performance was compared with his or her own previous performance independent of the opponent. Thus, these results supported the causal **S_1**–**PM** link in both situations, with or without a direct opponent. In another laboratory experiment, participants competed in a staged cycling race. Results showed that competitors' perceptions of momentum increased markedly when

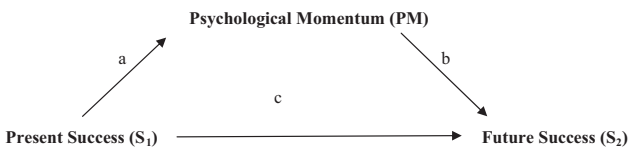

Figure 3. Mediational model of PM.

they ostensibly "came from behind" to grab the lead (i.e., when they succeeded; Perreault et al., 1998). There is also evidence that those performers who experience positive momentum have higher levels of self-efficacy than those who experience negative momentum (Mack & Stephens, 2000). This is consistent with Bandura's (1997) theory that mastery experiences (i.e., successful performances) effectively raise feelings of self-efficacy, which then are associated with momentum perceptions.

The effect of success on confidence is also seen in visual illusions. Baseball players, for example, often say that the ball appears bigger when they are hitting well. Witt and Proffitt (2005) demonstrated experimentally that this indeed is a psychological phenomenon: There was a significant positive relationship between recent success at hitting and the perceived size of the ball. In other words, increased confidence due to success made performers perceive (illusion) and believe something that was not real. These distorted perceptions and beliefs were likely accompanied by other altered states of mind, such as elevated concentration (Csikszentmihalyi, 1990). Recent research has even shown that this altered state of mind includes an enhanced connection between confidence and adaptive cortical dynamics, with the net result of improved performance and success (Hunt et al., 2013).

The emergence of PM also requires that initial success is attributed to one's skills and effort. Such attributions mean that a performer believes that initial success was due to his or her own actions and not lucky breaks and other external factors. They, then, fuel a sense of self-confidence and self-efficacy (Schunk, 1989) and together, further heighten psychological momentum. If, on the other hand, these attributions are made to external factors, they do not provide a strong psychological basis for momentum effects to materialize. Research suggests that internal attributions, however, are likely because success is generally attributed to ability and effort and failure to external factors (Sedikides & Gregg, 2008; Weiner, 1985). These attributions are even more likely if performers are highly committed to their goal, as competitors typically are, because goal commitment promotes effective responses to feedback by preventing performers from shifting attention away from the task (Kappes et al., 2012).

In short, research provides strong support for the effect of initial success on performers' internal attributions, competence, confidence, efficacy, perceived superiority over opponents, and likelihood of winning or succeeding. The resultant PM becomes a psychological force that determines how individuals see, experience, and deal with performance situations. What remains to be examined is the effect of different types of success (e.g., "big bang" vs. the perceived link between consecutive successes) on momentum perceptions and on PM as a synergistic force encompassing various psychological qualities. A related question is about adaptive team environments in which team members are more efficient in allocating their attentional resources and reducing cognitive workload (Miller et al., 2013), thereby allowing these environments to enhance performance without additional neurophysiological costs (Miller et al., 2014). Adaptive team environments are characterized by perceived interpersonal competence, mutual trust, and cohesiveness among team members. This suggests that such team environments are more conducive to the emergence of PM as they create favorable conditions for stringing together successes. Empirical research, however, is needed to explore these possibilities further.

Relative to the second link in the meditational model (b), does PM have a causal effect on performance and success? Empirical evidence suggests an affirmative answer to this question. Perreault, et al. (1998) reported that as competitors fell behind in a cycling race, their momentum perceptions plummeted and their performance (i.e., measured as energy output) remained at its lowest, but when they regained the lead their PM perceptions shot up sharply and performance increased significantly as well. The PM–success relationship was crucially influenced by the social comparison aspect of competition, that is, how one performed relative to his face-to-face opponent. It is natural that perceptions of superiority over an opponent, and thus momentum perceptions, would decrease when one falls behind his or her fellow competitor, as described in the basic model (see Table 1) and its mathematical derivation (Formulas 1 and 2). In such a situation, the reduced momentum is expected to trigger higher energy output as no competitor gives up easily (Briki et al., 2013). As long as a competitor is highly committed to his or her goal, this goal commitment promotes effective responses (e.g., increased energy output) to negative feedback and thus protects from giving up on task performance (Kappes et al., 2012). It is therefore not surprising that the subsequent overcoming of temporary performance setbacks boosts momentum and thus performance (Perreault et al., 1998).

In addition to PM perceptions' effect on success, according to the PM theory, causal attributions and self-confidence (and self-efficacy) should have a positive influence on performance. First, it is well established that causal attributions to internal factors promote effort expenditure and task persistence, and thereby performance success (e.g., Weiner, 1985). Second, it has been found that those participants who become more confident after initial success perform better subsequently than participants who exhibit less change in confidence following success or failure (Feather, 1968). In a related study, Witt, Linkenauger, and Proffitt (2012) found that the visual illusion influenced participants' motor performance. Specifically, those who were exposed to a perceptually bigger hole putted more successfully, presumably because they felt more confident when aiming at perceptually bigger targets. Finally, in a meta-analysis designed to determine the effects of self-confidence on sport performance, Woodman and Hardy (2003) found a significant overall "effect size" (0.24) for this relationship; additionally, the effect size for high-standard competition (0.33) was significantly higher than for low-standard competition (0.16). Taken together, these findings suggest that PM indeed has a significant effect on performance and success, as posited by the mediational model.

It was mentioned earlier that PM becomes a psychological force or power that influences how people feel, think, and behave in relation to performance situations. Power generally refers to one's ability to influence others and more specifically, the ability to control one's and others' resources, which is the essence of competitive and performance situations. Burgmer and Englich (2013) tested the effects of power on motor performance by activating (priming) power nonconsciously. They found that participants in the high-power priming condition performed more successfully in two motor tasks than controls. These findings provide further support for the idea that PM as a psychological force increases the likelihood of success. In this force or power (and thus momentum), many important psychological qualities (especially attributions,

confidence, efficacy, concentration, and perceived probability of success) converge in a synergistic way, enabling individuals to perform with fearlessness and aggressiveness, with freedom and even reckless abandon. There is no hesitation and doubt, no lack of confidence. Anecdotally, this was evident in Serena Williams' loss in the 2013 Wimbledon quarterfinal match. She admitted her inability to "play her own game" because of the opponent's spurts of momentum and her resultant ability to dictate pace and nature of the game. In short, losing momentum made Williams less aggressive and more hesitant, unable to control her own and the opponent's resources. More experimental research, however, is needed to further elucidate PM as a psychological force or power and its impact on performance.

The above research raises a distinct possibility that psychological momentum is an antidote to "choking." If players get on a roll, subjective probability of success, internal attributions, competence, confidence (and efficacy), and concentration (and physical effort in physically demanding tasks) are enhanced and as a result, they are less likely to be distracted or become skill focused, conditions known to lead to choking (DeCaro, Thomas, Albert, & Beilock, 2011). When stakes are high, pressure is also high and the likelihood of choking concomitantly increases (Baumeister & Showers, 1986; Lewis & Linder, 1997). Iso-Ahola and Dotson (2014) found that psychological momentum was more likely to surface when stakes were higher (i.e., trying to make the "cut" on the PGA Tour). It may be that those players who can put together a string of successful performances and grab momentum when stakes are high are trying to succeed rather than trying to avoid failure. Seeing momentum after making a couple of "birdies" or difficult par saves rather than viewing them as avoidance of disasters takes the mind away from skill failure to a possibility of continued success. Iso-Ahola and Dotson's (2014) data showed that higher ranked players are such performers as they were more efficient in putting together a longer string of cuts made, top 30, 20, and 10 performances.

All in all, research provides considerable support for the mediational model and suggests that success breeds success because PM mediates the link between consecutive successes. However, a direct empirical verification of the model would be provided by the data showing that the original $\mathbf{S_1}$–$\mathbf{S_2}$ (c) relationship is significantly reduced when $\mathbf{S_2}$ and **PM** are regressed on $\mathbf{S_1}$. Such a complete mediational test remains to be done.

Does PM Moderate the Relationship Between Consecutive Successes?

The PM theory posits that initial success ($\mathbf{S_1}$) has two major effects: (a) it increases the likelihood of subsequent success ($\mathbf{S_2}$) in and of itself; and (b) gives rise to psychological momentum and enhances its strength. The former occurs when a performer acquires technical know-how from his or her recent successful performance and applies it next time with equally good results. For example, a successful tennis player learns to exploit the opponent's weaknesses and avoid his or her strengths, and uses this knowledge to win the next game or match. Theoretically, then, such technical knowledge alone could be a reason for the original relationship between $\mathbf{S_1}$ and $\mathbf{S_2}$. However, if this relationship is *mediated* by PM, it means that initial success not only increased technical know-how but more importantly, created, reinforced, and lengthened PM. Because the mediation effect, by definition, indicates that the original $\mathbf{S_1}$–$\mathbf{S_2}$ relationship is severely weakened or even completely eliminated by the inclusion of PM, it shows that the real reason for the original relationship is psychological momentum, not technical knowledge about performance. Furthermore, technical know-how is more a matter of slowly cumulating experiences than a single successful performance.

Success is a powerful variable that almost always has strong psychological effects on performers, influencing their feelings and cognitions, as the previously cited studies have revealed. PM is one such influence because it is a direct outgrowth from initial success, without which it therefore does not exist. The two are interwoven in that initial success can create, reinforce, and lengthen momentums, and poor performance can degrade or kill positive PM altogether and start negative spiral. It follows that PM is situationally determined and not a stand-alone characteristic or resource that can modify the $\mathbf{S_1}$–$\mathbf{S_2}$ link independent of initial success. This suggests a significant $\mathbf{S_1} \times$ PM interaction, which would be indicative of a *moderation* effect (c in Figure 4). In other words, initial success with PM leads to a greater likelihood of subsequent success than initial success without PM. In doing so, PM modifies the $\mathbf{S_1}$–$\mathbf{S_2}$ link by strengthening it in interaction with $\mathbf{S_1}$ but without PM's independent effect on $\mathbf{S_2}$ (see Figure 4). This effect can occur when a competitor, as a result of increased PM, attains a higher level of concentration and mental effort, becomes bolder in his or her performance, and in those activities (e.g., basketball) in which enhanced physical effort is beneficial, increases his or her energy output (Perreault et al., 1998). Consistent with this suggestion, recent experimental data showed that compared with losers, winners exhibited greater mental effort and engagement of task-relevant attentional processes as manifested in lower high-alpha power across the left and right hemispheres (Hunt et al., 2013). Further research, however, is needed to test directly the possible moderating effects of PM.

Finally, it is also possible that there is a "moderated mediation" effect (Baron & Kenny, 1986). As an example, PM's mediated effect on $\mathbf{S_1}$–$\mathbf{S_2}$ could be moderated by such variables as gender and level of competition. This is indirectly supported by Woodman and Hardy's (2003) finding that the effect of self-confidence on sport performance was much greater for men (effect size 0.33) than women (0.04), suggesting that PM's mediation effect is greater for male performers. However, a direct test of such a moderated mediation effect on PM remains to be undertaken.

Summary, Conclusions, and Future Research

Although the basic tenet of the PM theory posits a positive causal relationship between consecutive successes, research suggests that this relationship is mediated (or moderated) by psychological momentum. Furthermore, PM can easily be disrupted by external events and agents, making it short-lived and temporary in

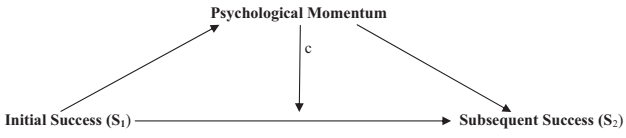

Figure 4. Moderation model of PM.

nature. It is not a stand-alone characteristic but situationally determined. Initial success, whether a "big bang" type like a ferocious dunk of the basketball or the perceived link between two closely occurring successes like two "birdies" in a row in golf, is critical for the formation of PM. Without it, PM does not emerge. Initial success creates, reinforces, and lengthens momentum. The more momentums there are during the entire contest or performance, the more likely is success or winning (frequency effect). And the longer the PM can be maintained, whether due to the frequency or intensity effect, the more likely is the success (duration effect).

PM occurs in situations where there are direct opponents (e.g., tennis, Presidential primaries) or where there are no face-to-face opponents (e.g., stock market trading). In the former, two perceptions are critical for PM: self as performer ($\mathbf{S_p}$) and opponent as a performer ($\mathbf{O_p}$). PM for self occurs only when $\mathbf{S_p} > \mathbf{O_p}$ and has its greatest impact when $\mathbf{S_p}$ is high and $\mathbf{O_p}$ low. Initial success enhances the value of $\mathbf{S_p}$ and lowers that of $\mathbf{O_p}$. Other things held constant, as $\mathbf{S_p}$ grows (and $\mathbf{O_p}$ decreases) so does PM. A boxer's devastating hit makes the opponent stagger and simultaneously builds $\mathbf{S_p}$ over $\mathbf{O_p}$, resulting in higher PM. However, even a large $\mathbf{S_p}$ over $\mathbf{O_p}$ would not automatically guarantee an equally large PM if the perception of superiority over the opponent did not translate in a performer's mind into an increased likelihood of success ($\mathbf{W_l}$). A competitor has to not only feel that he or she is much better than the opponent but also, sense that there is a great likelihood of victory or success. Therefore, $\mathbf{W_l}$ has to be introduced into the formula (the $\mathbf{O_p}/\mathbf{S_p}$ ratio multiplied by $\mathbf{W_l}$), which then corrects for the overestimation of PM if it is determined only on the basis of the $\mathbf{S_p}$ and $\mathbf{O_p}$ perceptions. In situations where no direct opponents exist, the same three perceptions ($\mathbf{S_p}$, $\mathbf{O_p}$, $\mathbf{W_l}$) are equally critical for PM, with the only difference being that $\mathbf{O_p}$ is less specific (e.g., the perceived difficulty of a golf course rather than a direct opponent). Continual climb of one's stock portfolio builds a trader's $\mathbf{S_p}$, diminishes $\mathbf{O_p}$ (or the perceived difficulty of managing the stock portfolio's movement), and increases the perceived likelihood of success in trading, and thus elevates PM. A trader's likelihood of mismanaging his or her stock portfolio rises in a direct proportion to a reduction in PM.

Preliminary evidence for the "mediation" effect comes from two sets of studies: (a) those that have shown present success ($\mathbf{S_1}$) to increase PM perceptions, causal attributions to internal factors, self-confidence, self-efficacy, and competence in particular; and (2) those that have demonstrated PM perceptions and confidence to significantly improve performance or increase the likelihood of success ($\mathbf{S_2}$). For example, it is well documented that initial success increases confidence and confidence in turn subsequent success. Similarly, research has shown that initial success increases attributions to internal factors, which in turn lead to higher effort expenditure and task persistence. Such attributions signify that a performer believes his or her skills and effort, not lucky breaks and other external factors, were critical for success. These attributions are more likely if goal commitment is high, as it typically is among competitors. A high goal commitment also promotes effective responses to failure, thereby preventing performers from shifting their attention away from the task and losing momentum. Taken together, although research supports both the $\mathbf{S_1}$–**PM** and **PM**–$\mathbf{S_2}$ links of the mediation model, in a complete test of the mediation effect, the original $\mathbf{S_1}$–$\mathbf{S_2}$ link has to be shown to decrease significantly when $\mathbf{S_2}$ and PM are regressed on $\mathbf{S_1}$. This test is yet to be conducted.

PM can also "moderate" the $\mathbf{S_1}$–$\mathbf{S_2}$ relationship. This would be evinced by a significant $\mathbf{S_1} \times$ **PM** interaction effect. Accordingly, initial success with PM leads to a greater likelihood of subsequent success than initial success without PM. In other words, PM modifies the $\mathbf{S_1}$–$\mathbf{S_2}$ link by strengthening it without PM's independent effect on $\mathbf{S_2}$. Finally, tentative evidence suggests that the mediation effect may be moderated by certain factors, such as gender because it has been found that self-confidence has a greater effect on men's than women's sport performance. Level of competition (high vs. low standard competition) has also been shown to moderate this relationship. It remains to be determined what other moderators might influence the PM mediation effect.

The proposed theory integrates the previous research into a coherent model and postulates that success breeds success because the effect of initial success is more psychological than technical. That is, as a result of initial success, PM becomes a psychological force in which various qualities converge in a synergistic way. Performers attribute success to their skills and effort, are confident and efficacious, concentrate better, believe in their abilities, think they are better than their opponents, and consequently expect to succeed. Such perceptions combine into one overarching force, psychological momentum, which astute performers seek to ride as long as possible. It is conceivable that success contributes to continued success in and of itself, for example, when a tennis player learns to exploit the opponent's weaknesses. However, acquisition of such technical knowledge is a matter of cumulating experiences rather than a single successful performance and thus, by itself, would not be expected to have much influence on the outcome. On the other hand, if technical know-how, in conjunction with initial success, increases one's perceived superiority over an opponent, then it can contribute significantly to PM and subsequent success. Such influences remain to be explored empirically.

Some performers appear to be quick to see and capitalize on PM, although others seem to be more hesitant. Besides individual differences, it is also important to understand when and under what conditions PM is lost and how tenaciously performers cling to it, how much failure they can tolerate before they cede PM to opponents. In sports contexts, hanging on tenaciously to PM and believing in its resurgence may be positive, but in stock market day trading, it is likely to be a killer. It is known that about 90% of day traders lose their money, probably because they stubbornly believe that they still have momentum on their side when, in fact, it is an illusion. Indeed, evidence indicates that gamblers overestimate the importance of momentum (Arkes, 2011), causing them to overstay in momentum-based bets. Perceiving momentum where there is none can be blinding and hazardous, and not perceiving momentum where there is one can be frustrating and discouraging. How to become better at accurately detecting momentum and at profitably capitalizing on it in various domains of human performance remains to be explored in the future. Another fruitful area for future research concerns the question on how PM is actively sought and managed by performers. In Presidential elections, for example, candidates intentionally seek to establish PM by trying to win certain small states (by electoral vote counts) in efforts to string together small victories in order to create a perception of an ever-growing snow ball of psychological momentum.

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