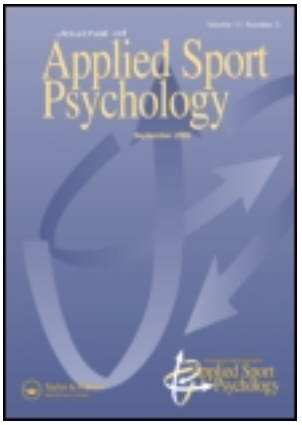

Journal of Applied Sport Psychology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/uasp20

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Available online: 29 Apr 2011

To cite this article: Jennifer Murphy-Mills, Mark W. Bruner, Karl Erickson & Jean Côté (2011): The Utility of the State Space Grid Method for Studying Peer Interactions in Youth Sport, Journal of Applied Sport Psychology, 23:2, 159-174

To link to this article: http://dx.doi.org/10.1080/10413200.2010.545101

JOURNAL OF APPLIED SPORT PSYCHOLOGY, 23: 159–174, 2011

ISSN: 1041-3200 print / 1533-1571 online
DOI: 10.1080/10413200.2010.545101

Routledge
Taylor & Francis Group

The Utility of the State Space Grid Method for Studying Peer Interactions in Youth Sport

JENNIFER MURPHY-MILLS, MARK W. BRUNER, KARL ERICKSON, AND JEAN CÔTÉ

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Although previous studies indicate that peer interactions represent an important component of the youth sport experience, studies examining peer interactions in the sport context are limited. Furthermore, the methodological tools commonly used to investigate peer interactions have restricted researchers' understandings of the complex, reciprocal nature of these experiences. This paper outlines the potential contribution of a novel dynamic systems-based methodology, the state space grid method (SSG; Lewis, Lamey, & Douglas, 1999), to the study of peer interactions in sport. Concrete recommendations to guide the practical application of the SSG method to future peer research in youth sport are presented.

Interactions with peers constitute an important context through which youth can acquire a range of skills, attitudes, and behaviors that influence their development (Rubin, Bukowski, & Parker, 1998). Previous research indicates that youth sport participants consistently cite peers as a source of both competence information (Horn & Amorose, 1998) and motivation to participate (Weiss & Petlichkoff, 1989). Peers also contribute to the enjoyment of sporting activities through their recognition of accomplishments, companionship, and support (Smith, 1999). However, in spite of consistent evidence that peers are an important component of the youth sport experience, the overwhelming majority of studies on social influence in sport focus upon the role of adults in facilitating youth's physical and psychosocial outcomes (e.g., Smith, Smoll, & Curtis, 1978). Therefore, in comparison with coach and parental influences, the influence of peers in youth sport remains a relatively unexplored area of research (Smith, 2007).

In addition to calls for more studies examining peer interactions in general, there appears to be a need to better understand the reciprocal and dynamic nature of peer interactions. Unfortunately, the complex and intricate nature of peer interactions presents a significant challenge for researchers seeking to describe and interpret these interactions. In response to similar challenges in developmental psychology, the dynamic systems perspective is proposed as a valuable framework for examining the effects of significant others on youth development (Granic & Hollenstein, 2003). Consequently, the aim of the present paper is to explore the potential contribution of a particular dynamic systems approach, the state space grid method (SSG; Lewis, Lamey, & Douglas, 1999), to the study of youth's peer interactions in sport. Specifically, the paper will (a) highlight the limitations of the existing literature on peer interactions in sport; (b) elaborate on how behavioral observation, dynamic systems theory,

Received 15 April 2010; accepted 30 November 2010.
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and the SSG method may be useful in addressing these limitations; (c) outline methodological and research design strategies for the incorporation of the SSG method into peer sport research; and (d) provide practical implications for the application of the SSG method for studying peer interactions in youth sport.

LIMITATIONS OF PEER LITERATURE IN SPORT

Although the body of literature on peer interactions in sport is not as extensive as the literature base examining coach or parental influences, evidence exists to suggest that peer interactions are an important component of the youth sport environment (Smith, 2003). Rather than replicate the existing comprehensive reviews of the peer literature (e.g., Smith, 2007; Smith & McDonough, 2008; Weiss & Stuntz, 2004), the aim of this section is to provide a clear picture of the limitations within the current youth sport peer literature. The peer literature in sport has been comprehensively reviewed and can be broken into four broad categories: peer acceptance, friendship, peer interactions and sport motivation, and peer interactions and moral development.

First, although many studies (e.g., Bigelow, Lewko, & Salhani, 1989; Chase & Dummer, 1992; Patrick, Ryan, Alfeld-Liro, Fredricks, Hruda, & Eccles, 1999; Smith, 1999; Weiss & Smith, 2002) have demonstrated that peer interactions facilitate positive sport experiences, the behaviors which make up these interactions have yet to be empirically evaluated. For example, it is unclear how behaviors that are directly sport-related, such as providing technical feedback or discussing team strategies, contribute to the quality of youth's sport experiences. Furthermore, studies examining the behavioral patterns that facilitate the exhibition of either sportspersonlike or unsportspersonlike conduct are limited (Smith, 2007). There is consequently a need to explore the interactive behaviors which occur between peers within the youth sport context.

The importance of investigating the behavioral patterns that shape young athletes' social interactions is further underscored by the fact that youth's interaction patterns and acceptance by the peer group are related (Steenbeek & van Geert, 2007). Indeed, there is an extensive body of evidence within the psychology literature suggesting that a link exists between both adaptive interaction patterns and high social status and between maladaptive interaction patterns and low social status (Steenbeek & van Geert, 2007). Asher and Coie (1990), for instance, found that children whose social skills led to maladaptive interaction patterns were more likely to be rejected by their peer group. It would thus be beneficial for researchers to examine whether similar associations exist in the youth sport setting. For example, researchers could investigate whether youth's interaction patterns with their peers are associated with their perceptions of peer acceptance, as well as their social status within the team.

Second, the current literature primarily focuses on how youth's perceptions of their peer interactions can facilitate psychosocial development (e.g., Daniels & Leaper, 2006; Moran & Weiss, 2006; Smith, 1999). More specifically, these studies evaluate the influence of peers based on the perspective of only one member of the relationship. This is a particularly important limitation to acknowledge because reciprocity is a significant characteristic of the structure of social relationships (Hartup & Stevens, 1997). To gain a deeper understanding of peer relationships, it is therefore necessary to recognize that peer experiences are bidirectional social interactions that occur between two or more individuals. As such, both participants in the relationship have an effect on the other and contribute to the progression of the relationship (Smith et al., 1978). Research that neglects the complex and reciprocal nature of peer

relationships by solely considering the perceptions of one member of the relationship thus provides an incomplete picture of youth's peer interactions.

A third limitation is that the majority of the youth sport peer interactions studies neglect time as an important component of peer interactions (Smith, 2007). As a result, the knowledge-base on peer interactions in sport would greatly benefit from a developmental perspective that addresses changes in peer interactions over time (Smith, 2007). The adoption of a time-based approach would be useful as it could help elucidate the ways in which peer interactions develop. Also, this approach could be used to illustrate the unique contributions made by peer interactions at different stages of development. In addition to examining peer interactions longitudinally, there is a need to examine the temporal structure of youth sport participants' real time, moment-to-moment interactions. This contention is reinforced by studies in the developmental psychology literature which have found an important relationship between real-time interactions and developmental outcomes (Granic & Hollenstein, 2003).

Finally, the methodological approach undertaken by many youth sport researchers involved the use of questionnaires or interviews to assess peer interactions at one point in time (e.g., Daniels & Leaper, 2006; Patrick et al., 1999; Smith, 1999; Weiss & Smith, 2002). Although these methodological tools have provided a wealth of insightful information on peer interactions, these techniques limit the nature of the information collected on influence of peers within the sport context by restricting the ability of researchers to conduct studies that fully examine the complex, reciprocal, and dynamic nature of peer interactions in youth sport. The over-reliance on such methods restricts the topics that researchers address in the first place (Baumeister, Vohs, & Funder, 2007; Rozin, 2001). In addition, although the majority of previous studies have examined individuals' perceptions of peer interactions in sport, few studies have attempted to confirm the accuracy of these perceptions (Smith, 2007). Consequently, the adoption of novel approaches to explore the question of perception-behavior consistency may be required. One methodology that may help to address some of the gaps that exist in the current literature on peer interactions in sport is behavioral observation.

METHODOLOGICAL APPROACHES

Behavioral Observation

The direct observation of behavior can play an important role in enhancing our understandings of peer interactions (Bierman, 2004). Using this measurement approach, researchers directly observe, record, and analyze the behaviors of individuals in either laboratory or naturalistic settings (Coie, Dodge, & Kupersmidt, 1990). One of the key advantages of behavioral observation over qualitative interview methods is that it is less likely to be affected by biases resulting from existing relationships between the participants and the observer (Dishion & Granic, 2004). McClelland and Scalzo (2006) suggest that direct observation "provides the most detailed, specific, and ecologically valid information about target behaviors" (p. 322).

An important benefit of direct observation is that it enables researchers to define and operationalize behaviors (Coie et al., 1990). For example, it may be more informative to know that an athlete positively communicates with peers at a rate of three times that of other athletes on the team, rather than just knowing that an athlete is "popular." Moreover, direct observation may be critical in elucidating the behaviors that characterize and contribute to the quality of peer interactions (Pepler, Craig, & Roberts, 1998). Observing athletes also enables researchers to evaluate the sequencing of behavioral events and the specific patterns of reactivity and responsivity that characterize peer interactions (Bierman, 2004). As such, observations allow

researchers to investigate the variability in youth's interactive style with different peers within the sport environment.

Finally, given that behavioral observation can provide researchers with an objective, quantitative, and contextualized examination of youth's social interactions, this methodology can serve as a supplement to other forms of assessment (interviews, questionnaires) and sources (coaches, parents). In doing so, direct observation can offer researchers a unique behavioral account of social interactions that is currently lacking in a field dominated by the assessment of individual perceptions. Observational methods may be instrumental in guiding intervention design, implementation, and evaluation by offering a more in-depth and objective analysis of the behavioral processes underlying youth's peer interactions in sport. In an effort to adequately address the gaps that exist in the current youth sport peer literature using behavioral observation, it is evident that novel approaches may be required (Smith, 2003). The subsequent sections explore the ways in which one such novel approach, the dynamic systems-based SSG method, can be applied to the study of youth's peer interactions in sport.

Dynamic Systems

The dynamic systems perspective is proposed as an effective theoretical framework for studying peer interactions in sport. According to Lewis (2000), a dynamic system is composed of the reciprocal interaction of individual components which influence and are influenced by each other to produce the functioning of the entire system. In this case, the system is defined as the peer network, in dyad form, with individual youth sport participants as the components of the system. Dynamic systems theory provides a framework by which to understand how an athlete dyad changes over time, both moment to moment and longitudinally. Indeed, the goal of dynamics systems-oriented research is to describe how patterns of interactions emerge, change, and stabilize through a system's own self-organization processes (Granic & Hollenstein, 2003; Lewis, 2000).

Theoretically, any complex system has a broad range of possible behavior patterns within which it can function (Hollenstein, 2007). In dynamic systems terms, this range is known as the *state space*. However, in reality, every system tends to stabilize within a fairly limited range of preferred behaviors or states (Granic & Hollenstein, 2003). Referred to as attractors, these stable patterns represent states that draw the system away from other possible states (Lewis et al., 1999). For example, a dysfunctional athlete dyad might often function in a mutually negative state and might therefore have difficulty maintaining interactions outside this range, such as in a mutually positive state. The strength of attractors can vary; the stronger the attractor, the more likely it is for an athlete dyad to frequently exhibit that particular behavioral state and to exhibit that behavior for longer durations of time (Granic & Patterson, 2006). In contrast to attractors, there are states that rarely or never occur, called repellors. An example of a repellor in interpersonal dynamics might be a mutually negative state, such as aggressive behavior, within a close and supportive friendship. It is the configuration of attractors and repellors that comprises the state space of the system (Hollenstein, 2007).

The State Space Grid Method

A dynamic systems perspective of interpersonal interactions thus relies on concepts of attractors and repellors within a state space. Unfortunately, the empirical evaluation of such concepts using traditional methodologies presents a significant challenge to researchers. In response to this challenge, Lewis et al. (1999) developed the state space grid (SSG) method. Inspired by dynamic systems principles, the SSG method is a graphical approach designed to account for the reciprocal nature and structure of interactions over time. This technique

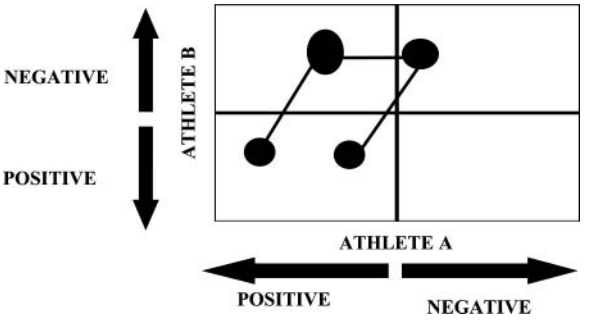

Figure 1. An example state space grid (SSG) depicting 15 seconds of an athlete dyad's interaction. In this example, the behaviors of both athletes are categorized as either positive or negative.

utilizes observational data to construct a state space grid for the system in question, a grid which represents all of the possible behavioral states within which the system could function.

The dynamic system between two actors is characterized by two or more categorical variables, each representing a component of the system. In examining peer interactions in youth sport, for example, the variables of the system are the behaviors exhibited in an interaction between two athletes. All of the potential behaviors of one of the athletes comprise the x axis of the grid while all of the potential behaviors of the other athlete comprise the y axis (see Figure 1). Each point on the grid represents the simultaneous occurrence of each athlete's behavior. Any time there is a change in either athlete's behavior, a new point is plotted on the grid in the cell representing the new joint behavioral event and a line connecting the two points is drawn. Thus, the SSG represents a sequence of real time, moment-to-moment, dyadic behavioral events (Lewis, 2005).

For example, a hypothetical trajectory representing 15 s of an athlete-athlete interaction is presented in Figure 1. In this example, the behaviors of both athletes are very simply categorized as either positive or negative. As shown in Figure 1, the size of the point in the cell corresponds to the duration of each joint behavioral event and the location of the point within the cell is random. The sequence depicted begins in the mutually positive cell with the two athletes engaging in a pleasant conversation. Three seconds later, athlete A jokes with athlete B for 5 s about a past performance, athlete B scowls, and a point is plotted in the athlete A positive/athlete B negative cell. Athlete B reacts to this by criticizing athlete A's technique for 4 s and thus a point is plotted in the mutually negative cell. Finally, athlete A makes a joke to lighten the mood, athlete B responds by laughing, and the interaction returns to the mutually positive cell for three seconds.

Whereas Figures 1 provides an example of a hypothetical interaction, Figure 2 illustrates a 3 min athlete-athlete interaction from a recent project examining interactions within a synchronized swimming environment (Erickson, Côté, Hollenstein, & Deakin, 2009).

In this example, each cell of the grid represents a distinct interactive state defined by the mutual occurrence of specific athlete behaviors. The behaviors on both the x and y axis of this SSG include engaging in practice activities (EngageTeam), discussing technique (TTalkAth), and discussing topics unrelated to practice or technique (GTalkAth). Within this SSG, each point within a cell represents a separate occurrence of this joint behavior, with the size of each point corresponding to the duration of the behavioral event. As shown in Figure 2, both athletes

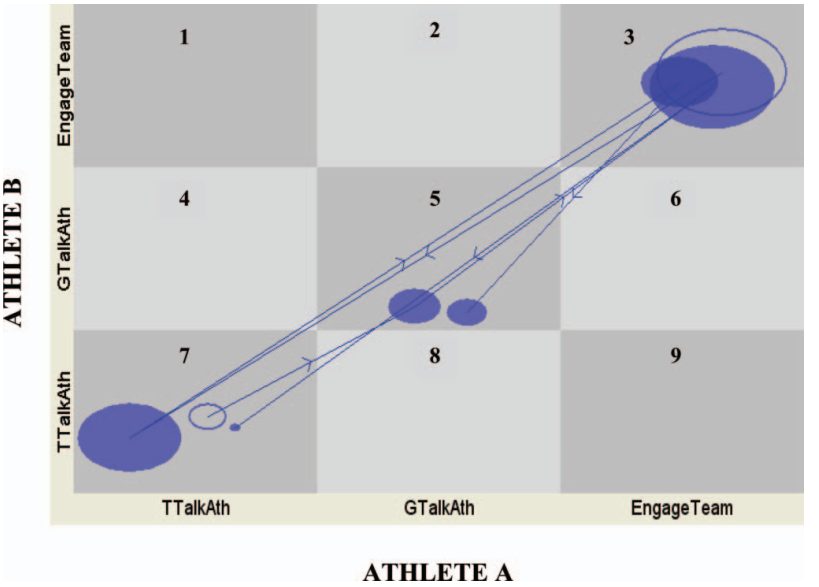

Figure 2. An example state space grid (SSG) depicting 3 min of an athlete dyad's interaction. In this example, categories of athlete behaviour include: engaging in practice activities (EngageTeam), discussing technique (TTalkAth), and discussing topics unrelated to technique or other practice activities (GTalkAth). (color figure available online)

spend the majority of their time engaged in practice activities (see Cell 3). The sequence of behaviors depicted in Figure 2 also indicates that both athletes spend a significant amount of time discussing technique with each other (see Cell 7). In addition, Figure 2 demonstrates that the athlete dyad makes several transitions between discussing technique (Cell 7) and discussing more general topics (Cell 5). Finally, given that the majority of the points within the SSG are along the diagonal axis, it is evident that both athletes tended to exhibit the same behaviors at the same time. This observation suggests that there is a high degree of congruence between the athletes' behaviors and helps to illustrate the reciprocal nature of the athletes' interaction.

In a more complex example, 10 min of an athlete-athlete interaction is presented in Figure 3. The behaviors of both athletes are grouped into 10 categories along the x and y axis. Similar to Figure 2, this SSG reveals that the athletes spend a substantial amount of time engaged in practice activities (as indicated by the top right corner of the SSG) and that the athletes make frequent transitions between technical and general talking. Figure 3 also demonstrates that athlete A spends a significant amount of time discussing technique with other athletes while athlete B is engaged in practice activities (as shown in the top left corner of the grid). Finally, given that the behaviors exhibited by both of the athletes are limited to a few select regions of the SSG, it is evident that this particular athlete dyad has very structured patterns of behavior.

As illustrated by the examples described above, the SSG method enables researchers to track not only the content of athletes' behavior, but the duration of these behaviors as well. This technique also affords researchers the opportunity to examine both athletes' behaviors simultaneously. Furthermore, because the SSG method permits researchers to observe changes in the system's location within the grid over time, it is possible to record the sequences and patterns of behaviors that occur during the interaction. The ability to chronicle these patterns

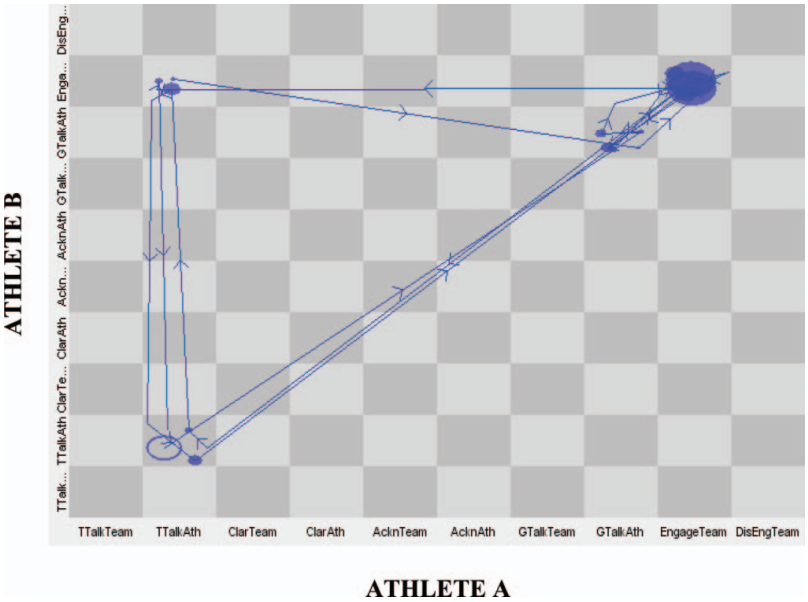

Figure 3. An example state space grid method (SSG) depicting 10 min of an athlete dyad's interaction. In this example, categories of athlete behavior include: engaging in practice activities (EngageTeam), discussing technique (TTalkAth, TTalkTeam), clarifying information (ClarAth, ClarTeam), acknowledging information (AcknAth, AcknTeam), discussing topics unrelated to technique or other practice activities (GTalkAth, GTalkTeam), and being disengaged (DisEngTeam). (color figure available online)

holds significant potential, as our understanding of the behavioral structures of peer interactions in sport is currently limited. It is thus evident that the SSG method offers researchers an appealing way of viewing and understanding complex interactional behavior.

USING THE SSG METHOD IN YOUTH SPORT RESEARCH

To further highlight how the SSG method may be of use to youth sport researchers, the following section presents some methodological and research design strategies for the practical application of the SSG method to peer research in youth sport. To examine peer interactions using the SSG method, one must (a) develop an observational coding system, (b) collect the observational data, (c) establish the reliability and validity of the coding system, (d) code the interactive behaviors, and (e) derive measures of peer interaction content and structure.

Step 1: Developing an Observational Coding System

The first step for researchers wishing to employ SSG techniques in their examination of peer interactions in youth sport is the development of an observational coding system. Although there are a number of coding systems in the developmental psychology literature (e.g., Dishion, Nelson, Winter, & Bullock, 2004) for coding peer interactions, no comprehensive measure presently exists for coding interactive peer behavior in sport. There is consequently a clear need to develop coding systems specifically designed to assess peer interactions within the sport environment. Although it is not within the scope of this paper to detail how such a coding

system could be developed (see Brewer & Jones, 2002; Erickson et al., 2009), some possible categories for interactive athlete behavior content may be (a) prosocial behaviors (helping behaviors, positive reinforcement), (b) neutral behaviors (conversation, technical feedback), (c) antisocial behaviors (criticizing, taunting, aggressive physical contact), and (d) solitary behaviors (sitting on the sidelines, onlooker behavior). In keeping with Brewer and Jones' (2002) recommendations for the development of contextually valid systematic observation instruments in sport psychology, the exact nature of the behavioral categories should reflect both the specific observation context and the research questions targeted.

Step 2: Collecting Observational Data and Refining the Coding System

Given that the aim of behavioral observation is to capture an objective, unmediated, and ecologically valid account of an individual's social interactions (Bierman, 2004), the importance of conducting observations in a naturalistic sport setting cannot be understated. However, naturally occurring peer interactions can be chaotic, confusing, and unfocused and can thus present a significant challenge to researchers seeking to describe and interpret peer interactions (Pierce Winsor, 2003). In an effort to address this challenge, researchers can utilize video technology to capture peer interactions occurring within the sport environment.

There are several advantages to videotaping behavioral observations. First, the number of behavioral events that can be accurately captured in real time is limited (Bierman, 2004). On the other hand, videotapes can be coded in finer detail than live observational coding systems will permit. Second, videotapes can be viewed repeatedly and thus researchers can code both individual and interactive activity with greater reliability (Coie et al., 1990). Third, videotapes can provide researchers with data without interfering with or manipulating the behavior of the participants being observed. Although videotapes can serve to improve the visual quality of the collected data, the utilization of wireless microphones can help to capture the content of peer interactions in sport.

This data collection strategy is supported by a recent study by Erickson et al. (2009) which successfully incorporated video and microphone technology into their comparison of the coach-athlete interactions occurring on two different synchronized swimming teams. Five practices for both teams were videotaped, with each coach wearing an omni-directional wireless microphone to capture both their own and their athletes' verbalizations. By employing this procedure, Erickson et al. (2009) were able to effectively capture a wide variety of coach-athlete interactions occurring within a natural sport setting.

Once the videotapes are collected, researchers can ensure that the observational coding system is able to effectively capture, categorize, and differentiate all behaviors relevant to their research question. To this end, researchers can engage in a test coding process during which the face and content validity of the observational coding system is evaluated. By viewing multiple video clips, researchers can assess whether the categories of the coding system accurately reflect youth's interactive behaviors. Moreover, researchers can ensure that the full scope of youth's interactive behaviors is accounted for by the observational coding system.

Step 3: Establishing the Reliability and Validity of the Coding System

The third step for researchers is to establish the reliability and validity of their observational coding system. To assess the contextual validity of the instrument, researchers can discuss the coding system with both coaches and youth sport participants (Erickson et al., 2009). This will not only help researchers gauge the validity of the behavioral categories, it will provide the participants with an opportunity to engage in the research process. The validity of the coding instrument can also be established by conducting pilot tests within the sport setting.

The inter-rater reliability of this coding system can be established through the use of independent coders. Coders can be trained in accordance with procedures put forth by Erickson et al. (2009) in which coders undergo a series of training tasks, including familiarization with the coding system, a pen and paper written test, and practice coding assignments. According to Hollenstein et al. (2004), coders should be required to meet a minimum standard of 75% reliability on frequency and 90% reliability on duration. Frequency agreement between coders refers to the total number of occurrences when coders activate the same behavioral category within a three second window. Alternatively, duration agreement refers to the total number of seconds of video for which coders have the same behavioral code active (Erickson et al., 2009). Additionally, by having multiple coders code the same video segments at various points during coding for analysis, further reliability analysis can be calculated to check for coder drift from the coding system.

Step 4: Coding Peer Interactions

Once the reliability and validity of the observational coding system have been established, researchers can utilize this system to code each athlete's interactive behaviors in accordance with SSG methodology. As such, each video is viewed in its entirety and the state variable of interest, in this case, athlete behavior is recorded continuously (accounting for every second of the observed segment). To ease coding procedures, the videotapes can be coded using Observer XT software by Noldus, a software system designed for recording, coding, and analyzing the frequencies and durations of observed behaviors (Noldus, Trienes, Hendricksen, Jansen, & Jansen, 2000). The use of this system enables researchers to code behavior at different playback speeds, while maintaining a proper time reference. Therefore, researchers are able to code the start time, duration, and stop time of each behavioral event. Finally, once all of the behaviors of each athlete are coded, the data can be used to construct specific SSGs (e.g., for the interaction between athlete A and athlete B, etc.) and measures of the interactions can be calculated using GridWare software (Version 1.1; Lamey, Hollenstein, Lewis, & Granic, 2004).

Step 5: Deriving Measures of Peer Interaction Content and Structure

There are several ways in which constructs derived from the SSG method can be used to explore peer interactions in the sport environment. Three examples of these constructs are (a) attractor states, (b) variability, and (c) transitions and sequences.

Attractor States

First, the SSG method allows researchers to investigate whether youth sport participants' behaviors cluster in a specific set of behaviors (identifying typical attractor states) or if they vary across the state space. Researchers might also track how long the youth's behaviors stay in certain areas of the state space over others and how quickly the behavioral patterns return or stabilize in particular areas. In doing so, researchers can examine the relative occurrence and strength of attractors, or conversely the variability (lack/weakness of attractors) within the system (Granic & Hollenstein, 2003). Furthermore, the occurrence and strength (or relative absence) of attractors within the youth's peer interaction can be derived quantitatively using the SSG method and can subsequently be tested statistically for changes in real and developmental time or compared between sport participants (Hollenstein, 2007). These attractor analyses can be used to illustrate how youth's patterns of interaction emerge and stabilize over time and can reveal the processes that underlie these dynamics.

Studies within the developmental psychology literature, the field in which SSG methodology was developed, have focused on identifying attractors and measuring the strength of these

attractors (Hollenstein, 2007). At the most basic level, these attractor states can be identified with measures of frequency and duration. For example, dysfunctional athlete dyads may be identified by excessively frequent bouts of yelling and taunting. Alternatively, attractors can be identified by how much time is spent in a particular region of the state space, with longer times indicating a stronger attraction. For instance, an athlete dyad might spend a significant amount of time in a cell corresponding to mutual technical feedback. This might serve as an indication that this peer interaction is primarily drawn towards dialogue that is sport-specific in nature.

Researchers can also investigate how quickly an interaction returns to a given cell or region in the SSG. An interaction which has a high return time to a region may be exhibiting either a weak attraction or even repulsion from this region (Martin, Fabes, Hanish, & Hollenstein, 2005). An example of this type of interaction might occur for an athlete dyad that tends to display hostile or aggressive behaviors towards each other, and thus has a higher return time for mutually positive cells of the grid. To further illustrate this, we can refer back to Figure 1, which depicts an athlete dyad taking nine seconds to return to the mutually positive cell of the grid. In comparison to this example dyad, an athlete dyad that tends to display aggressive behavior may take longer than nine seconds to shift between these two cells. Attractor states can also be measured by examining how quickly the interaction first enters a region. With this parameter, the assumption is made that an attractor draws behavior to it quickly whereas a repellor is a region of the grid that the interaction enters later, if at all. Therefore, if an attractor of an athlete dyad is discussing technique, athletes will display this behavior early on during the course of the interaction. Collectively, these parameters provide a sample of the possible ways in which interaction attractors can be quantified using the SSG method.

The importance of identifying and understanding the attractor states of peer interactions is highlighted by the work of Granic and Dishion (2003) which investigated the relationship between deviant talk in adolescent friendships and anti-social behavior. Although not specifically using the SSG method, Granic and Dishion (2003) employed a dynamic systems approach to assess the interactions between high risk adolescents and their friends. Results revealed that for adolescents with externalizing behavior problems, deviant talk became an attractor state over the course of an interaction. In addition, Granic and Dishion (2003) found that the strength of the deviant talk attractor predicted adolescent delinquency and substance abuse over the ensuing 2–3 years, even after controlling for the effects of prior levels of problem behavior. Taken together, these findings suggest that attractor analyses can enable researchers to identify the behavioral patterns that characterize antisocial peers and to predict future antisocial behavior.

Researchers in the sport domain can build upon this line of research by exploring the attractor states of both prosocial and antisocial athlete dyads and by investigating how the strength of these attractors relate to various psychosocial outcomes. For example, researchers interested in the relationship between peer interactions and moral development can use attractor analysis to identify attractors consistently associated with the exhibition of aggressive behavior. More specifically, researchers can evaluate whether or not discussion relating to cheating or unsportsmanlike conduct is a more attractive state for athletes who consistently exhibit aggressive behaviors. Practitioners can also utilize this technique as part of a diagnostic assessment of dysfunctional behavioral patterns, and then over the course of an intervention, measure whether there is a dissolution of those attractors in favour of more adaptive behavioral patterns.

Variability

In contrast to attractor states, which can be recognized by identifying and comparing parameters for each cell or area of an SSG, the variability of the interaction is assessed across

the whole state space. Variability, which refers to the degree to which the dyad changes its behavior over the course of an interaction (with high variability corresponding to multiple attractors), is an important feature of peer interactions that can be operationalized in at least two ways that correspond to SSG parameters (Hollenstein, 2007). The first parameter is the number of different cells (joint behavioral events) visited over the course of the interaction, with higher numbers of cells visited indicating a more variable pattern of behavior. The second parameter assesses variability by measuring the number of transitions between cells, with more transitions signifying greater variability. This parameter provides additional and different information from the first parameter since an interaction may be characterized by occupying a low number of cells, but having a high number of transitions between those few specific cells.

From a dynamic systems perspective, variability is a parameter that can provide valuable information about youth's experiences in specific contexts (Granic & Hollenstein, 2003). Consistent with this contention, previous studies employed measures of the variability of parent-child and peer interactions to examine the relationships between emotion, variability, and the development of antisocial behaviors (Dishion et al., 2004). Dishion et al. (2004) observed peer behaviors between adolescent males during a series of interactive tasks (planning an activity and discussing problems they were experiencing with parents and peers). The results indicated that males whose interactions were characterized by reduced variability and elevated levels of deviant content were most likely to continue to engage in antisocial behavior into adulthood. Similarly, lower variability in parent-child interactions has been associated with antisocial behavior problems in both children (Hollenstein, Granic, Stoolmiller, & Snyder, 2004) and adolescents (Hollenstein & Lewis, 2006). Given these findings, it would be informative to determine if this same pattern of variability in sport-based peer interactions also leads to negative outcomes.

Transitions and Sequences

Finally, in addition to identifying content specific changes (e.g., more mutual positivity in athlete interactions), the SSG method also has the potential to depict structural changes in the interaction's behavioral patterns over time, such as sequences of behaviors or transitions between different behaviors. For example, with the SSG method, researchers can test whether athletes in close friendships move more quickly from a negative interaction to a positive one, as compared to athletes in dysfunctional friendship. Understanding these structural and temporal changes may help researchers gain a better understanding of the behavioral processes underpinning both adaptive and maladaptive peer interactions in sport. In doing so, this research may educate coaches and practitioners on how best to cultivate adaptive peer interactions in the sport context.

Given the various ways in which the SSG method can be used to investigate behavioral interactions, it is evident that this methodology is well suited for the examination of peer interactions in sport. This suggestion is supported by previous studies which successfully used the SSG method to study peer interactions (Dishion et al., 2004; Martin et al., 2005). The following sections intend to build upon this line of research by considering how peer interactions in sport can be addressed using the SSG method.

Using the SSG Method to Illustrate Peer Processes

Over the short term, interactions with peers may vary in form, function, and in response to changes in the social context (Rubin et al., 1998). For instance, two athletes can display mutually positive interactive behaviors while discussing their favorite music on the bench

during a game. Conversely, this athlete dyad can demonstrate mutually negative behaviors while arguing about team strategies on the field during a practice. Finally, this same athlete dyad can exhibit a combination of negative and positive behaviors during a practice or a game. Drawing upon these examples, it is evident that the behaviors which athletes exhibit during peer interactions are indeed subject to variation. Therefore, it is of interest to sport psychology researchers to examine the types of behaviors which can be observed in athlete interactions across different contexts. In doing so, researchers may garner new insight into how different peer settings (e.g., engaging in practice activities, resting on the bench, participating in a competition) affect the actual behavioral patterns of athletes. Moreover, researchers may gain a better understanding of the types of interactive behaviors that are most relevant to the development of adaptive peer interactions in both practice and competition settings. This understanding may be critical for both coaches and practitioners attempting to structure sport environments that will optimize athlete development.

Furthermore, the SSG method enables researchers to examine the reciprocal nature of peer interactions. Previous research has primarily focused on how athletes' perceptions of their peer interactions can facilitate development (e.g., Bigelow et al., 1989; Patrick et al., 1999; Weiss & Smith, 2002). However, these studies assessed the influence of peers based on only one member of the interaction. Because both participants of an athlete dyad contribute to the progression of the interaction, it is important to consider the effects that both athletes may have on each other's development. By enabling researchers to evaluate the two members of an athlete dyad simultaneously, studies employing SSG techniques can thus provide a more complete picture of youth's peer interactions.

In addition, whereas previous studies examined athletes' perceptions of peer interactions (e.g., Daniels & Leaper, 2006; Moran & Weiss, 2006; Smith, 1999), the SSG method enables researchers to evaluate how these interactions are manifested behaviorally. The importance of understanding the behaviors that comprise peer experiences in sport is underscored by the fact that researchers and practitioners can utilize this information to both design and evaluate interventions. More specifically, SSG techniques can be employed to (a) screen and identify athletes with maladaptive behavioral patterns, and (b) provide an objective assessment of the degree to which an intervention has produced behavioral change. Because the SSG method enables researchers and practitioners to assess the temporal sequences that characterize peer experiences in sport, studies utilizing this tool can explore how antecedent conditions and interpersonal consequences may be eliciting or supporting behavioral change.

The utility of the SSG method for intervention research is highlighted in the work of Granic, O'Hara, Pepler, and Lewis (2007) which employed SSG techniques to assess the effectiveness of an intervention for aggressive children. More specifically, Granic et al. (2007) used this methodological approach to quantify the processes of change associated with treatment success. Results indicated that increases in the variability of parent-child interactions were associated with significant improvement in children's externalizing behaviors. Also, it was found that while parent-child dyads who improved still expressed negative behaviors during conflict, they had acquired the interpersonal skills necessary to shift out of negative behavioral patterns to more mutually positive behavioral patterns. Taken together, these results further reinforce the need for sport researchers to conduct studies that examine not only the behavioral content of athletes' peer experiences, but also the structure (variability and temporal patterns) of this behavioral content. The findings of such studies can enable coaches and practitioners to design and implement more effective behavioral interventions for youth sport participants.

Finally, the SSG method can be employed to investigate the ways in which interactive behavioral patterns may be associated with athlete outcomes. Whereas previous research has primarily focused on how perceptions of peer interactions may influence athlete outcomes,

studies using SSG techniques can examine the relationship between an objective index of athletes' real time interactive behaviors and athletes' experiences. Researchers can thus examine how certain behavioral attractors, such as positive general communication, may be linked with athletes' levels of enjoyment or motivation. Alternatively, researchers can examine how an athletes' propensity to give technical feedback and positive reinforcement to their teammates may be associated with the development of leadership skills. In doing so, future studies can highlight the types of behavioral patterns that are most conducive to adaptive peer interactions. Furthermore, these studies can serve to illuminate the behavioral processes underpinning the association between peer acceptance, friendship, and athletes' developmental outcomes. The findings of such studies can be used to educate coaches and practitioners on the interpersonal behaviors linked to positive athlete outcomes and hopefully, to inform these individuals on how to effectively structure sport environments to promote opportunities for adaptive behavioral patterns.

Limitations of the SSG Method

Although the SSG method offers many advantages to researchers examining peer interactions in sport, the measurement of behavior utilizing this novel methodology also entails several limitations. Inherent to all forms of behavioral observation, this methodological approach can be difficult, expensive, and time-consuming (Bierman, 2004). Along with the arduous task of developing the appropriate coding system for studying peer interactions in sport, the process of actually gathering and coding the observational data can be quite demanding on one's time and resources (Furr & Funder, 2007). There is currently a lack of observational coding systems specifically designed for examining peer experiences and consequently, researchers interested in this area must be willing to devote the necessary efforts to the development and validation of such a system.

In addition, practical and ethical considerations prevent the direct observation of many peer interactions that may contribute to the quality of peer interactions in sport. For example, it would not be possible to capture peer interactions that take place outside the parameter of practices or games, such as in the dressing room or in the athletes' homes. Conversely, questionnaires or interviews can be used to uncover participants' perceptions of peer interactions that occur in a wide variety of contexts. The SSG method may therefore be limited in capturing the broad range of interactions that may occur between athletes within the sport setting.

Finally, behavioral observation using the SSG method focuses on the assessment of direct behavior. This methodological approach, however, does not allow for the assessment of internal perceptions underlying athlete behaviors. Direct observation using SSG methodology is thus additionally limited by the fact that it is currently primarily researcher-driven. However, researchers can attempt to include youth's perceptions into this type of methodological approach by seeking athletes' input into the coding systems used to operationalize athlete behavior. Also, there is an exciting possibility that future research can involve athletes coding their own behavior. In doing so, this may help to bridge the gap between measuring athletes' behavior and athletes' perceptions.

Like all methodological techniques, it is evident that the SSG method has its own set of limitations. However, this novel approach enables researchers to focus on aspects of peer interactions that have been relatively overlooked by existing methodologies. The SSG method by no means diminishes the need for other methodological approaches. Rather, the SSG method may be most valuable as a component of broader research projects, which involve the use of methods such as interviews and questionnaires. By combining these multiple approaches,

researchers can garner a more comprehensive understanding of peer interactions in sport and ultimately, the contribution of these interactions to athlete development.

PRACTICAL APPLICATIONS

In spite of these limitations, the SSG method may still be eminently useful in exploring peer interactions in sport. As previously mentioned, the athlete dyad is a complex interpersonal relationship (Smith, 2003). Consequently, novel approaches to the study of peer interactions are needed in order to fully capture the multifaceted and reciprocal nature of these experiences. Also, because the SSG method is less technically intensive than other dynamic systems methodologies, the SSG method is more accessible to researchers, such as sport psychologists, who do not have the technical background in the area of dynamic systems (Hollenstein, 2007).

Furthermore, the SSG method affords researchers, coaches, and practitioners the opportunity to gain new insight into the intricacies of peer interactions. More specifically, this methodological tool enables researchers to compare observed peer behaviors with athlete perceptions and to identify the content and structural patterns underlying peer interactions in sport. In doing so, employing the SSG method to examine peer interactions may enable practitioners and researchers to (a) offer insight into adaptive and maladaptive interactive behavioral patterns, (b) educate coaches regarding both the importance of peer interactions and the effective management of these interactions in practice and competition settings, and (c) design and implement interventions that will help athletes develop adaptive peer interactions in the sport environment. Overall, the SSG method may provide a novel base of empirical evidence regarding the behavioral patterns conducive to the development of positive peer interactions. In doing so, this research may provide considerable insight into the behavior patterns underpinning peer interactions that have the potential to positively influence youth's sport participation and psychosocial outcomes. Furthermore, this insight may be used to educate coaches and practitioners on the practices that can effectively promote positive peer interactions, and ultimately, positive sport experiences.

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