

Game Location Moderates the Relationship Between Anticipatory Testosterone Changes and Athletic Performance

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The authors examined the extent to which changes in testosterone concentrations before competition would be associated with performance among elite male hockey players. Saliva samples were collected on 2 noncompetition days (baseline) and before 2 playoff games (1 home game, 1 away game). Individual performance was assessed by the coaching staff after each game. Results indicated that changes in testosterone before competition predicted performance, but this effect was influenced by game location. Unexpectedly, the authors found a significant negative relationship between a rise in testosterone and performance for the away game and a nonsignificant positive relationship for the home game. These findings indicate that game location should be considered in studies examining the neuroendocrine correlates of athletic competition.

Keywords: hockey, testosterone reactivity, game location

Testosterone concentrations typically rise in anticipation of athletic competition and remain elevated in winners relative to losers.¹ We recently reported that viewing a video of a previous victory produced a robust increase (40%) in testosterone among elite-level hockey players.² It has been argued that competition-induced changes in testosterone may serve to fine-tune ongoing and/or future competitive and aggressive behaviors.³ Laboratory studies are consistent with this hypothesis, indicating that a rise in testosterone during competition is positively correlated with subsequent competitive^{4,5} and aggressive behavior in men.⁶ Nevertheless, the extent to which acute fluctuations in testosterone before competition (referred to as anticipatory testosterone change) influence athletic performance is not clear.

Based on results from laboratory studies, we predicted that a rise in testosterone before competition would be associated with better athletic performance. Moreover, given that previous work indicates that game location influences testosterone reactivity patterns,⁷ we explored the extent to which game location may moderate the relationship between anticipatory testosterone change and athletic performance.

Methods

Participants consisted of 19 men on an elite hockey team in Ontario (mean age 18.22, SD 1.66). The average of 2 noncompetition-day saliva samples served as a baseline

measure of testosterone. Participants provided saliva samples before 2 playoff games (both at 7 PM) against the same opponent (1 away and 1 home game). All samples (baseline and precompetition) were collected at 5:45 PM. Procedures were approved by Canisius College's institutional review board and conform to the Code of Ethics of the World Medical Association.

Samples were collected in polystyrene tubes and stored at -20°C until assayed using commercial enzyme immunoassay kits (DRG International, Inc). All samples were assayed in duplicate and in the same batch. The average intra-assay coefficient of variation was 1.92%. After each game, 3 coaches provided independent ratings of each player's performance by responding to the question "How well did this player perform today compared to how he normally performs?" (10-point scale: 1 = *very poor* to 10 = *excellent*). The average was used as the criterion variable (Cronbach's alphas $> .80$). The first game was a 6-1 loss in the away venue, and the second game (2 days later) was a 7-6 loss in the home venue.

Results

A regression analysis was used to examine whether individual differences in anticipatory testosterone change were associated with athletic performance for home and away games. Anticipatory testosterone change was calculated as the unstandardized residuals of a regression analysis with baseline testosterone as the predictor and precompetition testosterone as the dependent variable. Next, performance was regressed onto game location and anticipatory testosterone change (step 1) and the anticipatory testosterone-change by game-location interaction (step 2). There were no significant main effects

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of game location or anticipatory testosterone change on performance ($R^2 = 2.3\%$, $F_{2,33} = 0.39$, $P = .69$). However, a significant game-location by anticipatory-testosterone-change interaction emerged ($R^2_{\text{change}} = 12.3\%$, $F_{1,32} = 4.61$, $P = .04$). Simple slope analyses indicated that there was a significant negative relationship between anticipatory testosterone change and performance for the away game ($b = -.84$, $P = .04$) and a nonsignificant positive relationship between anticipatory testosterone change and performance for the home game ($b = .33$, $P = .39$; see Figure 1).

Discussion

We examined the extent to which changes in testosterone concentrations before competition would be associated with performance among elite male hockey players. The major finding of this study was that changes in testosterone before competition predicted athletic performance, and the direction was influenced by game location. Unexpectedly, a rise in testosterone before an away game predicted poor performance, while changes in testosterone were not associated with performance when the game was played at home. Previous work indicates that pregame testosterone concentrations are sometimes associated with poor competitive performance (see Mehta et al⁸ for discussion). In the current study, this negative relationship (although anticipatory testosterone change, not baseline testosterone concentrations) was observed

only for the game played in the opponents' venue, not the home venue. Differences in aggressive play for home versus away games cannot account for the current findings, as penalty minutes were actually positively correlated (although not significantly) with both anticipatory testosterone change and performance for the away game (data not shown). Another possibility is that status relevance may play an important role here. For instance, players may be less concerned with status when playing in their opponents' venue, in which case a rise in testosterone may actually undermine athletic performance (an anonymous reviewer's suggestion). Speculations aside, future work will clearly be needed to elucidate the psychological and physiological mechanisms underlying the current findings.

Practical Implications

Based on findings from laboratory studies, we suggested that interventions aimed at raising testosterone concentrations before competition (eg, through natural means; eg, watching a video of a victory³) may have a positive effect on athletic performance. However, the results of the current study suggest that such an approach may actually have a negative effect on performance.

Conclusions

Counter to our prediction, we found that a rise in testosterone before an away game predicted poor athletic

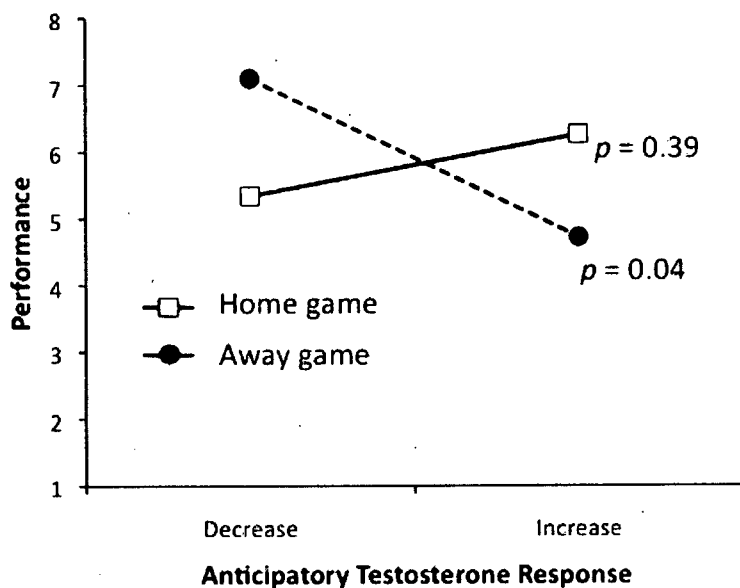


Figure 1 — Relationship between game location, anticipatory testosterone change, and performance. Anticipatory testosterone change (pregame testosterone concentrations after controlling for baseline testosterone concentrations) was assessed as a continuous variable, but for display purposes this variable was dichotomized as decrease (-1.5 SD from the mean) and increase ($+1.5$ SD from the mean) in testosterone.

performance. Our findings highlight the importance of considering the role of social context (ie, game location) when examining associations between hormones and athletic performance.

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