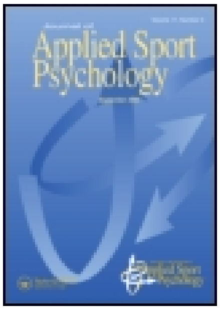

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A multidimensional model of momentum in sports

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A Multidimensional Model of Momentum in Sports

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The goal of the present paper is to provide a theoretical formulation of momentum in sports that articulates the processes involved in the development of momentum. Momentum is presently defined as: a positive or negative change in cognition, physiology, affect, and behavior caused by a precipitating event or series of events that will result in a shift in performance. The present model proposes a series of changes, termed the "momentum chain," that result in the development of momentum: (a) precipitating event or events, (b) change in cognition, affect, and physiology, (c) change in behavior, (d) the resulting increase or decrease in performance consistent with the above changes, (e) a contiguous and opposing change in the previous factors on the part of the opponent (for sports with head-to-head competition), and (f) a resultant change in the immediate outcome. A preliminary investigation of the first stage of the model examining the relationship between precipitating events and changes in competitive outcome provided initial support for the value of the model.

The concept of momentum is, at the same time, one of the most commonly referred to and least understood phenomena in the realm of sports. It is typically conceived of as an unpredictable and ethereal force outside the control of individuals and teams that can often dictate the outcome of competition. Despite its mysterious allure and prevalence in the col-

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lective psyche of the athletic community, only recently have there been attempts within the field of psychology to systematically consider momentum from a scientific perspective.

These investigations, both theoretical and empirical, have increased our understanding of the concept of momentum in sports (Adler, 1981; Iso-Ahola & Mobily, 1980; Silva, Hardy, & Crace, 1988; Vallerand, Colavecchio, & Pelletier, 1988). Yet, these explanations do not appear to provide a full accounting of the relevant aspects of the concept of momentum.

One difficulty found in this avenue of research has been a divergence between theorizing and empiricizing. In particular, some investigators (Adler, 1981) attempted to develop a theoretical view of momentum without effectively operationalizing its constructs. Others (Richardson, Adler, & Hankes, 1988; Weinberg & Jackson, 1989) produced what they considered to be empirical support for the concept without an adequate conceptualization of momentum.

The goal of the present paper is to provide a new formulation of momentum in sports that incorporates aspects of previous theoretical and empirical investigations, addresses theoretical and methodological weaknesses, and offers new directions for the study of momentum in sports.

Review of Theories on Momentum

The study of momentum as a physical, psychological, and social phenomenon can be traced back to some of our earliest thinkers including Aristotle, Galileo, and Descartes (for a historical review, see Adler, 1981). However, it was only in the early 1980's that Adler generated the first in-depth exploration of momentum as a social phenomenon (Adler, 1981). He defined momentum as: "a state of dynamic intensity marked by an elevated or depressed rate of motion, grace, and success" (p. 29). Adler further posited a model involving five essential and inter-related components: (1) focus on a specific goal; (2) motivation initiating the effort of goal attainment; (3) emotional feelings attached to motivation toward the goal; (4) increased arousal associated with the activity; and (5) enhanced performance due to the above factors.

The initial model and its subsequent application to sports was a strong step in the theoretical articulation of momentum. However, it also illustrated several areas of need for future development. First, Adler provided only a cursory discussion of how each part of the model directly affects momentum. Second, his formulation did not offer enough information to make specific predictions about the effects of each factor on momentum and performance. Third, an essential element that was not addressed was the influence of cognition on momentum. Finally, Adler underestimated the importance of physiological arousal in the generation and disruption of momentum.

Vallerand, Colavecchio, and Pelletier (1988) further advanced the delineation of momentum in offering their antecedents-consequences psychological momentum model. Their most significant contributions were in their consideration of two areas. First, they asserted that "psychological momentum refers to a perception that the actor is progressing toward his/her goal" (p. 94). Thus, the perception of the situation is critical. Second, they believed that psychological momentum is subjective and that perceptions of momentum are influenced by intrapersonal factors, such as perception of control and experience, and situational factors, such as score configuration. Most fundamentally, Vallerand and his colleagues suggested the importance of these factors with respect to their influence on certain cognitive functions, most notably, perceptions of control. However, their model also has some difficulties. As with Adler's conceptualization, the model of Vallerand et al. (1988) had elements, such as energy and synchronism, that were not easily operationalized. They also did not consider the influence of emotions and arousal on momentum.

Review of Empirical Research on Momentum

Though the evolution of models of momentum has progressed steadily during the past decade, empirical investigation has been sporadic. Furthermore, much of the research has resulted in possibly erroneous conclusions. For example, Iso-Ahola & Mobily (1980) reported that, in a racquetball tournament, first game performance was predictive of second game and match outcome performance. They concluded that the psychological momentum of winning the first game propelled these players to subsequent victory. Similar results emerged in a follow-up study (Iso-Ahola & Blanchard, 1986).

Other research using archival tennis match data at various levels of competition provided similar findings and conclusions. In particular, Weinberg and Jackson (1989) and Silva, Hardy, and Crace (1988) both demonstrated that prior performance success leads to future winning. Like Iso-Ahola and Mobily (1980), Weinberg et al. (1989) infer that psychological momentum was responsible for the results. However, Silva et al. (1988) provided what appears to be a more plausible interpretation. They indicate that all of these results may simply be due to greater ability on the part of the first game winners. In support of this position, research by Love and Knoppers (1984) and Richardson, Adler, and Hankes (1988), in which skill was controlled, indicated that momentum was not evident. Furthermore, Silva et al. (1988) suggest that psychological momentum may, in fact, be what Gilovich, Vallone, and Tversky (1985) called a "powerful and widely shared cognitive illusion" (p. 313) similar to the "hot hand" in basketball.

Only three studies to date have been based on clearly articulated theory. First, Vallerand et al. (1988) evaluated their antecedents-consequences psychological momentum model by employing hypothetical competitive tennis scenarios depicting either momentum or non-momentum situations, subjects' perceptions of momentum and its influence on performance inferences. Results indicated that score configuration exerted a strong influence on perceptions of momentum. Furthermore, score configuration, experience level, and perceptions of momentum had a significant effect on performance inferences. Miller and Weinberg (1991) produced similar findings related to situational influences on perceptions of momentum in volleyball matches. However, since both experimental situations were hypothetical, the external and ecological validity of the findings come into question. Miller and Weinberg (1991) also analyzed archival data from actual collegiate volleyball games and found no relationship between identified momentum situations and subsequent performance. Silva, Cornelius, and Finch (1992) demonstrated similar results to those of Miller and Weinberg (1991) using a novel laboratory competitive task.

The results of these three studies indicated several important implications relative to the current formulation. First, particular situational events produce a perception of momentum in a diverse sampling of individuals. Second, these perceptions of momentum do not generate a commensurate change in performance. What these two issues suggest is that, if momentum is more than a cognitive illusion, then there must be some intervening factors that influence the transmission of the perception of momentum to a change in performance. The goal of the present conceptualization is to propose what those mediating variables might be.

It has been argued in the literature that sport psychology needs to engage in more theory-driven research (Landers, 1983). As a result, it is suggested that there is a need for further exploration of the concept of momentum that: (1) provides a comprehensive model of momentum that includes a definition, causes, process, and outcomes; (2) is based on well-articulated operational constructs; and (3) can be empirically assessed for its validity. To this end, the multidimensional model of momentum is proposed.

New Conceptualization of Momentum

Providing a clear, comprehensive, and operationalizable definition of momentum has been one obstacle to prior conceptualizations. As discussed earlier, the definitions offered by Adler (1981) and Vallerand et al. (1988) are somewhat ambiguous and appear to lack precision and a clear articulation of the processes involved. It is presently suggested that the use of the term, psychological momentum, which is commonly used in the literature is inappropriate because it does not take into account the important role that emotional, physiological, behavioral, social, and environmental factors play in development of momentum.

Based on these considerations, momentum is presently 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.

Multidimensional Model of Momentum

The definition proposed above provides a sound foundation for the new conceptualization of momentum. It is now necessary to fully articulate the essential components and processes associated with the devel-

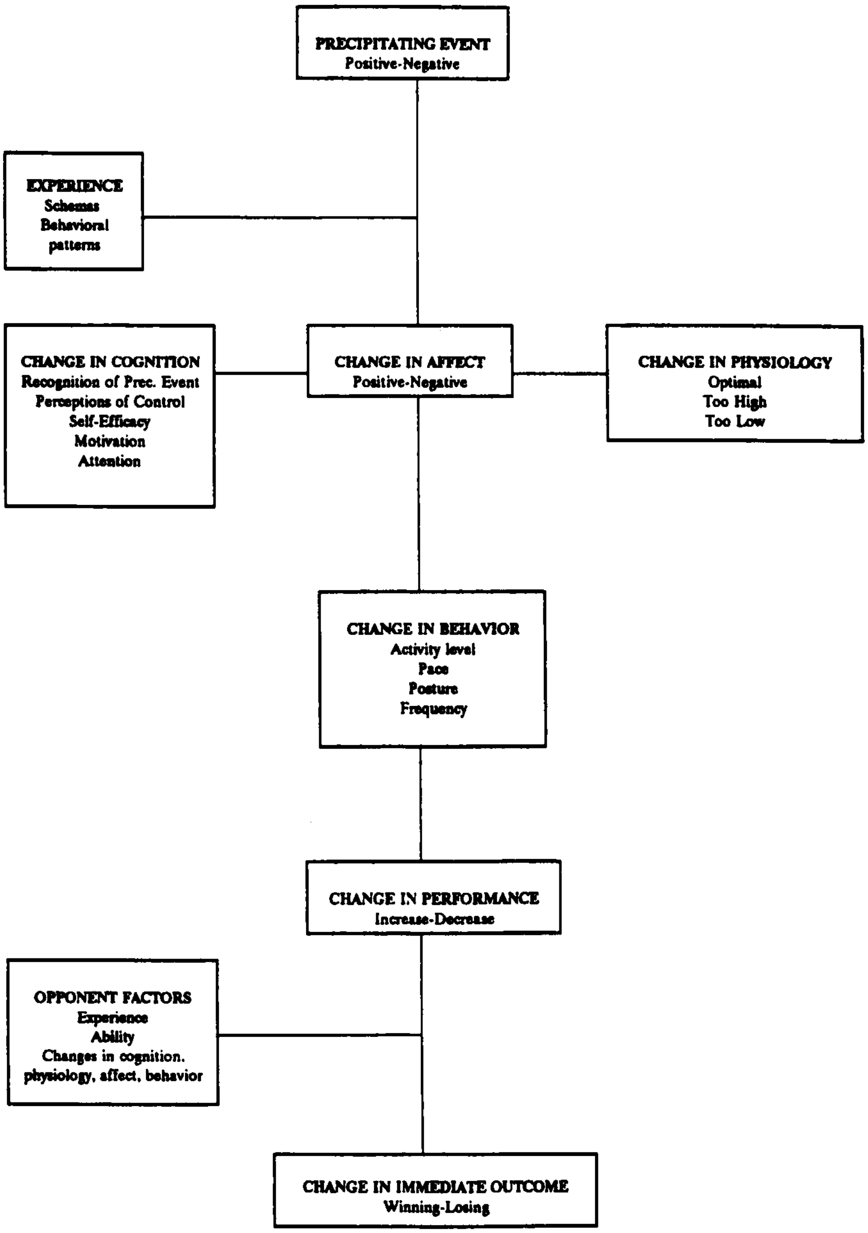

Figure 1. Multidimensional model of momentum in sports.

opment of momentum. The present model is composed of six critical elements to the development of momentum: (a) Precipitating event or events, (b) change in cognition, affect, and physiology, (c) change in behavior, (d) change in performance consistent with the above changes, (e) a contiguous and opposing change in the previous factors on the part of the opponent (for sports with head-to-head competition), and (f) a resultant change in the immediate outcome. These occurrences are presently termed the "momentum chain" (see Figure 1).

Precipitating Event or Events

The first step in the development of momentum is the occurrence of a precipitating event or series of events (Richardson, Adler, & Hankes, 1988). The ability of an event or events to precipitate the momentum chain depends in part upon its salience, that is, its capacity to alter atheles' perceptions about their performance.

Whether the precipitating events generate changes in athletes' perceptions depends upon the individual athlete (Miller & Weinberg, 1991; Vallerand et al., 1988). That is, the same event may trigger the momentum chain for one person but not another. Potential influencing factors in this subjective perception process include competitive experience, self-efficacy, perceptions of control, and cognitive schemas and behavioral response patterns for these situations (Miller & Weinberg, 1991; Silva et al., 1992; Vallerand et al., 1988). The type of precipitating events (e.g., dramatic or gradual, directly or indirectly related to performance, environmental or social, and external or internal) may also influence the change in perception.

Change in Cognition, Physiology, and Affect

The emergence of the precipitating event may then produce changes in a variety of cognitive, affective, and physiological areas. Moreover, considerable research indicates that these changes do not occur in a linear or sequential manner; rather, they reciprocally influence each other (Bandura, 1977).

Cognition. The precipitating event may produce an alteration in several important areas of cognition. The only superordinate change that must occur following a precipitating event and precede other cognitive, affective, and physiological shifts is the recognition of the event as being a potential precipitator of momentum. Research by Miller and Weinberg (1991), Silva et al. (1992), and Vallerand et al. (1988) support this notion by demonstrating that certain competitive events and situations generate perceptions of momentum. This notion is critical because it is presently asserted that momentum will not occur without this recognition.

Vallerand et al. (1988) propose that the most important cognitive change that will emerge is the individual's perceptions of control over the competitive situation. They suggest that perceptions of control are fundamental to many aspects of human functioning including sense of self-competence (Deci, 1980; White, 1959), the interpretation of self (Kelly, 1967) and other (Jones & Davis, 1965) information. In addition, it is presently suggested that perceptions of control influence individuals' self-efficacy, motivation, emotions, and physiological changes. Another central change in cognition for momentum is self-efficacy. There is considerable evidence that individuals' belief in their ability to succeed is significantly related to subsequent success (Bandura, 1977; Feltz, Landers, & Raeder, 1979; Gould, Weiss, & Weinberg, 1981). Furthermore, self-efficacy is also associated with motivation and persistence (Bandura & Schunk, 1981). It is suggested that precipitating events act to enhance or inhibit self-efficacy. It should also be noted that these events would, in turn, create greater or lesser perceptions of control (Bandura, 1977).

Motivation is presently regarded as another cognitive/affective factor responding to the precipitating event. Furthermore, it is believed that this effect is not a direct consequence of the event. Rather, it is mediated by the precipitating event's influence on self-efficacy and perceptions of control (Bandura & Schunk, 1981). In other words, a person's level of self-efficacy and perceptions of control will dictate his or her motivation (Bandura, 1981, 1982). For example, a golfer with little self-efficacy who perceives having little control over his play will be less likely to persist during a round. In contrast, a golfer with considerable self-efficacy will be highly motivated to continue play (Bandura & Cervone, 1983; Schunk, 1984; Weinberg, Gould, & Jackson, 1979).

Attentional concerns will also be influenced by the precipitating event (Dawson, 1973; Dawson & Furedy, 1976; Nideffer, 1976). That is, the event will produce either a positive (focusing) or negative (distracting) change in attentional focus due to its salience in the athlete's attentional field. In particular, in the development of positive momentum, the precipitating event, if recognized as such, will generate a refocusing on task-relevant information. Conversely, in the formation of negative momentum, the event will cause a refocusing on task-irrelevant cues, thereby contributing to the disruption of appropriate attentional focus.

Physiology. It is apparent from the research by Miller and Weinberg (1991) and Vallerand et al. (1988) that simply having precipitating events occur or recognizing the events as generating momentum and even producing changes in various cognitions such as self-efficacy, motivation, and perceptions of control is not sufficient to produce a change in performance. As a result, other changes must occur that make the link between the perception of momentum and a change in performance.

The previous theories of momentum that have been discussed have placed limited (Adler, 1981) or no (Vallerand et al., 1988) importance on physiological arousal. Adler (1981) views it mostly as a pregame influence and does not discuss its role during the course of competition. Vallerand et al. (1988) do not include arousal in their conceptualization at all. However, it is presently suggested that this phase is the most critical in the establishment, maintenance, and disruption of momentum.

Physiological arousal is a result of and an influence on the changes in cognition discussed above. A precipitating event produces changes in cognition which, in turn, generate alterations in physiological arousal (Bandura, Taylor, Williams, Mefford, & Barchas, 1985; Meichenbaum, 1977; Miller, 1980; Sarason, 1978). These changes in arousal include heart rate, respiration, and adrenaline. Conversely, physiological arousal may affect individuals' self-efficacy and motivation (Bandura, 1977), and attention (Nideffer, 1976). Furthermore, the direction and intensity of these shifts will dictate the valence of the momentum that is produced.

It is a widely held belief that individuals cannot optimally perform tasks if they are not physically primed to do so (Martens, 1977; Oxendine, 1970; Yerkes-Dodson, 1908). Specifically, optimal performance requires requisite physical changes that manifest themselves in terms of increased motor coordination and strength, enhanced sensory and perceptual processing, decreased reaction time, and higher thresholds of pain (Martens, 1977). In order for positive momentum to occur, there must be a physiological shift toward the optimal level of arousal that produces these manifestations. In contrast, for negative momentum to result, there must be a shift away from the optimal level of arousal in either direction that diminishes these manifestations.

Change in Affect. The alteration in cognitions generates a change in arousal which will then produce a commensurate shift in affective experience (May & Johnson, 1973; Schacter & Singer, 1962; Schwartz, 1971). Furthermore, this change in affect will be in the direction of the newly-formed cognition. Specifically, positive cognitions will generate positive affect (e.g., happiness, pleasure) and negative cognitions will result in negative affect (e.g., anger, frustration, sadness). Several researchers (Gill & Gross, 1979; Passer & Scanlon, 1980; Scanlon & Passer, 1979) have demonstrated that positive outcomes are related to positive affect. Similarly, negative outcomes are associated with negative affect (Geen & Rakosky, 1973). Consequently, precipitating events, viewed as valenced outcomes, may produce the resultant affect as mediated by cognition (Bandura, 1986). This affect may, in turn, influence cognition in the commensurate direction (Bandura, 1977).

Change in Behavior

At this point, the intrapersonal changes (cognitive, physiological, and affective) that have been described thus far will manifest themselves behaviorally (Zajonc & Markus, 1984; Zajonc, Pietromonaco, & Bargh, 1982). In other words, alterations in observable behavior will now be evident that are consistent with the direction of the changes that have occurred earlier in the momentum chain. In particular, changes in general activity level, pace, posture, and frequency of sport-specific behaviors will be clearly identifiable.

The nature of the behavior changes that result will depend on several factors: the valence of the momentum and the current level of physiological arousal of the athlete. Due to the latter issue, it is not possible to specify the particular direction of behavior change that will emerge. For example, in the course of a positive momentum chain, one athlete with a high level of arousal would respond with a calming effect physiologically which would, in turn, produce a decrease in observable behavior. In contrast, another athlete who is under-aroused would react with a higher level of arousal which would then be manifested in an increase in relevant behaviors. A similar pattern would result from a negative momentun chain. Regardless of the direction of the change in behavior, the outcome of this phase is the same: continuation of the positive or negative momentum chain.

Change in Performance

The changes that have occurred so far will then produce a commensurate shift in performance. That is, the momentum chain that results in positive momentum will exhibit an increase in individual performance and the momentum chain that leads to negative momentum will cause a decrease in individual performance. If the sport that the individual is participating in does not involve head-to-head competition such as alpine ski racing, golf, or shooting, then the change in performance will have a similar influence on the immediate outcome of the competition. In other words, in competition that is not head-to-head, performance is equal to immediate outcome (Adler, 1981).

In addition, momentum is not considered to be a force that is always present. Rather, it is suggested that the absence of momentum is the normative condition during competition. Moreover, it is only when precipitating events occur that momentum may emerge.

Opponent Factors

The direct relationship between performance and immediate outcome may not be evident in sports involving head-to-head competition, for example, tennis, boxing, and basketball. It is presently suggested that, in sports with head-to-head competition, there may be an interactive influence on competitive outcome. In order for the momentum chain which produces enhanced performance of one competitor to result in a change in immediate outcome, a contiguous and opposing momentum chain might have to occur for the opponent. In other words, for momentum to have a significant impact on competitive outcome, positive momentum would have to occur for one athlete and negative momentum would have to occur for the opposing competitor.

For example, in a tennis match, Player A makes a dramatic shot at a key point in the match. This precipitating event triggers positive momentum and increased individual performance on her part. However, the increase in Player A's performance may still not be sufficient to overcome the current level of her opponent's (Player B) play, thus no change in the immediate outcome of the match occurs. It may be that, for a change in immediate outcome to result, the precipitating event must also cause negative momentum and the coincidental decrease in performance in Player B. As presently conceptualized, only then would it be predicted that change in momentum and performance of the initial player would result in a change in the immediate outcome of the competition.

Experience and Momentum

The evidence to date examining experience as an important mediator of momentum has been equivocal. Richardson et al. (1988) and Vallerand et al. (1988) reported no difference in perceptions of momentum between individuals of differing abilities. However, the latter researchers suggest that the findings were due to the clear and unambiguous situations that subjects were asked to evaluate. In contrast, Miller and Weinberg (1991) found that skill level did discriminate perceptions of momentum.

In addition, research by Allard (Allard, Graham, & Paarsalu, 1980; Allard & Burnett, 1985) supports the relationship between experience and momentum. They indicate the reason for this difference in perception and processing may be due to more clearly defined schemas that enable more sophisticated, efficient, and rapid information processing and, subsequently, more effective cognitive strategies and behavioral responses to momentum.

This assertion is supported by non-sport research on self-schemas by Markus and her colleagues indicating that schemas enhance a wide array of cognitive processing and behavior including recall (Sweeney & Moreland, 1980) and decision-making (Markus, Crane, Bernstein, & Siladi, 1982). Schemas have also been related to expectations, attributions, and performance in competitive physical activities (Taylor & Boggiano, 1987).

These findings suggest that experienced athletes would differ from novice athletes in their ability to initiate, maintain, and interrupt momentum. In particular, they would be better able to recognize and act upon precipitating events, possess the skills necessary to regulate intrapersonal contributors to the maintenance of positive momentum (Bandura, 1986; Scheier & Carver, 1988), and mobilize their defenses against the activation of negative momentum.

Finally, Adler (1981) believed that momentum was based on the notion that an event is typically followed by a similar event. Specifically, success begets success and failure leads to failure. However, Silva et al. (1988) maintain that there are two alternative responses that might result: positive inhibition and negative facilitation. Positive inhibition refers to the process by which success produces a loss of momentum and an increase in the likelihood of failure. Similarly, negative facilitation suggests that, following failure, there will be an increase in momentum and the prior failure will enhance the probability for future success. It is presently suggested that experience will mitigate this effect. In other words, inexperienced athletes who lack the requisite schemas and skills will follow the "downward spiraling" (p. 86) trend described by Adler (1981). In addition, because they may not be accustomed to success, they will fall prey to positive inhibition.

In contrast, experienced athletes will be more likely to demonstrate an opposite pattern. That is, following success, experienced individuals will be able to maintain their success. In addition, following failure, they will be more likely to exhibit negative facilitation because they possess the necessary recognition schemas and action patterns that are required to actively counteract the negative momentum.

Avenues for Future Research

The first important step that must be taken in the investigation of momentum is to demonstrate that momentum does, in fact, exist and is not, as Gilovich et al. (1985) suggest, another "cognitive illusion." The value of the present conceptualization of momentum is that the steps in the sequence of events are open to measurement and, therefore, validation. Assessment at each stage of the operation leading to the development of momentum will enable researchers to identify and clarify the processes that are specifically involved. For example, it would be possible to measure precipitating events, changes in cognition, affect, physiology, and behavior, and shifts in performance and immediate outcome. An additional strength of the current model is that research testing it may employ physiological and behavioral assessment. Devices that assess physiological functions such as heart rate and galvanic skin response and behavioral measures such as the use of videotaped behavioral analysis may provide objective data relative to these influences on momentum.

Silva et al. (1988) suggest that future research must examine the phenomenon of momentum at a more micro level. What this line of reasoning indicates then is that the analysis of archival data as a means of measuring momentum may not be sufficiently precise for demonstrating the existence of momentum. Rather, in order for momentum to be clearly articulated, it will require theory-driven investigation at a more molecular level that examines the specific processes that produce momentum.

Initial Empirical Study

A sound program of research examining momentum will sequentially identify and demonstrate the influence of each step in the model. However, a difficulty with momentum research to date has been its inability to demonstrate that precipitating events do, in fact, result in a change in competitive performance (Miller & Weinberg, 1991; Silva et al., 1992). To this end, in order to initiate the validation process of the present model, two preliminary studies were conducted to examine the first stage of the model, that is, the presence of precipitating events during competition and their influence on immediate outcome. The study of the relationship between the first and final steps of the model was undertaken prior to the exploration of the intervening stages because, regardless of the value of the intermediary factors, their analysis would be moot if it could not be shown that precipitating events lead to changes in performance and immediate outcome.

The present studies had several goals. One aim was to identify events during the course of basketball and tennis competitions that are perceived to be precipitating events of momentum. An additional objective was to see whether the occurrence of precipitating events differed for winning as compared to losing teams and players. The final and most important goal was to demonstrate whether a shift in momentum and immediate outcome would be found on the basis of the occurrence of precipitating events during competitive play as compared to periods when these events did not occur.

Based on the proposed model of momentum, the following hypotheses are forwarded: (a) Winning basketball teams and tennis players will demonstrate more positive and fewer negative precipitating events, (b) Due to the complex activation of each of the five steps along the momentum chain, only one out of five of identified precipitating events would result in a measurable change in immediate outcome, (c) It is expected that winning as compared to losing teams and players will have significantly more positive precipitating events that lead to positive changes in immediate outcome and significantly fewer negative precipitating events that result in negative changes in immediate outcome, (d) There will be a significantly greater number of changes in momentum (as operationalized by changes in immediate outcome) following precipitating events than when no precipitating event has occurred.

STUDY #1

Method

Procedure

A sample of 25 tennis players of varying abilities from a Master's level psychology class completed a questionnaire asking them to list ten events that they believed would cause changes in momentum during professional tennis matches. In addition, they were asked to specify those situations in which this effect might result, for example, point in the match, who produced the event, score configuration.

The responses of this questionnaire generated 32 different precipitating events. Due to the nature of observing videotaped tennis matches, only those events that were environmental, such as an ace, were used because social and internal events including crowd influence or a player getting psyched up were not clearly observable. From this group, five of the most commonly indicated events were selected based on their possession of the characteristics asserted by Adler (1981) and the present model to be associated with precipitating events: (a) Dramatic shot: drop shot, ace, overhead smash; (b) Break of serve early in set; (c) Winning game after long deuce; (d) Making an unforced error at a crucial point; (e) Not converting 15–40 or 0–40 opportunity. These precipitating events were similar to those identified by Richardson et al. (1988).

Five matches from the quarterfinal and semifinal rounds of the 1990 Men's and Women's US Open Tennis Championships were videotaped. These later round matches from the tournament were chosen in order to control for ability which, as discussed previously, may be a significant factor in discriminating momentum. A trained observer then watched each match and, using a specially designed assessment form, recorded every occurrence of the five identified precipitating events and the subsequent scoring pattern.

Momentum, operationalized as a significant change in scoring or immediate outcome, was then assessed. A significant change was indicated if one of two immediate outcomes emerged: A run of three or more points or a subsequent service break in a game. These changes were based on discussions with a sample of professional players and coaches. The observer also examined game situations when a precipitating event was not evident and whether a change of immediate outcome occurred. A second independent observer then evaluated the assessments of the first observer, demonstrating their reliability (95% concordance).

Results

Across the five tennis matches, there were an average of 30.4 precipitating events per match. The most common type of precipitating event was the dramatic shot, accounting for 45.4% of those recorded followed by unforced errors (18.0%), break of service (16.0%), and not converting on a 15–40 or 0–40 break opportunity (15.0%). 66.4% of the events were positive and 33.6% were negative. The most common type of change in outcome was a three-point run (77.2%) followed by a break of service (22.8%).

A series of Chi-Square analyses was conducted to look at the relationship of precipitating events between the tennis players. Winning players experienced a significantly smaller proportion of negative precipitating events (18.7%) and a significantly greater proportion of positive precipitating events (81.3%) than losing players (68.9% and 31.1%, respectively; $\chi^2 = 35.80$, $p < .01$).

When the effects of precipitating events on changes in immediate outcome were considered, similar differences emerged. Winning players had a significantly greater proportion of positive precipitating events that resulted in a positive change in immediate outcome (35.6%) than losing players (0.0%, $\chi^2 = 7.20$, $p < .01$). Similarly, winning players had a significantly smaller proportion of negative precipitating events that led to a negative change in immediate outcome (15.0%) as compared to losing players (54.8%, $\chi^2 = 8.09$, $p < .01$).

A change in immediate outcome occurred 33.6% of the time that a precipitating event preceded it. When no precipitating event emerged, a change in immediate outcome occurred 23.2% of the time. Though in the expected direction, this difference was not statistically significant.

STUDY #2

Method

Procedure

In order to identify potential precipitating events in basketball, a questionnaire was developed which asked a sample of individuals to list ten events that they believed would cause changes in momentum during collegiate basketball games. In addition, they were asked to specify those situations in which this effect might result, for example, time of game, who produced the event, and score configuration.

Twelve volunteers who identified themselves as recreational basketball players and who were blind to the overall purpose of the study completed the questionnaire. Analysis of their responses resulted in 30 different potential precipitating events.

From this group, four events were chosen which demonstrated the most consensus among the respondents and which were consistent with the parameters suggested by Adler (1981) and the present model: (a) Starting player must leave game for a negative reason such as injury, foul trouble, ejection, (b) Scoring run of three straight baskets by one team, (c) Time-out called by the opponent after a scoring run, and (d) Dramatic play, for example, slam dunk, three-point basket, fast break, steal leading to a basket, blocked shot, "prayer" shot at the buzzer.

Five games from the round of 16 at the 1990 NCAA Men's Basketball Championships were videotaped. Games from this tournament were chosen in order to control for ability which, as discussed previously, may be a significant factor in discriminating momentum. A trained observer then watched each game and, using a specially designed assessment form, recorded every occurrence of the four identified precipitating events and the scoring pattern during the following five minutes.

Momentum was operationalized in a manner similar to that used in the tennis study. A significant change (i.e., momentum) was indicated if the team that the precipitating event favored changed the game score in its favor by at least five points during the five minutes following the events or the team won the game in overtime. This score change was derived following extensive discussion with a sampling of collegiate basketball players and coaches. Also, the observer examined five minute segments when a precipitating event did not occur and whether there was a subsequent change in outcome. Like the tennis study, a second observer demonstrated the reliability of the first observer's assessments (97% concordance).

Results

Across the five basketball games, there were an average of 12.8 precipitating events per game. The most common type of precipitating event was the dramatic play, accounting for 43.1% of those recorded followed by a scoring run (35.2%), an important player left the game (13.7%), and a time out (7.8%). 78.4% were positive and 21.6% were negative events.

A series of Chi-Square analyses were conducted in order to examine the relationship between precipitating events and changes in immediate outcome relative to winning vs. losing teams. An initial analysis indicated no significant differences between winning and losing teams in terms of the proportion of positive and negative precipitating events that occurred.

However, a near-significant change emerged ($\chi^2 = 3.37$, $p < .07$) when the presence or absence of change in immediate outcome was included. Specifically, winning teams had a near-significantly greater proportion of positive precipitating events that led to positive changes in immediate outcome (36.4%) than losing teams (11.1%).

A change in immediate outcome occurred significantly more often in the presence of a precipitating event than in its absence (22.0 vs. 0.0%, respectively; $\chi^2 = 4.57$, $p < .04$).

DISCUSSION

The purpose of the two studies was to initiate exploration of the value of the multidimensional model of momentum in sports. The specific objective was to examine the first stage of the model: precipitating events and their relationships to changes in immediate outcome. This goal was accomplished by investigating whether there were significantly greater number of changes in operationalized momentum following precipitating events than when no precipitating event had occurred.

In general, the findings of the two studies provide some support for the experimental hypotheses. Evidence for the first hypothesis was mixed. Winning and losing basketball teams did not differ significantly in the number of positive and negative precipitating events they experienced. In contrast, winning tennis players exhibited significantly more positive precipitating events and fewer negative precipitating events than losing players.

The second hypothesis suggested that, due to the complexity of the momentum chain, the occurrence of a precipitating event would not necessarily produce a commensurate shift in immediate outcome. Specifically, in order for momentum to occur, each athlete or team would have to go through an intricate series of cognitive, affective, physiological, and behavioral changes, and that the precipitating event is a necessary, but not always sufficient, catalyst for completion of the momentum chain. As predicted, in both studies, only a proportion of the precipitating events resulted in a change in immediate outcome.

The third hypothesis indicated that winning teams and players would have more positive precipitating events that lead to positive changes in immediate outcome and fewer negative precipitating events that would result in negative changes in immediate outcome. The present findings were somewhat supportive of this assertion. Significant differences were found between winning and losing tennis players for both valences of precipitating events. These findings indicate that not only do winning players produce more positive precipitating events and fewer negative precipitating events, they are also better able to successfully act on the former and restrict the latter.

In the case of basketball, a near significant difference emerged between winning and losing teams for positive precipitating events. These findings indicate that, though winning and losing teams generated a near equal number of precipitating events, the winning teams were more likely to complete the positive momentum chain and produce a positive change in immediate outcome.

These results are consistent with the proposed model with respect to completing the momentum chain for teams as compared to individuals. In particular, the magnitude of the relationship between precipitating events and changes in immediate outcome were greater for tennis than for basketball. In support of this aspect of the model, for singles tennis, a precipitating event must only activate the momentum chain of an individual player. In contrast, for basketball, the precipitating event would be required to catalyze the momentum chain of five players with potentially different cognitive, physiological, affective, and behavioral response thresholds simultaneously. As a consequence, it would be expected that it would be significantly more difficult for a team to complete the momentum chain than an individual player.

Finally, the fourth hypothesis, the one most critical to the model, asserts that there will be a significantly greater number of changes in immediate outcome following precipitating events than when no precipitating event occurred. This hypothesis was tested in order to rule out the possibility that the relationship between precipitating events and immediate outcome was due to chance. The present results offer supportive, though not conclusive, support for this position. As predicted, for basketball, changes in immediate outcome only emerged following a precipitating event. This robust finding suggests that, in basketball, a precipitating event may be necessary for a change in immediate outcome to occur.

The results were not so decisive in tennis. It was found that, though there was a noticeable difference between the presence and absence of precipitating events and the emergence of changes in immediate outcome, the difference was not statistically significant. In fact, even without a precipitating event, changes in outcome still occurred more than one-fifth of the time. Though there is no way to offer any decisive explanations for this finding, several potential perspectives may be considered.

First, it may be that precipitating events occurred that were not measured. Due to the nature of videotaped assessment, it was only possible to identify observable precipitating events. Intrapersonal or social precipitating events may have occurred, but were not assessed. Second, there may have been an accretion effect of earlier precipitating events. That is, a sufficient number of previous precipitating events may have accumulated to finally activate the momentum chain and produce a change in immediate outcome. Third, the lack of significant differences may have been due to chance, thus confirming the assertions of Gilovich et al. (1985) and Silva et al. (1988).

The divergent findings between an individual and team sport is surprising in light of our earlier statement that momentum would be less likely to occur in a team sport because complex activation of the momentum chain would be required for all five players on the team rather for just one tennis player. The reasons for this disparity are unclear. It may be that, in team sports, aspects of the momentum chain become "contagious," thus spreading from player to player and facilitating the progress of the momentum chain. It may also be that, with five players, a precipitating event is more likely to be recognized and the momentum chain initiated. The divergence may also be due to methodological concerns. For example, the operationalization of momentum for the two sports may not be equivalent. These suppositions are entirely speculative and additional research examining this particular issue is necessary before any substantive position is taken.

Directions for Future Research

Though the two studies have provided the first supportive, though not conclusive, evidence of the relationship between precipitating events and competitive outcome, further study is needed to confirm this initial support. Additionally, it is necessary to begin the process of examining each step of the momentum chain.

The research to date examining cognitions related to momentum has utilized hypothetical or contrived scenarios rather than naturally occurring competitive sport situations. In order to effectively study these cognitions (and related emotions), it will be necessary to assess them during the course of actual competitions. Two possible means of accomplishing this are suggested. The most direct way would be to wire athletes with microphones and have them verbalize their thoughts and emotions as they occur. This methodology, however, is clearly intrusive and might artificially interfere with the spontaneous flow of the competition and the generation of momentum-related cognitions and emotions. Another approach would be to videotape the athletes, have them view themselves following the competition, and ask them to recount post hoc their cognitions and emotions at critical points during the competition.

As mentioned above, this model is amenable to physiological measurement. The use of portable heart rate and galvanic skin response monitors would allow for objective assessment of physiological changes as they occur during competition. These changes could then be correlated with the presence of precipitating events.

Behavioral changes that are related to the occurrence of precipitating events could be obtained through videotape analysis of athletes. Baseline types and frequencies of behavior could be established and then compared with behavior changes that might emerge following precipitating events.

Finally, the interative effects of head-to-head competition on momentum could be examined by using the above methodologies simultaneously with competing athletes. A similar approach could be used to study how momentum is influenced by team vs. individual sports.

Conclusion

The goal of the present paper was to provide a new conceptualization of momentum in sports. The proposed model clearly articulates the necessary sequence of events that must occur in order for momentum to result. In addition to the presentation of the model, this work offered an initial investigation of its value. The findings of the two studies examining the first stage of the model, that is, the relationship between precipitating events and changes in immediate outcome, provided partial evidence in support of the model. As demonstrated above, one of the strengths of the model is that each of its stages is operationalizable and empirically verifiable. The next step in the investigation of the model will be to examine how each intermediary step of the model influences the relationship between the precipitating event and changes in immediate outcome. As a consequence, it is hoped that this model will generate interest for further study of the concept of momentum.

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