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The Moderating Effect of Hardiness on the Relationship Between Trait Anxiety and Performance in Collegiate Baseball Players

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The purpose of this study was to explore the moderating effect of hardiness on the relationship between trait anxiety and objective performance within NCAA Division I collegiate baseball players. An updated and shortened version of the Personal Views Survey (PVS III-R) was used to measure hardiness after a confirmatory factor analysis (CFA) was conducted. Of the total 389 players that participated, 171 met inclusion criteria and were split into two groups – hitters (*N* = 94) and pitchers (*N* = 80) – to identify differences in skills and how sub-constructs of hardiness (commitment, control, challenge) affected performance through a descriptive correlational design. The results show significant moderating effects of commitment for pitchers that accounted for the majority of variance in the relationship between perception of trait anxiety intensity and left on base percentage (LOB%) and wild pitches (WP). For hitters, significant moderating effects of control accounted for less variance in the relationship between perception of trait anxiety intensity on batting average on balls in play (BABIP) and grounding into double plays (GDP). The findings indicate there may be significant moderating effects of hardiness on the relationship between trait anxiety and objective performance that may be present in game situations with runners on-base. Practitioners could use these findings to target mental skills that could develop a pitcher's commitment or hitter's sense of control to enhance their performance within baseball-specific situations. For example, mental performance consultants could help athletes reframe the intensity of cognitive or somatic anxiety during situations with runners on-base.

Keywords: hardiness, personality, college baseball, objective performance, trait anxiety

The construct of hardiness has come into focus for researchers as it is a personality characteristic with a solid theoretical base and stimulates developmental research (Morris, 2011). The theoretical basis of hardiness was developed by Kobasa (1979) in a landmark study where researchers investigated hardiness as a factor predicting employees of a telephone company facing high levels of stress would fall ill. Those who reported high levels of stress and low levels of illness also reported higher levels of hardiness and had stronger commitment to themselves, an attitude of challenge toward the environment, and an internal locus of control (Kobasa, 1979). Hardiness was thus defined by the three key factors of challenge, control, and commitment. Kobasa defined commitment as the willingness to engage oneself fully in whatever one is doing, control as the ability to influence the events of their experience, and challenge as perceiving change to be exciting and essential to further development.

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Hardiness in Non-Sport Settings

Among studies conducted on hardiness since Kobasa's work, several researchers (Eschleman et al., 2010; Florian et al., 1995) have examined hardiness' influence in a range of sport and non-sport populations. The importance and potential of hardiness was examined in a meta-analytic review that included 180 studies investigating hardiness' antecedents and consequences across all domains. One finding from the study included that hardiness was positively correlated with job (r = .17, N = 676) and school performance (r = .21, N = 623). Eschleman et al. concluded that hardiness is one of the better predictors of well-being in general populations when compared to other predictors of how one responds to stress, such as self-esteem or locus of control. These findings point to a positive relationship

between hardiness and performance, which could be translated into a sport environment.

In other non-sport settings, such as military training, researchers have examined the influence of hardiness as a psychological resource in Israeli Defense Forces recruits (Florian et al., 1995). Researchers found that hardiness components helped individuals appraise combat training as less threatening, feel more capable of coping, and use more coping strategies. The ability to improve hardiness to deal with stress and anxiety in the military could be related to similar situations found in sporting contexts.

Hardiness in Sport

Despite previous research on hardiness, there has been a limited amount of research to examine the potential links between hardiness and objective performance. Previous researchers have examined hardiness in the context of flow states (Vealey & Perritt, 2015) and more broadly as a component of psychological skills training programs (Sheard & Golby, 2006). Vealey and Perritt identified hardiness as a predictor in the frequency of achieving reported flow states in collegiate athletes, specifically in the flow characteristics of clear goals, concentration on the task at hand, and sense of control, among others. Additionally, Sheard and Golby demonstrated hardiness as a psychological construct which can be developed within national-level swimmers as part of a multi-dimensional psychological skills training program. One way that hardiness has been explored within sport is its influence on sport injury. Researchers found hardiness inversely correlated with injury occurrence; as participants' hardiness scores increased, the likelihood of a future injury occurring decreased (Wadey et al., 2012). Athletes who reported higher levels of hardiness experienced demanding athletic situations similarly to athletes who reported low levels of hardiness. They appraised the situational demands as less stressful and decreased the stress response severity. Hardiness also helped athletes transform major life events from negative experiences into growth opportunities through appraisals, coping, and social support. Outside of sport injury, hardiness has been researched across differing competition levels. Sheard and Golby found that athletes in both individual and team sports at higher competition levels scored higher in hardiness than those at subordinate levels specifically regarding the subcomponents of commitment and control.

Trait Anxiety in Sport

Situations that have been identified as useful for athletes to be hardy are stressful situations when the athlete is experiencing cognitive and somatic anxiety (Hanton et al., 2013). In these situations, the athlete can either identify the cognitive or somatic anxiety as being facilitative or debilitative. However, it can be difficult, if not almost impossible, to measure real-time state anxiety during competition without inhibiting the competition itself. Trait anxiety oftentimes becomes a helpful measure of competitive anxiety due to the inability to access athletes moments before competition to measure their state anxiety. State anxiety is typically measured post-hoc and requires athletes to remember how they felt in their past competitions while trait anxiety just asks the athlete to reflect on their how they *usually* feel before their competitions. Athletes who appraise their typical precompetitive anxiety symptoms as debilitative for their upcoming performance experienced more negative overall competitive consequences (Mellalieu et al., 2003). The optimal level of facilitative and debilitative anxiety is also determined by the nature of the task at hand (Wolf et al., 2015). In a study sampling 252 competitive collegiate athletes, Wolf and colleagues found that athletes' levels of competitive trait anxiety contributed the most to the intensity and interpretation of precompetitive anxiety symptoms. Although effective anxiety regulation was not always easily reduced, researchers recommended future research focus on anxiety regulation interventions (Wolf et al., 2015). This finding supports studies examining the link between hardiness and an athlete's perception of their own trait anxiety as facilitative or debilitative.

Trait Anxiety & Hardiness

In a previous study that examined the link between hardiness and trait anxiety in 510 collegiate athletes, Hanton and colleagues (2013) found that athletes with higher levels of hardiness reported lower levels of worry and somatic anxiety as well as higher self-confidence. The researchers identified that hardiness could be developed through confronting and managing adverse anxiety-provoking situations and those with more experiences were better able to develop coping skills to increase their hardiness. Researchers also recommended future research examine hardiness and anxiety interpretation and its relation to specific sport performance as a logical next step (Hanton et al., 2013).

One study that investigated the interaction between objective performance and psychological constructs was conducted by Zizzi et al. (2003) where researchers examined the effect of emotional intelligence among college baseball players. The researchers found that hitting statistics did not seem to be significantly related to emotional intelligence, and of the pitching statistics,

only strikeouts were significantly related to emotional intelligence *(r(21) = .48, p < .05)*. This result was explained by the researchers to be correlated with the amount of control allowed in pitching and the reactionary nature of the act of hitting. This study supported a modest link between performance and emotional intelligence in pitchers *(r = .25 to .48, Cohen's d = .54 to 1.1)*. Although this study did not specifically examine hardiness, the methodological designs used in the study provided the basis to identify possible associations between hardiness and objective performance measures that are widely available via baseball box scores. Since this study was published, baseball analytics has emerged, and this approach would allow a more nuanced examination of objective performance in baseball.

Based on the need for continued research on hardiness, the present study examined relationships among hardiness, trait anxiety, and objective performance metrics in NCAA Division I collegiate baseball players. This study's research questions include:

1. How does hardiness affect objective performance for pitchers and hitters?
2. Is there a moderating relationship of hardiness on trait anxiety and performance?

The researchers of this study hypothesized that hardiness would have a moderating effect in the relationship between trait anxiety and objective baseball performance.

Method

Design

A prospective descriptive correlational design was utilized in this study, in which participant questionnaire data were matched with publicly available objective performance statistics from the 2020 COVID-19 shortened NCAA Division I baseball season. Collegiate baseball was chosen as the most appropriate sport to relate to hardiness as the individualized nature of the sport and statistics produced lend itself to identifying individual objective performance better than most other sports.

Participants

Participants in this study included 389 male collegiate baseball players from 18 NCAA Division I baseball teams and 14 different conferences. In terms of race/ethnicity demographics, 76% *(n = 296)* identified as White, 8% *(n = 30)* identified as Black or African American, 7% *(n = 27)* identified as Hispanic or Latino, 2% (*n = 7)* identified as Asian or Asian-American, 3% *(n = 12)* identified as biracial, and 4% *(n = 17)* preferred not to provide information.

Of the 389 participants, 32 participants did not provide identifying information and therefore their data were not able to be matched to their performance metrics. 58 of the rest of the 357 players who provided identifying information did not participate in any games during the 2020 shortened season. The remaining 299 players included 138 pitchers, 148 hitters, and 13 players who both pitched and hit at some point during the shortened season. Participants were separated into two different groups – hitters and pitchers – to separate the tasks required of different players within baseball. However, it was possible that players were included in both the hitting and pitching groups if they met both inclusion criteria. After excluding pitchers and hitters who did not meet the inclusion criteria during the shortened season, the final number of participants in the hitting and pitching groups were 94 and 80 respectively for a total of 171 participants with three players qualifying for both groups.

Inclusion Criteria

In order to participate in this study, athletes (a) were a listed member on the NCAA team roster, (b) agreed to the informed consent, and (c) were at least 18 years old. Inclusion criteria for hitters required at least two plate appearances per game and criteria for pitchers required at least two-thirds of an inning per outing. These inclusion criteria were modeled after a study that also measured objective performance in baseball (Zizzi et al., 2003).

Due to the shortened season, teams played between 13 to 21 games before the COVID-19 global pandemic terminated the remainder of the NCAA Division I 2020 season. This is equivalent to approximately one-quarter of the total number of games that collegiate baseball teams typically play. This range also includes more non-conference games played and fewer within-conference games than usual. Using the lowest number of the games played, inclusion criteria were multiplied by 13 to reach the minimum number of at-bats or innings needed for the inclusion criteria. Therefore, to be included in the study, hitters must have at least 26 official at-bats and pitchers must have pitched at least 8 innings.

Recruitment

Participants were recruited via a convenience snowball sampling approach. Head coaches whose emails were publicly accessible from 280 (94%) of

the 299 total NCAA Division I baseball teams were contacted across all 32 conferences via email to ask their athletes to participate in the study during the offseason. Of the 280 teams that were contacted, 40 (14%) teams and coaches responded and of those, 25 (9%) teams agreed to participate. After agreeing to participate and sending out questionnaires, 18 (6%) teams returned completed surveys comprising of the final 18 teams included in this study.

Measures

Hardiness

Hardiness was originally measured using the Personal Views Survey III-R (PVS III-R), an 18-item scale with six items pertaining to each of the three sub-scales of challenge, commitment, and control (Maddi et al., 2006). PVS III-R utilized a four-point Likert scale ranging from 0 (*not at all true*) to 3 (*very true*). An example item was "trying your best at what you do usually pays off in the end." The PVS III-R had an internal consistency coefficient alpha of 0.80 and strong positive inter-correlations were reported between the three subcomponents of hardiness and the total hardiness scale (Maddi et al., 2006). The PVS III-R has a range of scores from 0-54 for total hardiness with higher scores reflecting greater hardiness. For each sub-scale (challenge, control & commitment), the scores ranged from 0-18 with higher scores reflecting greater challenge, control, and commitment respectively. After reliability analysis of the collected responses revealed poor scale-level estimates of internal consistency, a confirmatory factor analysis (CFA) was conducted for this specific study.

A CFA resulted in a trimmed, 9-item model in which three positively-worded items each loaded onto the control, commitment, and challenge factors. Evaluation of the revised model indicated adequate fit, $\chi^2(23) = 39.27$, $p = .02$, RMSEA = 0.04, CFI = 0.96, SRMR = 0.04; the ratio of χ^2 to df was 1.71. The majority (77.78%) of standardized item loadings equaled or exceeded 0.50. To evaluate the contributions of these three revised factors to hardiness, a second-order CFA was then conducted; the subscales demonstrated strong loadings onto the hardiness factor, with the control (0.95), commitment (0.98), and challenge (0.86) factors demonstrating standardized loadings that exceeded 0.80. This CFA corroborated previous findings that challenge was the weakest loading of the three sub-scales (Sheard & Golby, 2006). The composite reliability estimate for the 9-item PVS III- R was 0.76 and additional reliability confirmation revealed a Cronbach's alpha of 0.73.

Trait Anxiety Intensity

Trait anxiety intensity was measured using the Competitive Trait Anxiety Inventory-2 (CTAI-2; Albrecht & Feltz, 1987). This scale was modified from the Competitive State Anxiety Inventory-2 by Albrecht and Feltz by asking how athletes usually felt right before competition to create a trait measure. Trait anxiety intensity was measured on the perceived intensity of pre-competition anxiety by the athlete and was measured on a four-point Likert scale ranging from 1 (*not at all*) to 4 (*very much so*). The 27-item scale consists of three subscales with nine questions each for cognitive anxiety, somatic anxiety, and self-confidence. For each sub-scale (cognitive anxiety, somatic anxiety, and self-confidence) the range of scores is between 9 and 36 with higher scores meaning more cognitive anxiety, somatic anxiety and self-confidence and lower scores meaning less cognitive anxiety, somatic anxiety and self-confidence. An example item was "I am concerned I may not do as well in this competition as I could." The CTAI-2 for this study has a Cronbach's alpha value of 0.83 which falls within the range of 0.79 and 0.90 which represents a high degree of internal consistency.

Demographics

Demographic information collected included each participant's name, age, ethnicity/race, college/university, position(s) played, current jersey number, previous experience with sport psychology, if any, and other NCAA DI sports played, if any. Participant names, college/university attended, and current jersey number were used as identifying information to link objective performance data to questionnaires completed by specific players.

Objective Performance Baseball Statistics

In addition to objective baseball performance statistics examined in a previous study (Zizzi et al., 2003), this study included newer objective performance data used to make analytical decisions in professional baseball organizations. These statistics included: Grounding into Double Plays (GDP), Weighted On-Base Average (wOBA), Batting Average on Balls in Play (BABIP) for hitters and Wild Pitches (WP), Fielding Independent Pitching (FIP), and Left On-Base Percentage (LOB%) for pitchers. For more detailed information and formulas to calculate each statistic, please reference FanGraphs' website (Slowinski, 2010). These statistics were chosen based on the feasibility using publicly accessible team websites and also because these statistics provide an indication of a player's individual performance.

Procedures

After obtaining institutional review board (IRB) approval, head coaches of 280 NCAA Division I baseball teams were contacted via email. Upon agreement, informed consent forms and questionnaires were distributed either through online Qualtrics links or via paper surveys depending upon preference. Measures were completed individually; players were given instructions to support accurate completion of all measures. PVS III-R and CTAI-2 measures were counterbalanced before being distributed. Performance statistics were tracked through each baseball team's website, which were made publicly accessible by the team after a NCAA official scorer tracked each game over the span of the season.

Data Analyses

Responses to questionnaires that were completed through Qualtrics were downloaded and aggregated together with paper responses after completion of a double-data entry system. Data collected from publicly available statistics on team websites were entered for players who provided identifying information and consented to be included in the study. Questionnaire data were then linked to available performance data and questionnaire and demographic information were de-identified and separated based on player group. Researchers used the inclusion criteria of at least 26 at-bats for hitters and 8 innings for pitchers to identify which players would be included in the analytic sample.

Using the updated scale for the PVS III-R based on CFA, data analyses were conducted using the updated PVS III-R scale, CTAI-2 Intensity scale, and selected objective performance statistics collected from the shortened season. Pearson correlations were first conducted in SPSS and moderation analyses were conducted using the PROCESS add-on in SPSS (Hayes, 2013). Following the Pearson correlations, moderation analyses were conducted to identify the moderating role of players' hardiness in the relationship between their trait anxiety and measures of their performance. During moderation analyses, the Johnson-Neyman technique probed significant interactions to support identification of conditional effects given evidence of a significant interaction between trait anxiety and hardiness (Hayes, 2013). The Johnson-Neyman technique was used to supersede the arbitrary pick-a-point approach at the 16th, 50th, and 84th percentiles typically used in conditional effects commonly conducted in PROCESS. The Johnson-Neyman technique helps identify regions in the range of the moderator variable where the effect of the variable on the outcome is either significant or not significant (Hayes, 2013).

Results

Descriptive statistics are presented in Table 1. Overall, pitchers and hitters showed evidence of mostly moderate to weak correlations between personality characteristics and objective performance. Moderation analyses were further conducted to examine the conditional effects of commitment on pitchers and control on hitters due to the results of exploratory correlational analysis. These analyses did not include challenge as it had the weakest loading during the CFA, and has previously been questioned as viable a sub-construct as commitment and control (Sheard & Golby, 2006).

Pitching Group

For pitchers, examination of the moderating effect of commitment on the relations between trait anxiety intensity and objective performance statistics revealed that for both WP and LOB%, all three sub-scales of trait anxiety intensity were significantly moderated by commitment while fielding independent pitching (FIP) was not significantly moderated by commitment. For all moderation analyses reported for pitchers, the degrees of freedom were 4 and 75 respectively.

Wild Pitches (WP)

For wild pitches, cognitive anxiety intensity, $\beta = 0.05$, $SE = 0.01$, $t = 3.53$, $p < 0.05$, 95% CI [0.02, 0.07], somatic anxiety intensity, $\beta = 0.04$, $SE = 0.01$, $t = 3.18$, $p < 0.05$, 95% CI [0.02, 0.07], and self-confidence intensity, $\beta = 0.03$, $SE = 0.01$, $t = 2.94$, $p < 0.05$, 95% CI [0.01, 0.05] were all significantly moderated by commitment. A pitcher would like to limit the number of wild pitches thrown as wild pitches occur while runners are on-base and usually indicates the pitcher threw a ball that allowed the runner to advance to the next base. The Johnson-Neyman technique indicated that for pitchers with scores above 6.37, or above the 54th percentile, on commitment, a significant positive relationship was found between pitcher's cognitive anxiety intensity and number of WP thrown for pitchers scoring higher on commitment, $\beta = 0.05$, $SE = 0.03$, $t = 1.99$, $p < 0.05$, 95% CI [0.00, 0.10]. These findings indicate that pitchers with higher levels of commitment threw fewer wild pitches when perceiving lower intensities of their cognitive anxiety. Commitment explained 23.6% of the variance in wild pitches thrown. The interaction between cognitive anxiety and commitment accounted for a unique 12.7% of the variance in wild pitches thrown ($\Delta R^2 = 0.127$).

Table 1. Overall Descriptive Statistics for Participants

	All Participants (*N* = 389)		Pitchers (*n* = 80)		Hitters (*n* = 94)	
	M	***SD***	***M***	***SD***	***M***	***SD***
Age[a]	19.85	1.24	20.01	1.27	20.20	1.20
Athletic Class[b]	2.25	1.12	2.42	1.11	2.66	1.08
Total Hardiness	17.13	3.91	17.09	3.57	17.03	3.88
Challenge	4.90	1.66	4.86	1.48	5.01	1.75
Control	5.90	1.59	5.74	1.60	5.72	1.71
Commitment	6.33	1.68	6.49	1.51	6.30	1.64
Trait Anxiety Intensity						
Cognitive Anxiety	16.81	6.08	15.52	6.34	16.73	5.28
Somatic Anxiety	15.25	5.46	14.80	6.08	15.02	4.41
Self-Confidence	26.45	7.65	25.62	9.13	27.93	6.69

[a] Age in years.

[b] Athletic Class is coded as 1 = freshman, 1.5 = redshirt freshman, 2 = sophomore, 2.5 = redshirt sophomore, 3 = junior, 3.5 = redshirt freshman, 4 = senior, 4.5 = redshirt freshman, 5 = fifth-year student, 6 = graduate student.

For somatic anxiety intensity, the Johnson-Neyman technique indicated that for pitchers with scores above 7.05, or above the 73rd percentile, on commitment, a significant positive relationship was found between pitchers' somatic anxiety intensity and number of wild pitches thrown for pitchers scoring high on commitment, $\beta = 0.06$, $SE = 0.03$, $t = 1.99$, $p < 0.05$, 95% CI [0.00, 0.12]. These findings indicate that pitchers with higher levels of commitment threw fewer wild pitches when perceiving lower intensities of their somatic anxiety. Commitment explained 20% of the variance in wild pitches thrown. The interaction between somatic anxiety and commitment accounted for a unique 10.8% of the variance in wild pitches thrown ($\Delta R^2 = 0.108$).

For self-confidence intensity, the Johnson-Neyman technique indicated that for pitchers with scores above 7.13, or above the 73rd percentile, on commitment, a significant positive relationship was found between pitcher's self-confidence intensity and number of wild pitches thrown for pitchers scoring high on commitment, $\beta = 0.04$, $SE = 0.02$, $t = 1.99$, $p < 0.05$, 95% CI [0.00, 0.09]. These findings indicate that pitchers with higher levels of commitment threw fewer wild pitches despite perceiving low intensities of their self-confidence. Commitment explained 18.4% of the variance in wild pitches thrown. The interaction between self-confidence and commitment accounted for a unique 9.4% of the variance in wild pitches thrown ($\Delta R^2 = 0.094$).

Left On-Base Percentage (LOB%)

Similarly, for LOB%, cognitive anxiety intensity, $\beta = -0.004$, $SE = 0.001$, $t = -2.95$, $p < 0.05$, 95% CI [-0.006, -0.001], somatic anxiety intensity, $\beta = -0.003$, $SE = 0.001$, $t = -2.72$, $p < 0.05$, 95% CI [-0.006, - 0.001], and self-confidence intensity, $\beta = -0.002$, $SE = 0.001$, $t = -2.10$, $p < 0.05$, 95% CI [-0.004, 0.000] were all significantly

moderated by commitment. A higher LOB% identifies that a pitcher was able to prevent runners that were allowed on base from scoring. The Johnson-Neyman technique indicated that for pitchers with scores above 8.78, or above the 88th percentile, on commitment, a significant inverse relationship was found between pitchers' cognitive anxiety intensity and LOB% for pitchers scoring high on commitment, β = -0.008, *SE* = 0.004, *t* = -1.99, $p < 0.05$, 95% CI [-0.02, 0.00]. These findings indicate that pitchers with higher levels of commitment had higher LOB% when perceiving lower intensities of their cognitive anxiety.

Conversely, the Johnson-Neyman technique also indicated that for pitchers with scores below 5.06, or below the 27th percentile, on commitment, a significant positive relationship was found between pitcher's cognitive anxiety intensity and LOB% for pitchers scoring low on commitment, β = 0.005, *SE* = 0.003, *t* = 1.99, $p < 0.05$, 95% CI [0.00, 0.01]. These findings indicate that pitchers with lower levels of commitment had lower LOB% when perceiving lower intensities of their cognitive anxiety. Commitment explained 11.6% of the variance in LOB%. The interaction between cognitive anxiety and commitment accounted for a unique 10.3% of the variance in LOB% (ΔR^2 = 0.103).

For somatic anxiety intensity, the Johnson-Neyman technique indicated that for pitchers with scores above 8.86, or above the 88th percentile, on commitment, a significant inverse relationship was found between pitcher's somatic anxiety intensity and LOB% for pitchers scoring high on commitment, β = -0.008, *SE* = 0.004, *t* = -1.99, $p < 0.05$, 95% CI [-0.02, 0.00]. These findings indicate that pitchers with higher levels of commitment had higher LOB% when perceiving lower intensities of their somatic anxiety. Commitment explained 9.8% of the variance in LOB%. The interaction between somatic anxiety and commitment accounted for a unique 8.9% of the variance in LOB% (ΔR^2 = 0.089).

For self-confidence intensity, the Johnson-Neyman technique indicated that for pitchers with scores below 4.01, or below the 8th percentile, on commitment, a significant positive relationship was found between pitcher's self-confidence intensity and LOB% for pitchers scoring low on commitment, β = 0.005, *SE* = 0.002, *t* = 1.99, $p < 0.05$, 95% CI [0.00, 0.01]. These findings indicate that pitchers with lower levels of commitment had lower LOB% when perceiving lower intensities of self-confidence, however this is limited to a small percentile and group of pitchers who scored below this low percentile. Commitment explained 6.9% of the variance in LOB%. The interaction between self-confidence and commitment accounted for a unique 5.5% of the variance in LOB% (ΔR^2 = 0.055).

Fielding Independent Pitching (FIP)

For FIP, cognitive anxiety intensity, β = 0.007, *SE* = 0.02, *t* = 0.45, $p > 0.05$, 95% CI [-0.03, 0.04], somatic anxiety intensity, β = 0.005, *SE* = 0.02, *t* = 0.33, $p > 0.05$, 95% CI [-0.03, 0.04], and self-confidence intensity, β = -0.004, *SE* = 0.01, *t* = -0.33, $p > 0.05$, 95% CI [-0.03, 0.02] were all not significantly moderated by commitment. A pitcher's FIP identifies a pitcher's ability to prevent runs independent of their defense. Commitment explained 12% of the variance in the relationships for cognitive anxiety intensity (R^2 = 0.119, ΔR^2 = 0.002), somatic anxiety intensity (R^2 = 0.121, ΔR^2 = 0.001), and self-confidence intensity (R^2 = 0.116, ΔR^2 = 0.001) and FIP.

Hitting Group

Objective performance statistical analyses for hitters were further narrowed down to examine the moderating effect of control on the relationship between trait anxiety intensity on newer objective performance statistics. Examination of the moderating effects of control revealed that control significantly moderated the relationship between somatic anxiety intensity and BABIP and the relationship between self-confidence intensity and grounding into double plays (GDP). For all moderation analyses reported for hitters, the degrees of freedom were 4 and 89 respectively.

Batting Average on Balls in Play (BABIP)

For BABIP, cognitive anxiety intensity, β = 0.001, *SE* = 0.001, *t* = 1.03, $p > 0.05$, 95% CI [-0.001, 0.004] and self-confidence intensity, β = 0.001, *SE* = 0.001, *t* = 0.96, $p > 0.05$, 95% CI [-0.001, 0.002] were both not significantly moderated by control. However, somatic anxiety intensity, β = 0.003, *SE* = 0.001, *t* = 2.15, $p < 0.05$, 95% CI [0.00, 0.006] was significantly moderated by control on somatic anxiety intensity's effect on a hitter's BABIP. Similar to batting average, higher BABIPs would indicate better objective performance for hitters. The Johnson-Neyman technique indicated that for hitters with scores below 5.50, or below the 44th percentile, on control, a significant inverse relationship was found between hitter's somatic anxiety intensity and BABIP for hitters scoring lower on control, β = -0.004, *SE* = 0.002, *t* = -1.99, $p < 0.05$, 95% CI [-0.09, 0.00]. These findings indicate that hitters with lower levels of control had lower BABIPs when perceiving high intensities of their somatic anxiety. Control explained 9% of the variance in the relationship between somatic anxiety intensity and BABIP. The interaction between somatic anxiety and

control accounted for a unique 4.7% of the variance in BABIP (ΔR^2 = 0.047). However, control explained 5.3% of the variance for cognitive anxiety intensity (ΔR^2 = 0.011) and 3.6% of the variance for self-confidence intensity (ΔR^2 = 0.010).

Grounding into Double Plays (GDP)

For number of double plays grounded into, cognitive anxiety intensity, β = -0.004, *SE* = 0.01, *t* = 0.36, $p > 0.05$, 95% CI [-0.03, .02] and somatic anxiety intensity, β = -0.02, *SE* = 0.01, *t* = -1.07, $p > 0.05$, 95% CI [-0.04, 0.01] were both not significantly moderated by control. However, self-confidence intensity, β = -0.01, *SE* = 0.007, *t* = -2.16, $p < 0.05$, 95% CI [-0.03, -0.001] was significantly moderated by control on self-confidence intensity's effect on the number of double plays grounded into. Hitters ideally would aim to avoid hitting into double plays and grounding into fewer double plays would represent a better hitter's performance. The Johnson-Neyman technique indicated that for hitters with scores above 5.93, or above the 43rd percentile, on control, a significant inverse relationship was found between hitter's self-confidence intensity and number of double plays grounded into for hitters scoring high on control, β = -0.03, *SE* = 0.01, *t* = -1.99, $p < 0.05$, 95% CI [-0.05, 0.00]. These findings indicate that hitters with higher levels of control grounded into less double plays when perceiving high intensities of their self-confidence. Control explained 16.3% of the variance in the relationship between self-confidence intensity and GDP. The interaction between self-confidence and control accounted for a unique 4.4% of the variance in GDP (ΔR^2 = 0.044). However, control explained 7.7% for cognitive anxiety intensity (ΔR^2 = 0.001) and explained 8.8% for somatic anxiety intensity (ΔR^2 = 0.01).

Weighted On-Base Average (wOBA)

For wOBA, cognitive anxiety intensity, β = 0.000, *SE* = 0.001, *t* = 0.24, $p > 0.05$, 95% CI [-0.002,0.003], somatic anxiety intensity, β = 0.002, *SE* = 0.001, *t* = 1.31, $p > 0.05$, 95% CI [-0.001, 0.005], and self-confidence intensity, β = 0.001, *SE* = 0.001, *t* = 1.66, $p > 0.05$, 95% CI [0.000, 0.003] were all not significantly moderated by commitment. While batting average weighs all hits the same, wOBA weighs hits according to number of bases and higher wOBA indicates better performance. Control explained approximately 5.8% of the variance in the relationship between somatic anxiety intensity and wOBA. The interaction between somatic anxiety and control accounted for a unique 1.8% of the variance in wOBA (ΔR^2 = 0.018). Also, control explained 7.6% of variance for self-confidence and wOBA (ΔR^2 = 0.028), but only 3.8% for cognitive anxiety intensity and wOBA (ΔR^2 = 0.001).

Discussion

Although there have been studies that have examined the effect of competitive anxiety on sport performance (Lagos et al., 2008) and baseball specifically (Chang & Torres, 2019; Chen et al., 2019; Han et al., 2014; Strack, 2003), very few studies have examined the influence of hardiness on a player's anxiety and performance in baseball. The current study provides contributions to further understand the influence of hardiness on objective performance statistics in the presence of competitive anxiety intensity, as was recommended by Hanton et al. (2013). This study also found similar objective performance results to previous correlational investigations with similar correlation patterns for both pitchers and hitters (Zizzi et al., 2003) and adds to the extant sport personality literature relating to objective performance in collegiate sport settings.

Pitching Group Interpretations

Among the moderating effects for pitchers, both statistically significant effects (LOB% and WP) suggest that there were situational effects of commitment which may help a pitcher's performance when perceiving high intensities of trait anxiety. Both LOB% and WP are statistics that require the presence of runners on base and typically are considered to be higher anxiety-provoking situations during games (Chang & Torres, 2019). Pitchers even change their stance on the mound from a windup position to a stretch position that is quicker and combats the likelihood or ability of a runner to steal a base against that pitcher. Pitchers may perceive their anxiety to be more intense during these situations and the data suggested that commitment moderated the effect of a pitcher's perception of the intensity of anxiety and led to less WP and higher LOB%. These effects were not found to be the case for FIP.

These situation-specific moderating effects on performance in pitchers align with previous research conducted by Zizzi et al. (2003). Although the overall R^2 may be considered small in this analysis, at higher levels of sport, physical abilities become more comparable and small increases in mental skills could lead to larger influences in performance outcomes (Zizzi et al., 2003). The R^2 change values for both situational statistics of WP and LOB% suggest that a large amount of variance on a pitcher's performance during on-base situations is influenced by a pitcher's level of commitment with runners on base in the presence of trait anxiety.

Especially in regard to LOB%, the majority of variance accounted for by commitment suggests that improving dimensions of pitcher's commitment could account for the majority of improvement in a pitcher's LOB% and could also be a focus for practitioners.

Hitting Group Interpretations

In comparison to pitcher group findings, the hitter group moderation analyses of the subscale of control were mostly non-significant with the exception of one situational statistic and one non-situational statistic. The non-situational statistic that was found to be significant was hitters' BABIP which has been identified to be more in control of a hitter than a pitcher (Slowinski, 2010). It is understood that a hitter has control over how often they put the ball in play and how hard they hit it, but not if it is a hit due to the defense or luck. The results of this research suggest that when hitters had lower feelings of control, they had lower BABIPs and higher perceptions of their somatic anxiety.

Similar to WP for pitchers, GDP for hitters requires runners on-base and is also considered a negative performance statistic. Typically, GDP is not seen to be in the control of a hitter, as various factors could affect whether the hitter actually hits into a double play and requires that there are fewer than two outs as well (Slowinski, 2010). Hitters' GDP situations may elicit higher feelings of self-confidence as there is a runner on-base that makes it easier for the hitter to score the runner on-base rather than having to hit a home run. The results from this study indicate that hitters who believe these situations with runners on-base are more in their control, and perceive higher levels of self-confidence, will ground into fewer double plays and allow their team to continue to hit.

In a previous study conducted by Davis and Sime (2005) in the context of baseball, the researchers recommended sport psychologists focus on improving self-confidence rather than reducing anxiety to help performance. The current study's results support two pathways for achieving this outcome. Practitioners could improve self-confidence and address anxiety for hitters through improvement of sense of control, while for pitchers, reduction of anxiety could be achieved through improvement of commitment to increase performance. For hitters, one example of this approach would be for consultants to explore ways to increase a hitter's perception of the situation being within their control through cognitive re-appraisal (De Castella et al., 2013).

Practical Applications

Practitioners should aim to increase a pitcher's ability to reframe the intensity of the anxiety that is perceived by focusing on their commitment towards the next pitch. The data examined in this research show that having a higher level of commitment in the pitches that pitchers are throwing could lead to higher LOB% and less WP even if they feel a high intensity of cognitive or somatic anxiety or lower feelings of self-confidence. Using the sub-construct of commitment, one's ability to persist in whatever one is doing, even when stress rises (Kobasa, 1979), practitioners could help pitchers re-focus their commitment through imagery or breathing when they feel they are in those situations. As found in a previous study that identified that breathing helped decrease heart rate variability and improved performance on the golf course (Lagos et al., 2008), a similar focus on the breath within a routine could help refocus the pitcher's sense of commitment. Additionally, practitioners should focus on improving pitcher's metacognition of their own commitment during performances as discussed in MacIntyre et al.'s article (2014). MacIntyre and colleagues identified that metacognition would help athletes build strategies, beliefs, and self-understanding to excel in sports and a pitcher's ability to re-focus their commitment would be accelerated with the first step being awareness and metacognition.

Hitters did not have as many moderating effects in situational settings, but control seems to moderate some overall performance, just not to the extent found in pitchers. This finding corroborates previous conclusions that hitters had less control over their presenting situation than did pitchers (Zizzi et al., 2003). Also, in a previous study conducted with professional baseball players in the Korean Baseball Organization, Han et al. (2014) found that skills such as imagery could provide hitters with a flexible coping method for anxiety and help with attention shifting and performance enhancement. Paralleling the findings of that study, practitioners could help hitters reappraise the somatic anxiety intensity that they perceive into impression of control. They could also redirect their attention to the task of hitting through imagery which could potentially improve their BABIP. Practitioners could emphasize elements that are within a hitter's control, such as choosing certain pitches or locations to swing at when in double play situations. Additionally, imagery was found to be useful to improve self-confidence within baseball players and helped improve their performance (Davis & Sime, 2005). With the finding that higher levels of self-confidence help hitters ground into less double plays, practitioners

could work on cognitive reappraisal (De Castella et al., 2013) of their self-confidence and help hitters practice brief imagery or mental rehearsals to improve their self-confidence.

Hardiness and the sub-constructs of challenge, control, and commitment lend themselves to overlap with similar mental skills constructs, such as self-talk, which can be taught to help address competitive anxiety. Mental skills such as mindfulness awareness to help identify things that are within one's control (Chen et al., 2019) could be one way to help improve a hitter's performance. Pitchers can work on refocusing one's commitment by shifting their attention from a narrow internal focus to a narrow external focus, according to Nideffer and Sagal's (2006) model of attentional control, when perceiving high intensities of cognitive or somatic anxiety with runners on-base. Mental skills sessions that utilize cognitive behavioral interventions to increase hardiness (Thompson, 2017) or overall motivational climate could be useful interventions to help pitchers or hitters during these specific situations. These findings could also be used by coaches as moments of emphasis to remind pitchers to stay committed, perhaps during a mound visit with runners on-base. Organizations could use this information as areas of emphasis to focus on during player development or recruitment and paired with mental skills consultants, could help develop these skills to help their players handle these situations.

Limitations

The first limitation to consider when interpreting this study's findings is the shortened data collection period for games played and statistics accrued due to the global COVID-19 pandemic. Although these statistics do not represent a typical season, ultimately the findings of this study still contribute to extant research and the field's understanding of hardiness' influence on objective performance, specifically with newer baseball statistics rarely seen in research. Self-selection bias could cause participants who have higher levels of hardiness or less anxious to elect to participate in the study. However, self-report measures might still be the most appropriate when there is a lack of other more accurate assessments to measure personality (Chan, 2009). Perhaps in future research, a triangulation method of self-reported data from the participant and their coach could be more appropriate.

Additionally, personality self-assessments were conducted in the off-season to be least burdensome to players and teams participating. These off-season self-assessments were used to compare and predict future objective performance during the shortened season. Some considerations of the timing of assessments used to predict future situational performance should be acknowledged. Future studies should consider multiple timepoints of personality assessments throughout the season paired with possible qualitative interviews to determine if the moderating effects of hardiness are consistent throughout situational states during a baseball season. Finally, a few objective performance statistics analyzed may contain subjectivity by the official scorer due to the nature of baseball's rules. Statistics such as WP and GDP contain subjective calls made by the official scorer.

Future Research

Given that this study was only able to collect one-fourth of a typical collegiate baseball season's worth of statistics, a follow-up study collecting a full season's statistics to replicate these findings would be worthwhile. Replication would also be useful to corroborate the validity and reliability of the truncated or updated version of the PVS III-R used in this sport-related study. Future research could also include more qualitative assessments to gain a player's reflection of their own personality and examine the metacognition or self-awareness of athletes and how they perceive their personality affecting their sport performance (MacIntyre et al., 2014). This triangulation could provide a mixed-methods approach to see if self-reported data could be relied upon for hardiness measurements.

Additionally, future research exploring the moderating effect of hardiness on anxiety's intensity or interpretation by an athlete within other divisions of NCAA baseball, professional levels, or other objective performance metrics could be useful to see if these moderating effects are present in other sports or settings. The field would also benefit from developmental research with adolescents and young adults to track hardiness and trait anxiety over time and to see if interventions could influence these developmental personalities. Finally, future research could also extend to coaches and officials who also face adversities or feel intense cognitive or somatic anxiety and could moderate their performance through higher levels of hardiness.

Conclusion

Hardiness has been commonly measured as one construct, but previous studies have proposed the possibility of separating the three sub-components of challenge, control, and commitment and treating those as their own constructs as well (Sheard

& Golby, 2006). Findings in this study were significant for commitment or control but not in total hardiness supporting the suggestion that these sub-constructs of hardiness could be better addressed individually by practitioners during mental skills interventions. Significant findings for the moderating effects of commitment accounted for the majority of variance within situations with runners on base for pitchers while significant moderations accounted for less variance for hitters and control. Overall, this study corroborates correlational findings previously found in a similar objective performance study in collegiate baseball and the moderating effect findings support previous interpretations that hitters have less control than pitchers within baseball (Zizzi et al., 2003). Additionally, since then, baseball analysts have added numerous statistics to attempt to isolate and represent more advanced objective performance metrics which were explored in the current study. This study also expands upon previous work that identified hardiness and trait anxiety as important individual difference variables by examining the possible moderating effect of hardiness on the relationship between trait anxiety and objective performance in sport (Hanton et al., 2013).

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References

Albrecht, R. R., & Feltz, D. L. (1987). Generality and specificity of attention related to competitive anxiety and sport performance. *Journal of Sport Psychology, 9,* 231-248. https://doi.org/10.1123/jsp.9.3.231

Chan, D. (2009). So why ask me? Are self-report data really that bad? In C.E. Lance & R. J. Vandenberg (Eds.), *Statistical and methodological myths and urban legends: Doctrine, verity and fable in the organizational and social sciences* (pp. 309-336). Routledge/Taylor & Francis Group.

Chang, M.O., & Torres, A. C. M. (2019). Multidimensional diagnosis of competitive anxiety in youth baseball team. *International Research Journal of Management, IT and Social Sciences, 6*(6), 104-110. https://doi.org/10.21744/irjmis.v6n6.783

Chen, J. H., Tsai, P. H., Lin, Y.C., Chen, C. K., & Chen, C. Y. (2019). Mindfulness training enhances flow state and mental health among baseball players in Taiwan. *Psychology Research and Behavior Management, 12,* 15-21. https://doi.org/10.2147/PRBM.S188734

Davis, P. A., & Sime, W. E. (2005). Toward a psychophysiology of performance: Sport psychology dealing with anxiety. *International Journal Stress Management, 12*(4), 363-378. https://doi.org/10.1037/1072-5245.12.4.363

De Castella, K., Goldin, P., Jazaieri, H., Ziv, M., Dweck, C. S., & Gross, J. J. (2013). Beliefs about emotion: Links to emotion regulation, well-being, and psychological distress. *Basic and Applied Sport Psychology, 35*(6), 497-505. https://doi.org/10.1080/01973533.2013.840632

Eschleman, K. J., Bowling, N. A., & Alarcon, G. M. (2010). A meta-analytic examination of hardiness. International *Journal of Stress Management, 17*(4), 277-307. https://doi.org/10.1037/a0020476

Florian, V., Mikulincer, M., & Taubman, O. (1995). Does hardiness contribute to mental health during a stressful real-life situation? The roles of appraisal and coping. *Journal of Personality and Social Psychology, 68*(4), 687-695. https://doi.org/10.1037/0022-3514.68.4.687

Han, D. H., Kim, B. N., Cheong, J. H., Kang, K. D., & Renshaw, P. F. (2014). Anxiety and attention shifting in professional baseball players. *International Journal of Sports Medicine, 35*(8), 708-713. https://doi.org/10.1055/s-0033-1363235

Hanton, S., Neil, R., & Evans, L. (2013). Hardiness and anxiety interpretation: An investigation into coping usage and effectiveness. *European Journal of Sport Science, 13*(1), 96-104. https://doi.org/10.1080/17461391.2011.635810

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* Guilford Press.

Kobasa, S. C. (1979). Stressful life events, personality, and health: An inquiry into hardiness. *Journal of Personality and Social Psychology, 37*(1), 1-11. https://doi.org/10.1037/0022-3514.37.1.1

Lagos, L., Vaschillo, E., Vaschillo, B., Lehrer, P., Bates, M., & Pandina, R. (2008). Heart rate variability biofeedback as a strategy for dealing with competitive anxiety. *Biofeedback, 36*(3), 109-115.

MacIntyre, T.E., Igou, E. R., Campbell, M. J., Moran, A. P., & Matthews, J. (2014). Metacognition and action: A new pathway to understanding social and cognitive aspects of expertise in sport. *Frontiers in Psychology, 5,* 1555. https://doi.org/10.3389/fpsyg.2014.01155

Maddi, S. R., Harvey, R. H., Khoshaba, D. M., Lu, J. L., Persico, M., & Brow, M. (2006). The personality construct of hardiness, III: Relationships with repression, innovativeness, authoritarianism, and performance. *Journal of Personality, 74*(2), 575-598. https://doi.org/10.1111/j.1467-6494.2006.00385.x

Mellalieu, S. D., Hanton, S., & Jones, G. (2003). Emotional labeling and competitive anxiety in preparation and competition. *The Sport Psychologist, 17,* 157-174. https://doi.org/10.1123/tsp.17.2.157

Morris, T. (2011). Personality and individual differences. In T. Morris & P. Terry (Eds.), *The New Sport and Exercise Psychology Companion* (pp. 11-36). Fitness Information Technology.

Nideffer, R. & Sagal, M. (2006). Concentration and attention control training. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th ed., pp. 382-403). McGraw-Hill.

Sheard, M., & Golby, J. (2006). Effect of a psychological skills training program on swimming performance and positive psychological development. *International Journal of Sport and Exercise Psychology, 4*(2), 149-169. https://doi.org/10.1080/1612197X.2006.9671790

Slowinski, S. (2010). *Sabermetrics Library.* Fangraphs.

Strack, B. W. (2003). Effect of heart rate variability (hrv) biofeedback on batting performance in baseball. *Dissertation Abstracts International: The Sciences and Engineering, 64*(3-B), 1.

Thompson, C. (2017). *Improving hardiness in elite rugby players.* (Other Degree thesis), Victoria University.

Vealey, R. S., & Perritt, N. C. (2015). Hardiness and optimism as predictors of the frequency of flow in collegiate athletes. *Journal of Sport Behavior, 38*(3), 321-338.

Wadey, R., Evans, L., Hanton, S., & Neil, R. (2012). An examination of hardiness throughout the sport injury process. *British Journal of Health Psychology, 17*(1), 103-128. https://doi.org/10.1111/j.2044-8287.2011.02025.x

Wolf, S. A., Eys, M. A., & Kleinert, J. (2015). Predictors of the precompetitive anxiety response: Relative impact and prospects for anxiety regulation. *International Journal of Sport & Exercise Psychology, 13*(4), 344-358. https://doi.org/10.1080/1612197X.2014.982676

Zizzi, S. J., Deaner, H. R., & Hirschhorn, D. K. (2003). The relationship between emotional intelligence and performance among college baseball players. *Journal of Applied Sport Psychology, 15*(3), 262-269. https://doi.org/10.1080/10413200305390