BEHAVIORAL MOMENTUM IN SPORTS: A PARTIAL REPLICATION WITH WOMEN'S BASKETBALL

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Previous research has applied the behavioral momentum metaphor to men's college basketball. In the current investigation, the relative rate of reinforcement prior to and following adversities (e.g., turnovers, fouls) and periods of time-out were examined in a subset of women's college basketball games.

DESCRIPTORS: basketball, behavioral momentum, resistance to change

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Behavioral momentum is a metaphor that is used to describe the relation between response rate and resistance to change when disruptive events occur (Nevin, 1996). The momentum metaphor has typically been applied to response acquisition (e.g., Mace et al., 1988). However, Mace, Lalli, Shea, and Nevin (1992) applied the concept of behavioral momentum to men's college basketball. They examined the relations among a team's local rate of reinforcement (e.g., rate of goals made), its response to an adversity (e.g., a turnover), and its response to a time-out called by the opposing team. Results indicated a positive relation between the rate of reinforcement prior to an adversity and a team's positive response to that adversity (i.e., teams who were performing well before an adversity generally responded better to that adversity than teams who were performing poorly). Results also indicated that a time-out called by the target team was effective in reducing the opponent's rate of reinforcement.

Previous research has noted that, for some sporting activities, response difficulty may vary across genders (e.g., Looney, Spray, & Castelli, 1996). Likewise, there are several differences in men's and women's college basketball rules that may affect game play. For example, women's college basketball has different rules regarding shot-clock duration (30 s for women and 35 s for men) and ball advancement from the backcourt (i.e., the 10-s rule; National Collegiate Athletic Association [NCAA], 1999). Women's basketball is also qualitatively different in its style of play relative to men's basketball (e.g., more perimeter play focused on shooting skill and passing in women's basketball and more play in the low-post or free-throw lane in men's basketball; Smith, 2002). In the current study, it was hypothesized that the style of play and rules of the game in women's basketball may affect the relative reinforcement rates that occur during play relative to men's. Changes in relative reinforcement rates may affect how favorably teams respond to adversities and to time-outs throughout a game.

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The purpose of the current investigation was twofold. First, we evaluated the extent to which relative reinforcement rates differed between the current sample and that of the Mace et al. (1992) investigation. We also sought to evaluate the generality of the results described by Mace et al. by applying the momentum metaphor to women's college basketball. Specifically, we assessed the degree of the relation between local reinforcement rates and responses to adverse events and to an opponent calling a time-out.

METHOD

Basketball Teams

A sample of six basketball games was selected from the 2000 NCAA women's tournament. The games were selected based on television broadcast (regional or national) and included the following: Louisiana Tech versus Vanderbilt, Georgia versus North Carolina, Tennessee versus Texas Tech, Louisiana Tech versus Old Dominion, Tennessee versus Rutgers, and Connecticut versus Tennessee.

Target Events and Data Collection

A trained observer collected data for each of the 12 teams (i.e., the six games each scored twice, once for each team) on a laptop computer. Data collection began with the onset of the game clock and included all game time, exclusive of halftime (i.e., play time and time-out periods with the halftime duration excluded from total game time). Three classes of events were recorded separately for each team (i.e., the target team). The classes of events were based on those described by Mace et al. (1992) and included reinforcers (i.e., 3-point goals, 2-point goals, 1-point foul shots, steals and turnovers favoring the target team), adversities (i.e., turnovers favoring the opponent team, missed field goals or free throws, committing a shooting foul), and responses to adversities (i.e., a reinforcer or adversity that occurred during the first possession following an adversity).

A second observer independently collected data for 33% of all separate team observations. Exact agreement coefficients were calculated by partitioning each observation period into 10-s intervals and by dividing the number of 10-s intervals with agreements (i.e., two observers scoring exactly the same number of all possible events) by the number of intervals with agreements plus disagreements, multiplied by 100%. Agreement averaged 99.1% (range, 98.8% to 99.3%) for all event categories.

RESULTS AND DISCUSSION

Based on the data collected across all games, the overall rate of reinforcement observed for women's play was somewhat lower than that observed by Mace et al. (1992) for men's play. Specifically, Mace et al. observed a reinforcement rate of approximately one reinforcer per minute across all games. By contrast, the current data yielded a mean reinforcement rate of 0.67.

As in the investigation by Mace et al. (1992), data were analyzed to evaluate two hypotheses regarding the effects of local reinforcement rates on a team's response to adversities and an opponent calling time-out. First, we evaluated the extent to which a team's local reinforcement rate affected their response to an adversity. It was hypothesized that teams with a higher rate of reinforcement would respond more favorably to an adversity. To test this hypothesis, local reinforcement rates for all teams were calculated for a period of time prior to the occurrence of an adversity. Specifically, the number of reinforcers that occurred in a 4.5-min period prior to an adversity was recorded. Mace et al. observed an average rate of one reinforcer per minute and set the interval length at 3

Table 1
Ratio of Adversities Responded to Favorably to Total Number of Responses to Adversities Across Rate of Reinforcement Categories for Each 4.5-min Period Preceding an Adversity

Game	Rate of reinforcement 4.5 min prior to adversity 0–0.44 (favorable response/total occurrences)	0.67–1.11 (favorable response/total occurrences)	1.33+ (favorable response/total occurrences)
Louisiana Tech vs.	11/31 (35%)	9/21 (43%)	8/15 (53%)
Vanderbilt	12/35 (34%)	6/20 (30%)	2/5 (40%)
North Carolina vs.	13/49 (27%)	7/18 (39%)	2/3 (67%)
Georgia	7/16 (44%)	18/27 (67%)	7/12 (58%)
Tennessee vs.	9/20 (45%)	12/37 (32%)	0/2 (0%)
Texas Tech	9/37 (24%)	4/13 (31%)	0/1 (0%)
Old Dominion vs.	11/32 (34%)	15/40 (38%)	1/1 (100%)
Louisiana Tech	9/13 (69%)	17/41 (41%)	3/6 (50%)
Rutgers vs.	15/40 (38%)	6/21 (29%)	1/2 (50%)
Tennessee	8/16 (50%)	19/40 (48%)	0/1 (0%)
Tennessee vs.	15/37 (41%)	8/25 (32%)	1/4 (25%)
Connecticut	6/13 (46%)	17/36 (47%)	3/5 (60%)
Six-game total	125/339	138/339	28/57
(weighted/unweighted means)	37%/41%	41%/40%	49%/42%

Note. Boldface indicates the winning team.

min so that, on average, there were three reinforcers prior to an adversity. To equate for the average of three reinforcers prior to an adversity, a 4.5-min interval was used for data analysis with the current sample. For the purpose of data analysis, reinforcement rates for individual teams in the 4.5-min interval prior to an adversity were grouped into three categories that corresponded to poor (0 to 0.44), better (0.67 to 1.11), and good (1.33 or greater) game play. To determine the extent to which a time-out disrupted a team's reinforcement rate, reinforcement ratios for the two teams in a given game were calculated for the 4.5-min period before the time-out (A), the 4.5-min period after the time-out (B), and for all periods of time-in except A.

Results of the team analyses yielded two different conclusions depending on which mean values were used. When weighted averages were used across all teams, a general positive relation was observed between local reinforcement rate and positive responses to adversities (similar to Mace et al., 1992; see Table 1 and upper panel of Figure 1). Specifically, for local reinforcement rates that were categorized as poor play (0 to 0.44), a favorable response to an adversity was observed on 37% of occasions. The percentage of favorable responses to adversities increased to 41% and 49% for reinforcement rates categorized as better and good game play, respectively. In contrast, when unweighted averages were used, there was no relation between local reinforcement rate and a positive response to an adversity (see Table 1 and upper panel of Figure 1).

On an individual-team basis, these results failed to replicate those of Mace et al. (1992). Specifically, the percentage of favorable responses to an adversity increased as the local reinforcement rates increased for 4 of the 12 teams. Four of the teams showed the opposite effect: Favorable responses to adversities decreased as local reinforcement rates increased. Finally, the remaining four teams showed a pattern in which a favorable

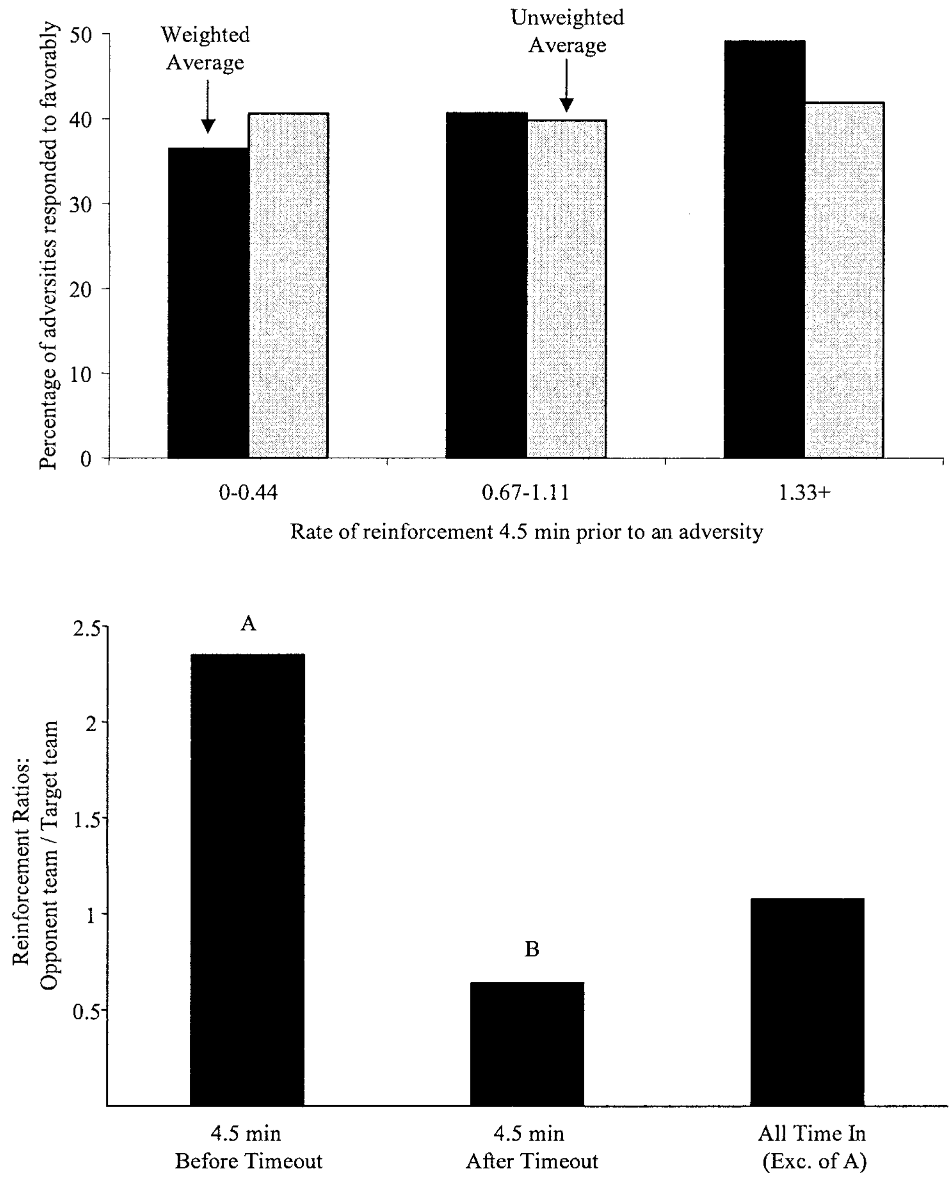

Figure 1. The percentage of adversities responded to favorably across three dimensions of game play (upper panel) and the ratio of opponent teams' rate of reinforcement to the target teams' rate of reinforcement at three different time periods of the games (lower panel).

response to an adversity increased at one level of reinforcement rate but not at another level (see Table 1).

In the evaluation of the relation between local reinforcement rates and calling a time-out, it was observed that a time-out called by the target team was effective in decreasing the opponents' local rate of reinforcement (similar to Mace et al., 1992; lower panel of Figure 1). Across all teams, the average reinforcement ratios decreased from 2.35 in the 4.5-min interval prior to a time-out to 0.64 in the 4.5-min interval that followed a time-out. Eleven of the 12 teams showed this pattern, with one team showing the opposite pattern (i.e., the relative reinforce-

Table 2
Reinforcement Ratios: Opponent Team/Target Team

Game	Reinforcement ratios A 4.5 min before time-out	B 4.5 min after time-out	C All time-in
Louisiana Tech vs.	1.27	1.00	0.87
Vanderbilt	1.86	0.76	1.16
North Carolina vs.	2.21	0.72	1.73
Georgia	2.02	0	0.57
Tennesee vs.	1.52	0	0.54
Texas Tech	0.33	0.49	1.86
Old Dominion vs.	1.56	0.30	1.06
Louisiana Tech	1.68	1.00	0.94
Rutgers vs.	4.54	1.00	1.18
Tennessee	1.60	0.22	0.85
Tennessee vs.	8.09	1.52	1.47
Connecticut	1.52	0.66	0.68
Twelve-team total	2.35	0.64	1.07

Note. Boldface indicates the winning team.

ment ratio increased following the time-out; see Table 2). These results showed that a target team's calling of a time-out was followed by a 73% reduction in reinforcement ratios, on average. Time-out also appeared to be effective at reducing the discrepancy in reinforcement ratios in that the average reinforcement ratio was lower ($M = 0.64$) in the 4.5-min period after a time-out than the reinforcement ratio ($M = 1.07$) for all other time-in periods.

Results of the Mace et al. (1992) investigation yielded two findings: (a) The probability of a team's response to an adversity increased as a function of the team's rate of reinforcement prior to the adversities, and (b) calling a time-out was effective at reducing an opponent's rate of reinforcement. The current study partially replicated the first finding in that responses to adversities increased as a function of rate of reinforcement for only 4 of the 12 teams (in contrast to 8 of 12 teams in the Mace et al. investigation). Furthermore, Mace et al. showed a positive relation between local reinforcement rate and favorable responses to adversities across all 12 teams. In the current study, a similar momentum effect was observed when the weighted averages were used; however, the effect was not observed across teams when unweighted averages were used (see Table 1 and upper panel of Figure 1).

It is unclear why the momentum effect was less frequent for women's play as opposed to men's. One potential reason is that the overall reinforcement rate observed for women's games was lower (0.67) than that observed by Mace et al. (1992), which underlies an important consideration regarding behavioral momentum: Resistance to change is dependent on the rate of reinforcement obtained (Nevin, 1996). Thus, it is not surprising that responding (e.g., good game play) did not persist following an adversity as often for women as it did for men given the lower reinforcement rate observed for women. Also, there were fewer total occurrences at the highest level of reinforcement rate (1.33+), suggesting that the results may have been due to a limited number of opportunities at this level (see Table 1).

Results of the time-out analysis in the current study replicated those of Mace et al. (1992) and suggested that calling time-out was an effective procedure to reduce an opponent's local rate of reinforcement. Although the data suggested that time-out was an effective intervention for decreasing relative reinforcement ratios, previous research (e.g., Duke & Corlett, 1992) has shown that college basketball coaches may focus on other factors (e.g., their players' physical states) rather than on their opponents' scoring behavior. The current data suggest that coaches should examine reinforcement ratios when considering whether to call a time-out.

The momentum metaphor is not the only possible account for the effectiveness of calling a time-out on reducing an opponent's rate of reinforcement. For example, the development of strategy to decrease scoring, the insertion of a new player (e.g., a defensive specialist), and fatigue are all factors that could influence the opponent's reinforcement rate following the time-out. Nevertheless, the findings of the current investigation and those of Mace et al. (1992) are consistent with a behavioral momentum interpretation of the effects of time-out.

The current data are correlational, but the similarity of these results to those of Mace et al. (1992) suggests that group behavior in unstructured settings may be amenable to individual analyses. Therefore, future research may consider applying the momentum metaphor, as well as other principles of behavior analysis, to other sports (e.g., tennis) or other group behaviors (e.g., opinion polling). Future research may also consider the variables that contributed to different reinforcement rates observed between the current study and the Mace et al. investigation. Although it is possible that rule variations or qualitative style of play might influence reinforcement rates, it is also possible that other variables (e.g., changes in coaching philosophies over time) may have contributed to the differences observed.

REFERENCES

Duke, A., & Corlett, J. (1992). Factors affecting university women's basketball coaches' timeout decisions. *Canadian Journal of Sports Sciences, 17,* 333–337.

Looney, M. A., Spray, J. A., & Castelli, D. (1996). The task difficulty of free throw shooting for males and females. *Research Quarterly for Exercise and Sport, 67,* 265–271.

Mace, F. C., Hock, M. L., Lalli, J. S., West, B. J., Belfiore, P., Pinter, E., et al. (1988). Behavioral momentum in the treatment of noncompliance. *Journal of Applied Behavior Analysis, 21,* 123–141.

Mace, F. C., Lalli, J. S., Shea, M. C., & Nevin, J. A. (1992). Behavioral momentum in college basketball. *Journal of Applied Behavior Analysis, 25,* 657–663.

National Collegiate Athletic Association. (1999). *1999 NCAA men's and women's basketball rules and interpretations.* Overland Park, KS: Author.

Nevin, J. A. (1996). The momentum of compliance. *Journal of Applied Behavior Analysis, 29,* 535–547.

Smith, M. C. (2002, February 6). Ability, not gender, is shaping women's sports identity. *The Orange County Register.*

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