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Primary Research

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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 54^{th} 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 27^{th} 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 88^{th} 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 8^{th} 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 44^{th} 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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Effect of Watching Comedy on Affect in Young Adult Runners

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In many studies, researchers have investigated the positive effects of distractions while exercising. In most gyms, there are usually televisions playing random channels. Young adult undergraduate runners (N = 125; 64 female and 61 male) completed one mile on a treadmill at their selected pace. Approximately half the participants (n = 63) were randomly assigned to watch the comedy video while completing their mile, and the other half (n = 62) completed their mile with no video. The Feeling Scale (FS; Hardy & Rejeski, 1989), which asks participants to rate on a scale from -5 (very bad) to 5 (very good) was administered to all participants before starting the mile and after completing the mile. A repeated-measures ANOVA was used to compare group means over two observations. Results revealed statistically significant greater change in affect from pre- and post-mile in the watch group than in the no watch group. These results indicate there was an increase in affect when participants watched the comedy film while completing the mile versus the participants that only completed the mile and did not watch the video. This suggests that, on average, watching videos, such as a comedy film, is an effective option to distract gym patrons from their exercise, which may further increase their affect.

Keywords: college students, exercise distractors, feeling scale, fitness facilities

It is well understood that exercise is beneficial; however, many people decide not to exercise (Hallal et al., 2012). Even though exercise buffers consequences related to aging and decreases chances of cardiovascular disease, diabetes, cancer, osteoporosis, depression and obesity, the National Center for Health Statistics (2018) indicated approximately 50% of people in most states do not meet the Centers for Disease Control (CDC) exercise recommendations. Though leisure-time physical activity trends (e.g., membership in fitness facilities) have remained relatively stable over the last 40 years, factors related to sedentary behavior such as television (TV) watching have almost doubled (Kruger et al., 2007). Although the perceived lack of time is often the most frequently reported barrier to exercise for inactive adults (Hoare et al., 2017), perceptions that other activities, like watching TV, are more enjoyable or appealing is often the second most common barrier (Auweele et al., 1997; Bartlett et al., 2011; Hoare et al., 2017; Privitera et al., 2014). Despite heavy research focus, continued research on factors that promote exercise adherence is needed (Hallal et al., 2012). Jones et al. (2014) indicated that discontinued exercise is often due to feelings of fatigue and negative effects that exercising have on the body.

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One possible solution to this challenge is to distract the mind of the exerciser from the feelings of fatigue and negative effects by focusing their attention elsewhere (Jabr, 2013; Russell et al., 2002). Distractions while exercising have a high demand on the auditory and visual systems of the body by commanding our attention and focus rather than our attention and focus centering on the exercises themselves (Hutchinson et al., 2015). In fitness facilities, people who use cardio equipment (e.g., treadmills) often listen to music, watch TV, or read books. Listening to music, watching TV or reading are considered an attentional distraction from the workout (Russell et al., 2002). The TV shows in each recreation facility differ from place to place; however, some fitness facilities have banned certain content because it was deemed to promote negativity (Walsh, 2018). For a distraction to be beneficial, it is recommended to be individually based on what the person perceives as enjoyable, appealing, and/or motivating (Privitera et al., 2014).

Many researchers have found that listening to music and/or watching TV while exercising can be used as a distraction to possibly increase pleasure and enjoyment of exercise (Hutchinson et al., 2015; Privitera et al., 2014). Given that enjoyment is a key predictor in determining future participation (Bartlett et al., 2011), positively manipulating other factors that foster enjoyment may improve adherence. Although some fitness professionals argue that exercisers should concentrate on their exercise programs and not be distracted, the majority of leisure-time exercisers disagree as they seek facilities with sophisticated exercise entertainment, like TVs and cardio machines with touchscreens (Hoffman, 2019). Further, exercise itself can act as a distractor as it can distract exercisers from the daily grind and related stressors; it distracts the engagers from focusing on stressful stimuli and emancipates them from related negative mood enhancers (Anderson & Shivakumar, 2013).

While not the same, mood and affect are related and often congruent, with the glossary of the DSM-V differentiating between the constructs as *"affect is momentary (like weather), while, mood is a prolonged emotion (like climate)"* (American Psychological Association, 2013, p. 824). It is well established that exercise of appropriate intensity and duration, on average, results in enhanced mood (Hoffman & Hoffman, 2008). It is also established that laughter enhances mood (Bahari & Lorica, 2019). Given Hutchinson and colleagues (2015) found the greatest affective valence scores participants had while exercising was when participants experienced greater dissociation (e.g., watching a music video), the current study aimed to investigate whether the distraction of watching comedy during exercise (i.e., one mile on a treadmill) led to an enhanced positive affect over and above exercising with no distractors present. It was hypothesized that participants who were distracted by watching a comedy program while exercising (i.e., treatment condition) would report a statistically significant greater increase in affect following the bout of exercise (i.e., one mile on a treadmill) over and above participants who completed that same exercise activity but were not distracted (i.e., control condition).

Method

Participants

Participants were undergraduate students from a Hispanic-serving university in the Southwest region of the United States. Once the study received approval from the Institutional Review Board, participants were recruited via posted flyers throughout common areas on the university campus and via face-to-face through class announcements during the first two weeks of a 5-week summer semester. For compensation, each participant was entered into a lottery to win a university logoed double-wall vacuum insulated water bottle. A priori power analysis for a repeated-measures, between-factor ANOVA indicated the minimum total sample size needed to achieve 80% power with a moderate effect size (f = .25) and an alpha level of 0.05 was 98 participants (49 per group). One-hundred and twenty-five students were recruited to participate (64 female and 61 male) in this study to protect against participant attrition, outlier deletion, and to avoid an underpowered analysis, in that, researchers tend to overestimate the effect sizes in a priori analyses (Brysbaert, 2019; McCrum-Gardner, 2010). Participants were able to choose a participation time slot that suited their schedules within a three-week span. Each participant provided written informed consent before he or she participated, and all participants were healthy enough to participate according to the 2017 Physical Activity Readiness Questionnaire (Warburton et al., 2017). In addition, for inclusion in the study, participants needed to be familiar with using a treadmill and be confident they could complete one mile on a treadmill at a fixed self-selected speed. Participants were systematically randomly assigned to either the experimental group (n = 63) or the control group (n = 62) after they completed the warm-up. The experimental group (i.e., watch group) watched the video while completing the one mile on the treadmill, and the control group (i.e., no watch group) completed the one mile on the treadmill without any distractors present.

Procedures and Materials

Selection of Standup Comedy

A panel of 25 university students, (12 male and 13 female) from the same university in which the participants were to be sampled, were asked to write their top three favorite standup comedy shows on a piece of paper. For each of the 25 responses, first choice was given three points, second choice was given two points, and third choice was given one point. This procedure was done to ensure that the video playing would have a greater probability of being deemed humorous by the participants (Hutchinson et al., 2015). Of the 25 responses, Jeff Dunham: Relative Disaster (Simon & McNeil, 2017) appeared on 17 papers, with ten first choices and total score of 42 points. Second highest score was 21 points; thus, *Jeff Dunham: Relative Disaster* was selected as the video used in this study.

Measures and Equipment

Sex was the only demographic information collected. All participants used the Woodway© For The Long Run® DESMO model treadmill (Woodway USA, Inc.) to complete one mile on the treadmill. During a warm-up, participants were asked to self-select a fixed speed at which they completed their one mile. The speed was recorded for each participant. The Feeling Scale (Hardy & Rejeski, 1989) was used to assess the affective valence of the participants twice: once before participation in the one mile on the treadmill and once after the one mile on the treadmill was completed. Participants were asked to rate how they felt, right now, on a scale ranging from *very bad* (-5) to *very good* (5) using the posted scale. The Feelings Scale (Hardy & Rejeski, 1989), which was designed as a measure of in-task affect, was posted on the wall in front of the treadmill so that the participants could clearly view it (Figure 1). Participants randomly assigned to the watch group were also asked to rate the extent they enjoyed the video on a scale from *strongly did not like* (1) to *strongly liked* (10).

Figure 1. Equipment and Instrument Setup

Note. Feeling Scale (How do you feel right now?) is posted on the wall in front of participant and above the HP® Laptop streaming the video. Speakers are to the right and left of the laptop. The HP® Laptop was closed for participants in the no-watch group.

The video was streamed on an HP® Laptop placed directly in front of the treadmill, and an auxiliary speaker was used to provide appropriate user selected audio volume (Figure 1).

Procedure

After the participants met the inclusion criteria and agreed to participate, they selected their 30-minute participation time slot. Time slots were available from 7:00am to 7:00pm for 25 straight days during the summer of 2019. Participants were informed of the particulars of the study protocol, including the setting and appropriate wear (i.e., shoes and clothing) when they selected their 30-minute participation time slot. In addition, a researcher sent all participants a text message reminding them of their participation time slot 24 hours before their 30-minute participation time slot. This message also reiterated location and appropriate wear guidelines for participation. During their self-selected time slot, each participant read and signed the informed consent and were again informed of the safety guidelines and potential risks. Participants were then asked to start a two-minute warm up, which consisted of finding the preferred speed at which they chose to complete the one mile. At the end of the two-minute warm-up, participants preferred speed was finalized and recorded. Participants would then click the stop button on the treadmill. Before participants began the one mile, they were asked to rate their affective valence using the Feeling Scale (Hardy & Rejeski, 1989). The rating was recorded as the pre-mile measure. Participants were then given time to prepare and stretch, whether it was dynamic or static, before running their one mile. Once participants indicated they were ready to begin, they were told their group assignment and to begin their one mile at their self-selected fixed speed until one mile was completed. As displayed in Figure 1, when the watch group began their one mile on the treadmill, the video also began streaming from the beginning of the video on the HP® laptop in front of them at the audio volume they selected. For all participants, once they completed their one mile, they were again asked to rate their affective valence using the Feeling Scale (Hardy & Rejeski, 1989). This rating was recorded as the post-measure. For the watch group, participants were also asked to rate the extent they enjoyed the video. This measure concluded participation.

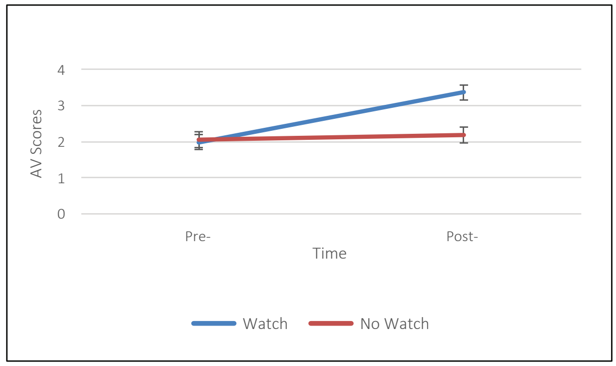
Data Analysis

Statistical analyses were conducted using SPSS® 24.0 (IBM Corporation, Armonk, NY, USA) for Windows®/ Apple Mac®, and statistical significance was set at $\alpha < .05$. G*Power Version 3.1.9.6 (Faul et al., 2009) was used to perform the a priori power analysis. Before hypothesis testing, descriptive statistics were explored and independent-samples *t*-tests were conducted to explore mean differences of the studied variables (i.e., speed, pre- and post-affect rating, and enjoyment of video) between sexes to determine if sex should be controlled and to explore speed mean difference between groups. To determine whether differences in participants' affect between the pre- and post-measure were statistically significantly different across groups a repeated-measures ANOVA was performed with group assignment as the between-subjects variable and affect as the within-subjects variable.

Results

Results of the initial independent-samples *t*-tests, displayed in Table 1, indicated mean values of the studied variables were not statistically significantly different between sexes. Additionally, mean speed of the watch group (M = 4.92 mph, SD = 1.65) and no-watch group (M = 4.60 mph, SD = 1.34) were not statistically significantly different, $t(123) = -1.19$, $p = .24$. Given the results of the previous tests, sex and speed were not controlled in further analyses. As displayed in Table 2, results of the repeated-measures ANOVA indicated a statistically significant within-subjects main effect for affect, $F(1, 123) = 23.12$, $p < .001$, $\eta_p^2 = .16$, and interaction effect for affect * group, ($F(1, 123) = 16.66$, $p < .001$, $\eta_p^2 = .12$. Results also indicated a statistically significant between-subjects main effect for group, $F(1, 123) = 3.97$, $p = .048$, $\eta_p^2 = .03$. Figure 2 is the graphic representation of the mean differences in the affect scores between the treatment and control groups.

Figure 2. Pre- and Post- Affective Valence Mean Score Differences Between the Watch and No-Watch Groups



Note. This figure demonstrates the change in mean scores of affective valence (AV) from pre- to post-mile. Error bars reflect the standard error of the mean scores.

Table 1. Results of Independent-Samples *t*-tests Examining Mean Differences Between Sexes

Variable	Female (n = 64)		Male (n = 61)		t	p-value
	M	*SD*	*M*	*SD*		
Speed	4.51	1.42	5.02	1.56	-1.94	.055
Pre-AV	1.92	1.65	2.13	1.75	-0.69	.492
Post-AV	2.63	2.09	2.93	1.78	-0.89	.375
Enjoyed Video	6.47	1.48	6.00	2.91	0.81	.421

Note. Enjoyed Video n = 63; AV = affective valence.

Table 2. Means, Standard Deviations, and ANOVA Statistics for the Studied Variables

Variable	Watch Group		No-Watch Group		ANOVA			
	M	*SD*	*M*	*SD*	Effect	*F* Ratio	*df*	η_p^2
AV					G	3.97*	1	.03
Pre-AV	1.98	1.65	2.06	1.75	T	23.12**	1	.16
Post-AV	3.37	1.65	2.18	2.05	G x T	16.66**	1	.12

Note. N = 125. ANOVA = analysis of variance; AV = affective valence; G = group; T = time. *$p < .05$. **$p < .01$.

Discussion

The purpose of the present investigation was to examine whether the distraction of watching comedy while completing one mile on a treadmill demonstrated enhanced affect over and above completing one mile on a treadmill with no distractors present. Results indicated the treatment group experienced a statistically significant greater positive change in affect from pre- to post-activity than the control group. This finding supported the hypothesis that being distracted by watching comedy while running would demonstrate a positive affect increase significantly greater than an increase from running with no distractor present. Although, this greater increase in affect is likely to solely be attributed to being distracted (Hutchinson et al., 2015; Privitera et al., 2014; Russell et al., 2002), Bahari and Lorica (2019) indicates that laughter is also likely to enhance mood, and thus affect. Therefore, this significant positive change could also be due to watching the comedy film alone. However, Bahari and Lorica (2019) explain that laughter therapy can increase a chance of having a more positive experience overall while strengthening positive emotions, in that laughter is associated with enhanced dopamine and serotonin levels. Therefore, an increase in affect from watching comedy may also increase the positive emotions of activity performed while watching comedy (e.g., running). However, this hypothesis should be further tested by adding an additional control group that watches the video without completing a mile. Further, future studies can also compare varying levels of perceived comedic value on affect while exercising to measure if comedic value moderates the relationship.

As previously noted, any form of distraction that is perceived enjoyable could have raised the affect in that it provided a distraction (Hutchinson et al., 2015; Privitera et al., 2014; Russell et al., 2002). Many researchers have found that listening to music and/or watching TV while exercising can be used as a distraction to possibly increase pleasure and enjoyment of exercise (Hutchinson et al., 2015). The comedy film could have been a distraction to the stressor of completing the mile for some; thus, increasing their pleasure and enjoyment of exercise. In Hutchinson and colleagues' article, the highest pleasure was when participants listened to music or when they listened to music and watched a video. Although enjoyment and affect response are not the same construct, previous research indicates they are highly related (Raedeke, 2007). While watching a comedy film, participants were using visual and audio senses, therefore, creating a distraction from the exercise and having a more positive affect than participants who were not provided a distractor. Distractions such as music and video can grab a person's attention, reduce the perception of the amount of exertion and increase motivation to exercise (Hutchinson et al., 2015). Distractions such as watching an enjoyable video can induce positive effects of exercise onto one's mood (Privitera et al., 2014). Distractions during exercise can enhance mood during exercise, but also after exercise is complete (Privitera et al., 2014).

To our knowledge, this was the first study to investigate the effect of watching comedy on affect while running in young adult runners. Therefore, the current study expands the existing knowledge related to the studied variables. On the other hand, results of the present study should be considered in light of the following limitations. First, particulars of the sample may limit generalizability to populations with similar geographical and age demographics. To increase generalizability, subsequent research should examine samples with different geographical and age demographics, as well as conducting analyses that control for possible covariates such as preferred exercise mode, exercise experience, and race. Second, results may have been different with a different comedy. While the results of the enjoyment of video measure indicated the participants who watched the video, on average, perceived the video more positively than negatively, distraction activities like watching TV should be enjoyable to the person and have self-motivating factors to the individual for best mood enhancement results after exercise (Russell et al., 2002). Thus, future studies should examine a more individually determined comedy selection. Third, it should be noted that a positive affective response after activity may not predict future motives and may decrease with time (Cavarretta et al., 2019; Rhodes & Kates, 2015). Subsequent research should include additional measurement times of affect, such as during and 30 minutes after activity. Lastly, results may be attributable to the distraction alone. Future studies should include equivalent controls such as a group watching a non-comedy video or group watching the video but not completing a mile. In addition, future studies should also examine the possible negative effects of distractions that runners do not enjoy as an equivalent control.

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Comparing the Effects of Affect-Regulated Green and Indoor Exercise on Psychological Distress and Enjoyment in University Undergraduate Students: A Pilot Study

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The purpose of this pilot study was to compare the acute effects of affect-regulated green exercise and indoor exercise on psychological distress and enjoyment in university undergraduate students. Using a repeated measures experimental design, 18 undergraduate students at an urban university in England completed three conditions: green exercise; indoor exercise; and a non-exercise control condition. Stress and anxiety were measured using standardised measures before and after each condition, while enjoyment was assessed after each condition. Affective valance was also assessed during the exercise conditions. A significant decline in stress was found after each exercise condition, with pre- to post-condition anxiety changes shown only after the green exercise condition. When assessing effect sizes, larger reductions in stress and anxiety were shown after the green exercise condition compared to the indoor exercise condition. No significant effect was present for enjoyment for any of the conditions. A primary contribution of this pilot study was that participants reported greater anxiety reductions in the green exercise condition versus the indoor exercise condition, as well as decreased stress in both the green and indoor settings, of which, a larger effect was shown for green exercise. Affect-regulated exercise could be a promising approach for acute reductions in psychological distress in exercise bouts in university students.

Keywords: mental health; physical activity; anxiety; stress; enjoyment

In recent years, psychological distress and mental health issues in university students have emerged as growing public health concerns (e.g., Sharp & Theiler, 2018; Wynaden et al., 2013). Psychological distress refers to a discomforting emotional state people experience in response to specific demands (Ridner, 2004), while mental health is defined as a "state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community" (World Health Organization, 2018). Evidence indicates that university students report significantly more negative mental health symptoms compared to age-matched employed individuals (Winzer et al., 2014). For instance, up to 83.5% of Australian university students (N = 6,479) reported elevated psychological distress levels, with 19.2% of the sample reporting symptoms at a severe or extremely severe level (Stallman, 2010). Concerns about poor mental health in university students are also highlighted by the prevalence of suicidal thoughts in this population, which have been found to range from 11.1% to 22.3% in meta-analyses (Mortier et al., 2018; Rotenstein et al., 2016).

Several reasons can explain the prevalence of mental health problems in university students. The transition into university can be difficult for students as this period involves moving from dependent living to independence (Kim & McKenzie, 2014), financial pressures (Stallman, 2010), and a change in social environment (Mikami et al., 2019). In addition, university students are at greater risk of experiencing psychological distress, as the typical age range for university study (18-21 years)

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is a period during which mental health issues can reach their developmental peak (Ibrahim et al., 2013). Mental health problems can evoke a range of negative outcomes, such as decreased academic performance (Bruffaerts et al., 2018), higher dropout rates (Arria et al., 2013), and greater likelihood of self-harm and suicide attempts (McManus & Gunnell, 2020). Thus, given these adverse outcomes could have significant consequences for students, as well as society more generally, it would be valuable to identify strategies that help university students to maintain good mental health.

A substantial body of evidence suggests that physical activity (PA) can be an effective non-clinical intervention for reducing symptoms associated with poor mental health (see Wegner et al., 2014 for a review of meta-analyses). Physical activity refers to any movement that increases energy expenditure, with exercise being one sub-category of PA and is defined as structured, repetitive, and planned bodily movements undertaken for the primary goal of increasing physical fitness (Caspersen et al., 1985). Research across a broad spectrum of mental health symptoms and populations has generally found that PA can help to reduce psychological distress (e.g., Morres et al., 2019), as well as anxiety and depression symptoms (e.g., Wegner et al., 2014). Furthermore, there is also evidence to suggest that PA can have mood-enhancing benefits (Chan et al., 2019) and can improve positive affect and psychological wellbeing (Elkington et al., 2017). In university students, a range of cross-sectional studies have identified positive relationships between levels of PA and mental health, whereby students who engage in PA more frequently report better mental health and wellbeing (e.g., Budzynski-Seymour et al., 2020; Murphy et al., 2018). This evidence suggests that strategies to increase levels of PA could not only enable students to reap the considerable physical health benefits associated with engagement in PA (e.g., Reiner et al., 2013), but could also have a positive impact on their mental health.

Despite the well-known benefits of PA, research suggests that physical inactivity is prevalent across a high proportion of the university student population (e.g., Clemente et al., 2016). For example, an accelerometer study that examined PA over the course of a week in university students (n = 296) found that only 5.4% of participants accumulated the World Health Organisation's (WHO, 2020) recommendations of 150 minutes per week of moderate-intensity PA or 75 minutes per week of vigorous-intensity PA in bouts of 10 minutes or more (Arias-Palencia et al., 2015). Importantly, recent reviews have found the transition from secondary education to university can have an adverse effect on levels of PA (Gropper et al., 2020; Kwan et al., 2012). In turn, this highlights the importance of developing intervention approaches that encourage university students to become, and remain, physically active throughout their studies.

While the majority of early work on PA promotion was largely dominated by cognitivist approaches (e.g., social cognitive theory), there is growing recognition of the importance of approaching research on the promotion of exercise and PA from an affective perspective (Ekkekakis & Zenko, 2016). Evidence suggests that positive affect (i.e., pleasure) *during* exercise could be key to promoting future PA behaviour, with results of a meta-analysis indicating that positive affect during exercise was positively associated with long-term PA, but positive affect after exercise displayed no significant relationship with long-term PA (Rhodes & Kates, 2015). Furthermore, enjoyment during PA predicts long-term adherence to PA (Williams et al., 2006). However, research has found that inactive students report significantly lower enjoyment in PA than somewhat active and active students (McArthur & Raedeke, 2009). Collectively, this suggests that understanding how university students can experience positive affect in exercise could have benefits for promoting PA and its associated mental health benefits. Indeed, based on the growing evidence surrounding the importance of positive affect for long-term PA, it has been suggested that replacing traditional methods for prescribing PA (e.g., based on specific intensities) with guidelines that facilitate positive affective responses could offer a promising avenue to improve PA participation (Ekkekakis & Brand, 2019). For instance, recent research has found that affect-regulated exercise (e.g., exercising at an intensity that "feels good") had a more positive effect on subsequent PA than heart-rate guided prescription (Baldwin et al., 2016; Williams et al., 2016). Thus, shifting away from traditional exercise prescription methods and towards affect-regulated exercise prescription could have benefits for university students, although further research is required to substantiate and generate preliminary evidence in this cohort.

A final area that warrants further consideration in the prescription of exercise for reducing psychological distress in university students is the exercise environment. The term green exercise refers to PA or exercise that occurs in the presence of nature (Lahart et al., 2019). Green spaces, such as parks, open spaces, trails, beaches, and bodies of water (Araújo et al., 2019; Mackay & Neil, 2010), are a key facet of healthy universities (Holt et al., 2019).

Review evidence indicates that short-term exposure to nature can benefit students' cognitive performance (Mason et al., 2022) and much effort has been made to create green or urban-green spaces on university campuses (Speake et al., 2013). Although the evidence is far from conclusive, meta-analyses offer tentative evidence that green exercise can confer some additional psychological benefits over indoor exercise (Lahart et al., 2019; Li et al., 2022). For example, acute bouts of outdoor exercise (i.e., single sessions) have been found to produce greater reductions in stress (Olafsdottir et al., 2020) and anxiety (Lee et al., 2014; Song, 2019), as well greater enjoyment (Focht, 2009; Plante et al., 2007) compared to indoor or non-green environments. Green exercise could be a viable, accessible, and low-cost form of PA for students, yet limited attention has been directed towards understanding the effects of green exercise on mental health in university populations. Previous researchers that have examined the effects of green exercise on psychological well-being (i.e., affect and emotions) in university students have prescribed exercise intensity based on objective measures. For example, participants have been asked to walk and cycle at an intensity within a specific heart-rate range (i.e., 60-70% of their maximum heart rate, Plante et al., 2007), complete a specific distance or move at a specific speed (e.g., Plante et al., 2003; Rider & Bodner, 2016), or walk at a subjectively-perceived "comfortable" pace (Plante et al., 2006). In studies that instructed participants to use heart-rate ranges or subjective-intensity measures to regulate the intensity of outdoor and indoor exercise, participants have reported significantly greater enjoyment (Plante et al., 2007) and perceived energy (Plante et al., 2006) when exercising outdoors compared to indoors. To date, however, no studies have compared the effects of affect-regulated green exercise, whereby subjective measures of affect are used as a basis to prescribe exercise intensity, to affect-regulated indoor exercise on psychological distress in university students.

The aim of this pilot study was to compare the acute effects of green exercise and indoor exercise on psychological outcomes when university undergraduate students were asked to exercise at an intensity that felt "good". More specifically, we sought to examine the acute effects of both exercise conditions to a non-exercise control condition on measures of psychological distress and enjoyment. By doing so, the findings of the study could expand understanding of exercise prescription for reducing psychological distress in university students, which could have important applied implications for students, university staff, and student well-being support provision. In the current study, we focused on two specific symptoms of psychological distress, stress and anxiety, both of which have been classified as constructs capturing aspects of psychological distress in past research (e.g., Awick et al., 2017). We hypothesised that there would be: (H_1) a significant reduction in psychological distress from pre-exercise to post-exercise in the green exercise and indoor exercise conditions, with no significant changes in the control group; (H_2) a greater effect of green exercise on psychological distress compared to the indoor exercise and control conditions; and (H_3) higher levels of enjoyment in the green exercise condition compared to the indoor exercise and control conditions.

Method

Participants and Recruitment

Ethical approval for the study was granted by the authors' school ethics committee. Eighteen university students (male n = 7, female n = 11; M age = 20.44 years, SD = 2.43) from one urban English university took part in the study. Participants were recruited on a voluntary basis through advertisements posted on online platforms and through snowball sampling. The inclusion criteria for the study stipulated that participants were (a) university undergraduate students, (b) aged 18-40 years, and (c) free from medical conditions, as confirmed by a screening form. Participants provided written informed consent and the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003) was used to determine whether participants' PA levels, in terms of metabolic equivalents (METs), were low (≤ 599 MET-mins/week), moderate (600-1499 MET-mins/week), or high (≥ 1500 MET-mins/week). Based on the IPAQ criteria, most participants were highly (n = 10) or moderately (n = 7) active, with only one participant classified as having a low level of PA.

Procedures

A repeated measures experimental design was employed. Participants attended the laboratory three times over a 13.50-day period on average (range = 11-22 days). Participants were exposed to three conditions: green exercise condition; indoor exercise condition; and control condition. Each experimental trial lasted 20 minutes to coincide with previous research (e.g., Plante et al., 2006, 2007; Yamaguchi et al., 2006) and exercise guidelines of 150 minutes of moderate PA per week, or roughly 20 minutes per day (National Health Service, 2021). To avoid the potential for ordering, practice, or learning effects, participants were assigned to the conditions in a randomised, counterbalanced (i.e., systematically varied) order. The randomisation was conducted using a Latin square with random allocation to one of six potential condition orders. All conditions took place during the academic term between November 2019 and February 2020.

Control Condition

For the control condition, participants completed two tasks that examined neuropsychological functioning. The first task was adapted from the memory-loaded search task (Smith & Miles, 1987) and required participants to draw a line through a specified target letter in each line as quickly as possible. A paper and pen version of the task was performed, with four grids of target letters. The second task was performed immediately after and used the iDichotic app (Bless et al., 2013) on an iPhone. This involved listening to a list of different sounds as a test of selective attention and auditory processing. These tasks were chosen for the control condition as previous research has employed similar tasks that do not involve PA to compare the effects of exercise to inactivity on psychological outcomes (e.g., Reed & Ones, 2006). For the green and indoor exercise conditions, participants performed a 5-minute warm-up within their exercising environment prior to completing their 20-minute exercise bout, with a 5-minute cool down period completed after the activity.

Experimental Conditions

In the green exercise condition, the participants were required to walk or run around a 200-meter rectangle on a synthetic surface surrounded by trees on a university campus. An urban green space on the university campus was selected to enhance the ecological validity of the findings on the basis that most students live close to and spend large periods of time in this setting. Only the participant and researcher were present on the synthetic surface during testing. The temperature of the green exercise condition averaged 7.7 degrees Celsius (range = 6-9 degrees Celsius) and testing was conducted during daylight hours (09:00 to 15:00). In the indoor exercise condition, participants walked or ran for 20 minutes on a treadmill in a laboratory. Instructions for adjusting the speed of the automatic treadmill were provided before the warm-up to allow participants to increase or decrease the pace as desired. Participants were instructed before the exercise trials began to walk or run at a pace that felt between "*good*" and "*very good*" on the Feeling Scale (FS; Hardy & Rejeski, 1989; see measures), which corresponded to a FS value of 3-5. Although previous research has instructed participants to exercise at an intensity that feels "good" (e.g., Hutchinson et al., 2018), the instructions in the current study were adapted on the basis that understanding the effects of exercise experiences that are at least "good" could have important applied implications.

Measures

Affective Valence

Affective valence (pleasure-displeasure) was assessed using the FS (Hardy & Rejeski, 1989) during the exercise conditions. The FS is an 11-point bipolar scale, with anchors that range from -5 (*very bad*) to +5 (*very good*). As the FS was used to regulate the pace and intensity of exercise in the current study, participant ratings on this measure served as a manipulation check. The FS has been widely used as a measure of affect in exercise (e.g., Hawkins et al., 2020; Hutchinson et al., 2018) and has demonstrated good convergent validity ($.41 \geq r \geq .88$) with other measures of affect (Van Landuyt et al., 2000). Measures of affective valence were obtained before, during (at minutes 5, 10, and 15), and at the end (at minute 20) of each exercise condition. An aggregate score was obtained for each trial by computing the average of all time points.

Stress

Perceived stress was measured using a modified Perceived Stress Scale-10 (PSS-10; Cohen et al., 1994). The PSS-10 is a unidimensional scale consisting of 10 items that range on a continuum from 0 (*never*) to 4 (*very often*). Scores on the PSS-10 range from 0 to 40, with higher scores indicating greater perceived stress. The PSS-10 has demonstrated excellent internal consistency ($\alpha = .84$ - $.86$) and test-retest reliability scores ($r = .85$; Roberti et al., 2006). To anchor each participant's responses in the present moment, participants were asked to complete each item based on how they felt "right now at this moment." Items were modified from the original scale to ensure that the measure captured how participants felt in a specific moment (i.e., present tense). Example item modifications to present tense include: "in the last month, how often have you been able to control irritations" to "I feel able to control irritations in my life"; and "In the last month, how often have you been angered because of things that were outside of your control?" to "I feel angered by things that are outside of my control." The PSS-10 was completed before and after all conditions by each participant. The internal consistency coefficient of the PSS-10 in the current study was excellent ($\alpha = .92$).

Anxiety

The state subscale of the State-Trait Anxiety Inventory (STAI Y-1) was employed to assess state anxiety (Spielberger et al., 1983), which has displayed excellent internal consistency (α = .89 - .94; Guillén-Riquelme & Buela-Casal, 2011) and test-retest reliability scores (*r* = .88; Grös et al., 2007). Participants completed the STAI Y-1 before and after all conditions. The STAI Y-1 contains 20 items that are rated on a Likert scale, which ranges from 1 (*not at all*) to 4 (*very much so*). Scores on the STAI Y-1 range from 20 to 80, with higher scores indicating higher anxiety. Sample items included: "I am relaxed" and "I feel nervous." The STAI Y-1 demonstrated very good internal consistency in the current study (α = .81).

Enjoyment

The Physical Activity Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991) was administered after each condition to assess enjoyment. The PACES is an 18-item bipolar scale that asks participants to rate their experience in a task on a 7-point scale, ranging from 1 (*I hated it*) to 7 (*I enjoyed it*). Scores on the PACES range from 18 to 126, with higher scores indicating greater enjoyment. Within exercise, the PACES has been widely used to assess enjoyment (e.g., Hawkins et al., 2020) and has previously exhibited very good internal consistency (α = .79 - .90; Crocker et al., 1997). The internal consistency coefficient of the PACES in the current study was acceptable (α = .73).

Distance

Distance was measured in both exercise conditions. In the green exercise condition, the number of 200-meter laps completed by participants were tallied. In addition, participants carried a bean bag and after dropping this at the end of the 20 minutes, the additional distance was recorded using a measuring wheel. The distance walked for the indoor exercise condition was recorded on the treadmill and noted by the researcher.

Statistical Analyses

Data were analysed using SPSS 27. Descriptive statistics, including means and standard deviations, were calculated for each variable (see Table 1). Non-parametric tests were used for all statistical analyses to account for the small sample size in the present study. A manipulation check using a Wilcoxon signed-rank test was conducted to compare affect in the green exercise and indoor exercise conditions. Preliminary analysis using two separate Friedman tests were performed on the anxiety and stress variables to test for any baseline differences between the three conditions. Follow-up post hoc tests using Wilcoxon signed-rank tests were conducted to identify specific differences between conditions (e.g., green vs indoor, green vs control, indoor vs control). Two separate Friedman tests were conducted to test anxiety and stress changes (pre−post) between the three experimental conditions. Follow-up Wilcoxon signed-rank tests were used to identify which conditions displayed significantly different change scores. Wilcoxon signed-rank tests were also conducted to identify pre-to-post differences in anxiety and stress within each condition (e.g., green pre-to-post, indoor pre-to-post, and control pre-to-post). A Friedman test compared differences in enjoyment between the three conditions. Distance walked was compared between the green and indoor conditions via a Wilcoxon signed-rank test. Effect sizes (*r*) were calculated from the post-hoc Wilcoxon results and interpreted as small ($r < .30$), moderate ($.30 \le r \le .50$), and large ($r \ge .50$).

Table 1. Mean and Standard Deviation Scores for all Psychological Variables in the Study

Condition	Time	Stress		Anxiety		Enjoyment		Distance		Affect	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Green	Pre	15.11	5.04	35.83	7.53	-	-	-	-	3.64	.39
	Post	9.89	6.50	29.72	6.38	98.39	15.71	2482.47	835.36		
Indoor	Pre	13.50	6.11	32.72	5.38	-	-	-	-	3.57	.51
	Post	10.00	6.07	31.06	5.20	95.22	17.29	1892.74	800.13		
Control	Pre	12.67	5.55	35.17	8.16	-	-	-	-	-	-
	Post	12.33	5.56	33.22	6.77	81.33	18.59	-	-		

Note. M = mean; *SD* = standard deviation.

Results

Preliminary Analyses

When comparing the average affect scores between exercise conditions, a Wilcoxon signed-rank test showed no significant difference (Z = -0.76, p = .45, r = -.13) between green (M = 3.64, SD = 0.39) and indoor (M = 3.57, SD = 0.51) conditions. Two separate Friedman tests showed significant differences in pre-condition scores for anxiety (χ^2[2] = 6.43, p = .04), and stress (χ^2[2] = 6.54, p = .04), between the three conditions. For anxiety, follow-up Wilcoxon signed-rank tests showed no significant differences in pre-condition anxiety between the green and indoor conditions (Z = -1.95, p = .05, r = -0.33), green and control conditions (Z = -1.12, p = .26, r = -0.19), or indoor and control conditions (Z = -1.33, p = .18, r = -0.22). Wilcoxon signed-rank tests were also used to investigate significant differences in pre-exercise stress between conditions. The only significant baseline difference for stress was between the green and control conditions (Z = -2.54, p = .01, r = -.42), with reported stress in the green condition significantly higher than in the control condition. Non-significant differences in baseline stress scores were shown between the green and indoor conditions (Z = -1.63, p = .10, r = -.27), and indoor and control conditions (Z = -0.18, p = 0.86, r = -.03).

Main Analyses

Stress

For change in stress scores (pre–post), a Friedman test revealed no significant effect (χ^2[2] = 5.48, p = .07), indicating no significant differences in changes from pre-to-post conditions between the three conditions. However, Wilcoxon signed-rank tests revealed significant pre-to-post condition changes in stress in the green condition (Z = -3.30, p = <.01, r = -.55) and indoor conditions (Z = -2.64, p = .018, r = -.44), but not in the control condition (Z = -0.17, p = .86, r = -.03). Results suggest significantly lower stress scores were reported from pre-to-post condition for the green and indoor groups. Non-significant differences were reported for the control condition.

Anxiety

A Friedman test revealed a significant effect between conditions on changes in pre- to post-condition anxiety scores (χ^2[2] = 7.39, p = .03). Follow-up Wilcoxon signed-rank tests showed moderate, significant differences in anxiety changes in the green condition compared to the indoor condition (Z = -2.43, p = .01, r = -.41) and in the green condition compared to the control condition (Z = -2.12, p = .03, r = -.35), but no significant difference between the indoor condition and the control condition (Z = -0.63, p = .53, r = -.11). Results suggested that reported anxiety scores changed significantly more in the green condition compared to the other two conditions. Moreover, Wilcoxon signed-rank tests showed large, significant changes from pre-to-post conditions for the green condition (Z = -3.62, p = < .01, r = -.60), but not the indoor (Z = -1.24, p = .21, r = -.21) or control conditions (Z = -1.59, p = .11, r = -.27). In turn, this suggests anxiety was significantly lower from pre-to-post condition in the green condition, but not the indoor or control conditions.

Enjoyment

A Friedman test was conducted to compare enjoyment between the exercise conditions. The results indicated no significant difference between the green and indoor conditions (χ^2[2] = 4.97, p = .08).

Distance

Results from a Wilcoxon signed-rank test showed significant differences between conditions for distance covered (Z = -3.20, p = <.01, r = -.75). Participants ran or walked significantly further in the green condition (M = 2482.47m, SD = 835.36) compared to the indoor condition (M = 1891.74m, SD = 800.13).

Discussion

This pilot study aimed to compare the effects of green exercise and indoor exercise on psychological distress and enjoyment when university undergraduate students were asked to exercise at an intensity that felt at least "good." As such, the study sought to explore whether exercising in accordance with an affect-regulated instruction in green and indoor environments would produce different psychological effects. Although the study hypotheses were only partially supported, undertaking green exercise decreased both stress and anxiety from pre-to-post condition, with anxiety changes being significantly greater in the green condition compared to the indoor and control conditions. Further, the manipulation check indicated that participants reported their experiences felt at least "good" during the exercise conditions, which offers further support for the utility of an affect-regulated exercise prescription (Baldwin et al., 2016; Ekkekakis & Brand, 2019; Williams et al., 2016). Together, the findings provide preliminary evidence of the efficacy of affect-regulated exercise for reducing psychological distress in university undergraduate students, which could prove particularly beneficial for university students, a population that has reported elevated psychological distress levels (Stallman, 2010; Winzer et al., 2014). However, further large-scale studies are required to generate more robust practical recommendations for universities, practitioners, and students.

The first hypothesis, which specified that there would be a significant reduction in psychological distress from pre-exercise to post-exercise in the green exercise and indoor exercise conditions was partially supported. Undertaking green exercise significantly reduced levels of stress and anxiety, with indoor exercise resulting in a significant reduction in stress, but not anxiety. No pre- to post-condition changes were observed for the control condition. Overall, the findings indicate that engaging in short bouts of green or indoor exercise were more beneficial for reducing stress than sedentary behaviour and green exercise had a particularly positive acute effect on anxiety. The current results show a similar trend to previous research with significant improvements in stress after both indoor and outdoor walks (Olafsdottir et al., 2020) and significantly lower anxiety after walking outdoors (Lee et al., 2014; Song, 2019). In turn, the current findings support past evidence on the positive effects of exercise for reducing psychological distress (Chan et al., 2019; Elkington et al., 2017).

Our second hypothesis that there would be a greater effect of green exercise on psychological distress compared to the indoor exercise and control conditions (H_2) was partially supported. Significantly larger reductions in anxiety scores were produced after the green exercise condition compared to the indoor and control conditions, with no differences between indoor and control conditions. Therefore, these findings concur with previous research (Lawton et al., 2017) suggesting that exercising in a green location conferred additional benefits for reducing anxiety symptoms in comparison to indoor exercise. In contrast, the green and indoor exercise conditions both produced significant reductions in stress, but no significant differences were revealed between conditions. Although the absence of a significant difference between the green and indoor conditions for stress reductions was not in line with our hypotheses, past studies have also reported no significant interaction effects for stress based on environment (e.g., Klaperski et al., 2019). Interestingly, Klaperski et al. (2019) reported that outdoor environments perceived as more calming had greater stress-reducing effects than those perceived as less calming. Although somewhat speculative, it is plausible to suggest that in comparison to other potential green exercise environments, the environment used in the current study (i.e., walking on a synthetic surface on a university campus) might not have been as calming as the environments used in other green exercise studies (e.g., woodlands in Olafsdottir et al., 2020), and thus might have been less stress reducing than other green environments in comparison to an indoor environment. The nuanced differences in anxiety and stress responses also somewhat align with previous research by Kajosaari and Pasanen (2021), which found that different outdoor exercise environments elicited different psychological responses; for example, stress reductions were more likely to be experienced during exercise in larger natural areas and near blue spaces, whereas enjoyment was related to exercising in all natural environments regardless of size. Overall, the study offers evidence that green exercise could have greater potential to ameliorate anxiety in university students versus indoor exercise, as well as exercise in general being beneficial for reducing stress compared to sedentary activities.

The third hypothesis, that enjoyment would be significantly higher in the green exercise condition compared to the indoor and control conditions (H_3), was not supported. The lack of a significant effect for enjoyment is in contrast to previous research highlighting significantly greater enjoyment in outdoor walks compared to indoor walks in 10-minute (Focht et al., 2009) and 20-minute durations (Plante et al., 2007). Despite no significant effect being present for enjoyment scores, it should be noted that the mean scores for both the green exercise and indoor exercise conditions appear considerably larger than enjoyment in the control condition. The inclusion of an affect-regulated exercise instruction may have contributed to the similar enjoyment scores in the exercising conditions, as the affect scores also showed no significant differences between conditions. Future research regarding affect-regulated exercise prescriptions and comparisons between green and indoor exercise in larger samples should further examine enjoyment, as enjoyment during exercise is associated with a higher likelihood of engaging in long-term PA (Williams et al., 2006) and may be integral to reducing physical inactivity (Brand & Ekkekakis, 2018). Additionally, further empirical work examining affect-regulated exercise and the mediating effect of enjoyment could be useful.

Finally, the distance walked after 20 minutes was significantly higher in the green environment compared to the indoor environment, despite participants being instructed to walk at the same intensity (+3 to +5 on the FS) and there being no significant difference in affective valence between conditions. This finding is similar to past research (Krinski et al., 2017), which found that participants walked significantly further in the outdoor track-walking condition versus an indoor treadmill walking condition. A potential explanation for this finding is that participants were more familiar with walking outdoors compared to treadmill walking (Gladwell et al., 2013), which might have increased the pace at which they walked. In addition, as treadmill exercise requires greater voluntary control to alter walking speed compared to outdoor walking (i.e., adjusting the pace), participants might have chosen to stay at a constant velocity on the treadmill rather than changing their velocity, as might occur when walking outdoors (Lindsay et al., 2014). Future studies could assess the degree of variability in walking speed during indoor and outdoor walking tasks in addition to total distance.

Limitations and Future Directions

Whilst the current study provides novel understanding of affect-regulated green and indoor exercise, several limitations should be noted. First, as the current research was a pilot study, the sample was relatively small, meaning that caution should be taken when considering the wider impact of the results. Accordingly, there is a need for further studies using larger sample sizes with a wider range of physical activity levels to produce stronger evidence for affect-regulated green exercise in order to impact the way universities and practitioners facilitate or prescribe exercise to students. With additional supporting research, universities could increase efforts to promote and facilitate green exercise on university campuses as this form of exercise could confer additional benefits for reducing psychological distress, an issue that has been highlighted for students in recent years, whilst providing a cost-effective form of exercise for many students. Additionally, the small sample size might have had some effects on statistical power. As such, effect sizes generated in the current study could be used in power tests to determine an appropriate sample size in future, larger-scale studies. Future, more adequately powered, studies could also consider using more sophisticated analytic techniques to examine the mechanisms underlying the effects of exercise environment on psychological outcomes (e.g., mediation analysis).

Second, the sample consisted of university students at one institution, the majority of whom were moderately or highly active, which may have limited the findings' generalisability. Therefore, future studies could use purposive sampling to recruit active and insufficiently active participants to determine if the study findings can be replicated in more diverse populations. Third, the current study only examined the psychological effects of green and indoor exercise on participants on one occasion, hence, the long-term effects of the interventions remain unknown. Consequently, future studies should examine the effects of affect-regulated exercise on psychological outcomes over a longer period and examine the effects of such interventions on longer-term PA adherence. Fourth, the green exercise condition was performed on a synthetic surface on a university campus, whereas the indoor condition was undertaken on a laboratory treadmill. Large-scale versions of the current study may benefit from using more ecologically valid outdoor and indoor exercise spaces. For example, potential green spaces could include parks, countryside, or any open green spaces (Mackay & Neill, 2010) and indoor settings could include gym and/or leisure centre environments (Olafsdottir et al., 2020). In addition, as the study was conducted during the winter, it may be beneficial to compare the effects when exercise is undertaken in the summer, to determine the interplay between environmental factors (e.g., temperature, light exposure, ambience) and psychological responses during outdoor exercise. Finally, the current study only compared the affect-regulated exercise prescription to a control condition. Future studies are required to compare the effects of affect-regulated exercise to more traditional forms of exercise prescription (e.g., percentage of heart rate maximum) to determine the effectiveness of affect-based exercise regulation. In future, affect-regulated exercise may offer a pragmatic alternative to traditional exercise prescription, but expansions on the current pilot study are needed before stakeholder recommendations can be made.

Conclusion

The current study examined the effects of affect-regulated green exercise and indoor exercise on mental health and affective outcomes in university undergraduate students. As such, current findings respond to calls for research that examines participatory experiences in exercise and PA from an affective perspective (Ekkekakis & Zenko, 2016). Overall, the findings support the efficacy of affect-regulated exercise prescription for reducing stress and anxiety as acute symptoms of psychological distress. Further, exercising at an intensity that feels at least "good" in green exercise conditions could confer additional psychological benefits compared to indoor exercise for reducing anxiety. In sum, the current pilot study provides preliminary evidence of the efficacy of affect-regulated exercise in both green and indoor environments for improving psychological outcomes in university students, but further research that recruits a larger sample is required to examine these effects in more detail and generate more robust conclusions.

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