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Mastery Imagery Ability Moderates the Relationship Between Heart Rate Reactivity to Acute Psychological Stress and Perceptions of Stress and Physiological Arousal

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Abstract

Imagery has been associated with cardiovascular and psychological responses to stress, however the mechanisms underlying this association are not fully understood. The present study examined if the ability to image mastering challenging or difficult situations moderated the relationship between heart rate reactivity to and perceptions of stress and physiological arousal experienced during acute stress. 458 participants completed a standardised laboratory stress protocol with heart rate being measured throughout. After completing an acute psychological stress task, participants rated how stressed and physiologically aroused they felt (i.e., intensity) and whether they perceived the stress and physiological arousal as being helpful/unhelpful to performance (i.e., interpretation). Mastery imagery ability was assessed by questionnaire. Moderation analyses controlling for gender demonstrated that imagery ability moderated the relationship between heart rate reactivity and interpretation of stress ($\beta = .015$, $p = .003$) and perceived physiological arousal ($\beta = .013$, $p = .004$). Simple slopes analysis indicated that in those with higher imagery ability, heart rate reactivity was associated with stress and arousal being perceived as more positive towards performance. Imagery ability did not moderate the relationship between heart rate reactivity and perceived stress intensity or physiological arousal intensity (*p's* > .05), but imagery ability did predict lower perceived stress intensity ($\beta = -.217$, $p < .001$) and perceived physiological arousal intensity ($\beta = -.172$, $p < .001$). Higher mastery imagery ability may possibly help individuals perceive responses to stress as more beneficial for performance and thus be an effective coping technique.

Keywords: imagery, stress, physiological arousal, heart rate

1.0 Introduction

Psychological stress is highly prevalent in modern society. In a sample of 10,000 adults, 35% reported that they were stressed, 23% of which stated they were moderately to very stressed (Mirzaei et al., 2019). Exposure to stress is a risk factor for adverse physical and mental health outcomes (Schneiderman et al., 2005). For example, higher levels of stress are associated with the development of cardiovascular disease (Dimsdale, 2008; Gianaros & Jennings, 2018; Ellins et al., 2008) and increased risk of mental health disorders (Auerbach et al., 2018). Identifying factors or dispositions which are associated with more adaptive responses to stress is an essential step to informing the development of evidence-based interventions to reduce stress-related disease risk promote better health and wellbeing.

Although acute stress elicits both cardiovascular and psychological responses (e.g., Skoluda et al., 2015; Gianaros & Jennings, 2018), research examining the extent to which these responses are associated with one another is somewhat mixed. A meta-analysis including nine studies reported a small effect size for the associations between negative emotional responses to stress and cardiovascular responses to stress (Feldman et al., 1999). Similarly, a meta-analysis of 49 studies, all using the Trier Social Stress Test, demonstrated a weak relationship between emotional (e.g., perceived stress, anxiety, negative affect) and physiological (i.e., cortisol and cardiovascular) responses to stress (Campbell & Ehlert, 2012). A recent study reported a stronger association between reports of perceived heart rate (i.e., individual ratings of heart rate changes) during acute psychological stress and anxiety responses to stress compared to the relationship between actual heart rate reactivity (i.e., measurement of heart rate changes) to the task and anxiety responses to stress (Trotman et al., 2019). Actual heart rate reactivity was associated with more debilitative interpretations of anxiety intensity (i.e., participants felt that their level of anxiety was more harmful to their performance), suggesting there may be a link between physiological responses to stress and interpretations of psychological responses (Trotman et al., 2019). Interestingly, recent experimental research has demonstrated that pharmacological suppression of the autonomic and endocrine stress systems does not alter the intensity of emotional stress experiences during a laboratory-based stress task (Ali et al., 2017).

Taken together, the associations between psychological and physiological responses to stress are complex and somewhat inconsistent across the literature. It has been suggested that the associations between psychological (e.g., stress, anxiety, negative affect) and physiological responses to stress should not be examined without considering potential moderators (Campbell & Ehlert, 2012). Indeed, factors such as attachment style (Ditzen et al., 2008) and internalizing problems (Hastings et al., 2009) have been shown to relate differentially to physiological and psychological responses to stress. A recent study examined the moderating effect of psychological wellbeing on the relationship between self-reported stress and heart rate reactivity in a large sample (N > 1000), individuals with higher levels of anxiety and depression displayed a lower stress-heart rate coherence (i.e., the association between individuals' self-reported stress experienced and their heart rate; Sommerfeldt et al., 2019). In contrast, individuals in the same study who had lower depressive symptoms and trait anxiety experienced greater stress-heart rate coherence (Sommerfeldt et al., 2019).

Another disposition which may moderate relationships between physiological and psychological responses to stress is imagery ability. Imagery ability is an "individual's capability to form vivid and controllable images and retain them for sufficient time to effect the desired imagery rehearsal" (Morris, Spittal, & Watt, 2005, p. 37). Research has demonstrated that in sport settings, higher mastery imagery ability (i.e., the natural disposition to form, create, and control images related to overcoming challenging or difficult situations; Quinton et al., 2018), measured by the Sport Imagery Ability Questionnaire (Williams et al., 2011), is associated with greater challenge appraisal tendencies, lower levels of anxiety, and more positive interpretations of anxiety (Williams et al., 2021; Williams et al., 2015; Quinton et al., 2018). Similarly, in a non-athlete sample of 240 young adults, higher mastery imagery ability, as measured by the Sport Imagery Ability Questionnaire, was associated with lower levels of perceived stress and anxiety (Möller, 2019).

Recent research into the regulatory effects of mastery imagery ability has demonstrated that higher mastery imagery ability can buffer against levels of stressor-evoked anxiety (Quinton et al., 2019). Using a computer-based competition stress task, Quinton et al. (2019) assessed ratings of anxiety in response to the task and mastery imagery ability in 78 male undergraduate students. Mastery imagery ability significantly moderated the relationship between cognitive and somatic anxiety intensity and interpretation (p's $< .05$). Specifically, for those with lower mastery imagery ability, increased cognitive and somatic anxiety intensity was associated with more debilitative perceptions of anxiety. In those with higher mastery imagery ability, the simple slope analysis pattern suggested higher anxiety intensity was perceived as more facilitative, albeit not significantly.

Although relatively stable, imagery ability varies between individuals (Floridou et al., 2022). Previous research suggests that in both athlete and non-athlete populations higher levels of mastery imagery ability are associated with lower anxiety and/or more positive interpretations of the anxiety in response to stress. Given that mastery imagery ability can be modified with training (Mathieson, 2023), understanding how trait level mastery imagery ability relates to interpretations of actual physiological responses to stress may provide a potential method to improve stress related interpretations.

The aim of the present study was to investigate the potential moderating role mastery imagery ability has on the relationship between physiological arousal during stress (i.e., heart rate reactivity) and the intensity and interpretation of stress and perceived physiological arousal in response to an acute psychological stress-evoking situation. Specifically, the study examined whether trait level mastery imagery ability moderated the relationship between heart rate reactivity to a psychological stress task, and self-reported ratings of both stress intensity and perceived physiological arousal intensity. The study also examined whether mastery imagery ability moderated the relationship between heart rate reactivity and the extent to which the experienced stress and the perceived physiological arousal is considered to be facilitative or debilitative towards performance of the task. Based on the previous mastery imagery ability literature in both athlete and non-athlete populations, it was hypothesised that: 1) mastery imagery ability would be a significant independent predictor of lower levels of stress and perceived physiological arousal, as well as more positive interpretations of these responses, 2) mastery imagery ability would moderate the relationships between heart rate reactivity and stress and perceived physiological arousal ratings, 3) greater heart rate reactivity would be associated with more facilitative interpretations of perceived stress and physiological arousal in individuals with a higher mastery imagery ability, whereas greater heart rate reactivity would be associated with more debilitative interpretations of perceived stress and physiological arousal in individuals with a lower mastery imagery ability.

2.0 Methods

2.1 Participants

Four hundred and fifty-eight participants (62% female, 66% white; *M age* = 19.48, *SD* = 1.26 years) participated in this study. All participants were healthy university students who had no history of cardiovascular disease or current illness or infection. Prior to data collection, participants were told to refrain from: consuming alcohol or taking part in vigorous exercise for 12 hours, drinking caffeine for two hours or consuming food or any drink except water for two hours.

2.2 Questionnaires

2.2.1 Mastery imagery ability

The mastery subscale of the Sport Imagery Ability Questionnaire (SIAQ; Williams & Cumming, 2011) was used to assess mastery imagery ability. Composed of 15 items, three items measure each of the five types of imagery ability assessed (strategy, affect, skill, goal imagery, and mastery). For the present study only the three items assessing mastery imagery ability were used (i.e., "remaining confident during a challenging situation"; "staying positive after a setback"; "remaining confident in a difficult situation"). Participants image each item and then rate on a 7-point Likert type scale ranging from 1 (*very hard to image*) to 7 (*very easy to image*) how easily they are able to image the item. Items for each subscale are then averaged so that a higher score indicates a greater ease of imaging. The SIAQ has been identified as a valid and reliable measure of imagery ability (Williams & Cumming, 2011) and has been used successfully in non-athlete samples in which it has been shown to be related to general levels of stress and anxiety (e.g., Möller et al., 2019; Williams et al., 2021). For the present study a confirmatory factor analysis revealed a good factor structure comparable with previous studies validating the questionnaire, χ^2 (80) = 305.48, $p < .001$, CFI = .94, TLI = .93, SRMR = .05, RMSEA = .08 (90% CI = .07 – .08) and the mastery subscale displayed good internal reliability with the Cronbach alpha's coefficient being .82.

2.2.2 Perceived stress and physiological arousal

Participants completed two single items to assess how stressed and how physiologically aroused they felt during the stress task. Ratings were made for both items using a 7-point Likert type scale from 1 (*not at all stressed/physiologically aroused*) to 7 (*extremely stressed/physiologically aroused*). Two more single items measured the extent to which participants perceived their stress and physiological arousal to be facilitative or debilitative for performance at the upcoming stress task. These items were also rated on a rating 7-point Likert type scale from -3 (*very debilitative (negative)*) to +3 (*very facilitative* *(positive)*). Although it may be seen as a limitation to use single items, they were developed based on the Immediate Anxiety Measures Scale (IAMS; Thomas et al., 2002) which has been shown to reliably measure intensity and interpretation of different constructions using a single item (Thomas et al., 2002). Both intensity and interpretation of psychological experience in response to the stress task were selected given recent evidence demonstrating that interpretations of stress have important implications for health (e.g., Crum et al., 2013; Crum et al., 2017; Keech et al., 2018).

2. 3 Heart Rate

Heart rate was obtained via standard electrocardiography using a 3-lead configuration. Raw electrocardiogram (ECG) data were collected using BioLab, a Mindware acquisition and laboratory integration platform at a sampling of 500 Hz (MindWare Technologies LTD, Westerville, Ohio). Following automated R-peak detection, research staff visually inspected all individual heart rate (HR) traces for removal of artifacts using MindWare's HR/HRV analysis software. Data were then imported into Kubios HRV which was used to calculate average heart rate for each minute of the resting baseline and stress task periods. Averages were then created of the total baseline period and the total stress period. Heart rate was the physiological parameter in the present study based on previous work focusing on the relationship between heart rate reactivity and psychological responses to stress (Sommerfeldt et al., 2019; Trotman et al., 2019).

2.4 Acute Psychological Stress Task

The four-minute version of the Paced Auditory Serial Addition Test (PASAT; Gronwall, 1977) was completed by all participants. The PASAT is a mental arithmetic task in which individuals listen to a tape recording that reads out a series of single digit numbers at a gradually increasing pace. Participants are required to add together consecutive numbers heard and say the answer out loud while remembering the most recent number heard so it can be added to the next number heard. In order to increase the task stressfulness, participants were told that their performance would be assessed and directly compared to each other, with incorrect answers causing 5 points to be deducted from their starting score of 1000 points. Also, participants were told that they are being videotaped, and that body language experts would assess the videos as a measure of anxiety levels. A mirror was placed in front of the participants, and they were told they must look at the mirror at all times. Participants were also told that they would hear a loud buzzer each time they gave an incorrect answer, looked away from the mirror or stuttered or mumbled. In reality, participants were not videotaped, and they all received the same standardized number of loud beeps every 10 numbers. The PASAT has been found to exemplify good test-retest reliability (Willemsen et al., 1998; Ginty et al., 2013), and generalizability (Ginty et al., 2013; Ginty et al., 2019), whilst elements of social evaluation, time pressure and competition have also shown to perturb the cardiovascular system (Veldhuijzen van Zanten et al., 2004).

2.5 Procedures

The study was approved by the university's institutional review board. Participants were recruited using the SONA online psychology subject pool. All participants provided informed consent and received two SONA credit hours. First, participants height and weight were measured to calculate BMI. Then, ECG electrodes were placed in a three-spot configuration. Participants were then instructed to sit quietly for a 10-min acclimatization phase. This was followed by a 10-minute resting baseline period during which cardiovascular activity was continuously recorded. Then, participants were provided the PASAT instructions and engaged in a brief practice period to ensure they understood the task. Participants then complete the PASAT; cardiovascular activity was continuously recorded during the PASAT. As soon as the task ended, participants rated their experienced stress and physiological arousal and whether this was considered to be positive or negative. Finally, participants were removed from the cardiovascular equipment and debriefed and thanked for their participation. Then, participants completed the SIAQ (Williams & Cumming, 2011). Lastly, the electrodes were removed and participants were debriefed on the protocol.

2.6 Data Analysis

Heart rate reactivity was calculated as average heart rate during stress – average heart rate during baseline period. Creating averages of each phase and calculating a reactivity change score is a well-established method (e.g., Turner et al., 2020). Using SPSS (IBM SPSS Version 24.0), a one-way repeated measures ANOVA was first run to determine that the stress task perturbed a significant increase in heart rate from baseline to stress. Next, independent samples t-tests were conducted to examine the extent to which participants' gender impacted their responses to stress before correlation analyses explored the relationships between heart rate reactivity and the psychological responses. Finally, four independent moderation analyses were then undertaken using the PROCESS SPSS add-on (Hayes, 2017) using a bootstrap of 95% bias-corrected confidence intervals (CIs) of 5000 samples. To prevent any potential issues with multicollinearity with the interaction term, all variables were centred. Mastery imagery ability was entered as the moderator, heart rate reactivity as the predictor, and stress and physiological arousal intensity and direction were entered as the outcome variables. Gender and baseline heart rate were included as covariates. For all analyses, the critical alpha level was set at .05 and unstandardized estimates were reported.

3.0 Results

3.1 Participant Characteristics

Means and standard deviations of mastery imagery ability, heart rate, stress intensity and interpretation, and physiological arousal intensity and interpretation are shown in Table 1. Results of the one-way repeated measures ANOVA showed that the PASAT induced a significant increase in heart rate from baseline ($M = 77.31$, $SD = 11.25$) to stress ($M = 88.43$, $SD = 15.30$), $F(1, 452) = 482.37$, $p < .001$, $\eta_p^2 = .516$. Independent samples t-tests demonstrated that males displayed significantly higher mastery imagery ability than females, $t(454) = 5.34$, $p < .001$, but females displayed significantly higher heart rate reactivity compared to males, $t(450) = -2.33$, $p = .020$. Further t-tests showed that females demonstrated significantly higher physiological arousal intensity than males, $t(451) = -4.90$, $p < .001$, however, there were no significant differences between males and females for stress intensity, or stress and physiological arousal interpretation (p's > .05). Due to the differences between males and females, subsequent moderation analyses controlled for gender.

3.2 Correlation Analyses

Pearson bivariate correlations examining the relationship between mastery imagery ability, heart rate reactivity, stress intensity and interpretation, and perceived physiological arousal intensity and interpretation are displayed in Table 2. Results demonstrated mastery imagery ability was significantly negatively correlated with stress intensity and perceived physiological arousal intensity, and significantly positively associated with stress interpretation and perceived physiological arousal interpretation. No significant relationships were observed between heart rate reactivity and stress and perceived physiological arousal intensity, and stress and perceived physiological arousal interpretation.

3.3 Moderation Analyses

Results of the four separate moderation analyses examining the moderating effect of mastery imagery ability on the relationship between heart rate reactivity and stress intensity, perceived physiological arousal intensity, stress interpretation, and perceived physiological arousal interpretation are reported in Table 3. Each regression model accounted for a significant portion of the variance on the specific outcome variable.

3.3.1 Stress intensity

Results for stress intensity demonstrated that mastery imagery ability independently predicted stress intensity while heart rate reactivity was a nonsignificant predictor. Furthermore, mastery imagery ability did not moderate the relationship between heart rate reactivity and stress intensity. The negative beta weight indicates that greater mastery imagery ability predicted lower stress intensity (see Table 3).

3.3.2 Stress interpretation

Results revealed that mastery imagery ability was a significant independent predictor of stress interpretation. Furthermore, while heart rate reactivity was not an independent significant predictor, there was a significant interaction demonstrating that mastery imagery ability moderated the relationship between heart rate reactivity and perceived stress interpretation. A simple slopes graph to depict the moderation effect is displayed in Figure 1. Specifically, there was a positive association between heart rate reactivity and more positive stress interpretation for individuals with higher mastery imagery ability ($\beta = .021$, $p = .024$). Therefore, for individuals displaying higher mastery imagery ability, a higher heart rate reactivity was associated with the stress being interpreted more positively. By contrast, there was no significant association between heart rate reactivity and perceived stress for those with moderate mastery imagery ability ($\beta = .003$, $p = .667$). Although Figure 1 suggests that for those with low imagery ability the relationship between heart rate reactivity and perceived stress interpretation was in the opposite direction to that for individuals with higher imagery ability, this association was non-significant ($\beta = -.015$, $p = .110$).

3.3.3 Perceived physiological arousal intensity

Moderation analysis showed that mastery imagery ability was a significant independent predictor of perceived physiological arousal intensity such that greater mastery imagery ability predicted a lower perceived physiological arousal (see Table 3). Heart rate reactivity did not significantly independent predict physiological arousal intensity and mastery imagery ability did not moderate this relationship.

3.3.4 Perceived physiological arousal interpretation

Mastery imagery ability was found to be a significant independent predictor of perceived physiological arousal interpretation. While heart rate reactivity did not independently predict perceived physiological arousal interpretation, mastery imagery ability moderated this relationship (see Table 3). The moderation effect can be observed in Figure 2 which shows a positive association between heart rate reactivity and more positive interpretations of perceived physiological arousal in those with higher mastery imagery ability ($\beta = .017$, $p = .044$). There was no significant association between heart rate reactivity and perceived physiological arousal interpretation in individuals with moderate mastery imagery ability ($\beta = .002$, $p = .751$). Similar to the finding for stress interpretation, while Figure 2 suggests that the relationship between heart rate reactivity and perceived physiological arousal interpretation in those with low mastery imagery ability was in the opposite direction to that for individuals with higher imagery ability, this association was non-significant ($\beta = -.013$, $p = .129$).

4.0 Discussion

The aim of the present study was to examine if the trait disposition of mastery imagery ability impacts the associations between cardiovascular and psychological responses to stress. First, we examined whether mastery imagery ability moderated the relationship between heart rate reactivity and perceived stress and physiological arousal. Mastery imagery ability directly predicted perceived stress and physiological arousal intensity, however, in both instances mastery imagery ability did not moderate the relationship between heart rate reactivity and these variables. Secondly, we examined whether mastery imagery ability moderated the relationship between the interpretation of perceived physiological arousal and stress with heart rate reactivity. Mastery imagery ability directly precited more positive interpretations of stress and physiological arousal and, in further support of the hypotheses, mastery imagery ability moderated the relationships between heart rate reactivity and these interpretations. Results showed that in higher cardiovascular stress responders, mastery imagery ability is protective against negative interpretations of that physiological arousal as well as feelings of stress.

Interestingly, there was no association between physiological responses to stress and the interpretation of stress or physiological arousal in those with low or moderate ability. Research examining the association between physiological and psychological responses to stress have found weak associations, but overall mixed results (Campbell & Ehlert, 2012; Feldman et al., 1999). The present study confirms the importance of considering the role of moderating factors in the relationship between physiological and psychological responses to stress (Campbell & Ehlert, 2012).

These results build on previous literature which highlights the moderating effect that mastery imagery ability has in regulating psychological responses to stress, especially in enabling participants to perceive their psychological responses as more facilitative towards performance (Quinton et al., 2019). When examining the relationship between anxiety intensity and anxiety interpretation in response to stress, Quinton et al. (2019) showed that those with a lower mastery imagery ability interpreted higher levels of anxiety as more debilitative in comparison to those with a higher mastery imagery ability who perceived higher anxiety levels as more facilitative. The present study extends these findings by demonstrating that mastery imagery ability can also enable greater intensity of physiological arousal responses to be perceived as more facilitative. It also shows that mastery imagery ability has a moderating role not just with the interpretation of anxiety, but also with the interpretation of perceived stress and physiological arousal. Collectively these findings suggest that more intense psychophysiological responses to stress (e.g., heart rate, anxiety) are likely to be interpreted as more facilitative (or less debilitative) if they are experienced in individuals who display greater mastery imagery ability.

The moderating role of mastery imagery ability on the relationship between heart rate reactivity and perceived stress and arousal interpretation also supports the psychophysiology literature which has suggested associations between cardiovascular and psychological responses to stress could be moderated by individual dispositions (Sommerfeldt et al., 2019). However, contrary to our hypotheses and previous research (Sommerfeldt et al., 2019), mastery imagery ability did not moderate the relationship between heart rate reactivity and stress or physiological arousal intensity. The individual dispositions examined by Sommerfeldt et al. (2019) were indicators of psychological well-being, such as depressive symptoms and trait anxiety, whilst the present study examined mastery imagery ability, which is a skill. Although the assessment of mastery imagery ability measures an individual's disposition for being able to naturally imagine overcoming challenges, research suggests mastery imagery can be improved (Möller et al., 2019) with an intervention. Improving mastery imagery ability may possibly be a relatively low-cost and impactful way to improve interpretations of anxiety and stress when encountering challenging and difficult circumstances. Future research should examine if improving mastery imagery ability results in 1) more positive interpretations of perceived physiological arousal and psychological stress during stressful situations, 2) increases the association between actual physiological responses to stress and the interpretations of these responses and 3) more positive interpretations of depressive symptoms and trait anxiety.

Although the present study found that mastery imagery ability did not moderate the relationship between heart rate reactivity and stress and physiological arousal intensity, in support of the hypotheses the results do highlight the importance of mastery imagery ability as an independent and direct predictor of the intensity of the perceived stress and physiological arousal experienced during an acute psychological stress. Individuals displaying greater mastery imagery ability reported lower levels of perceived stress and physiological arousal irrespective of heart rate experienced. Such findings highlight the importance of mastery imagery ability in non-athlete populations, showing that those with a higher mastery imagery ability view stress as more positive than those with a lower mastery imagery ability, and adds to the growing body of literature showcasing mastery imagery ability's association with more adaptive appraisals of stress and anxiety (Quinton et al., 2018; Williams & Cumming, 2012; Williams & Cumming, 2015).

Results of the present study show multiple benefits of having a higher mastery imagery ability. As those with a higher mastery imagery ability report lower levels of stress and view stress as more facilitative than those with a lower mastery imagery ability, results suggest that higher levels of mastery imagery ability are associated with more adaptive coping during exposure to acute psychological stress. Given that imagery ability is a modifiable disposition (Möller et al., 2019), running interventions to improve an individual's mastery imagery ability shows the wide implications of this study for health, as increased stress levels have been linked to worse physical and mental health (Cohen et al., 1995; Schneiderman et al., 2005). The present study demonstrated that higher mastery imagery ability was directly associated with lower stress levels in response to a standardized acute psychological stress task. Increasing levels of mastery imagery ability may possibly lead to lower levels of self-reported stress potentially reducing stress-related physical and mental health problems caused by stress exposure.

Furthermore, the moderating effect of mastery imagery ability on stress and physiological arousal interpretations suggests that elevations in heart rate responses due to stress will be associated with more adaptive interpretations of stress and these physiological responses in those displaying higher mastery imagery ability. Previous work suggests that the interpterion of stress or anxiety can be a more important predictor of performance and mortality than its intensity (Chamberlain & Hale, 2007; Keller et al., 2012). Collectively these results highlight the potential usefulness of practitioners helping individuals to improve their mastery imagery ability, whether that be for athletes seeking to prepare for competition or non-athlete populations to negate the debilitating effects of day to day stress and physiological arousal.

Despite the study's implications it is not without limitations. Mastery imagery was measured using a questionnaire designed for measuring sport related content. However, it is the only validated questionnaire currently available to measure mastery imagery ability. Additionally, SIAQ has been used in non-sport settings (Williams et al., 2021) and all participants had recently engaged in some broad type of sport as part of university Lifetime Fitness requirements. Despite this, future research should seek to validate a non-sport specific measure of mastery imagery ability to use in general populations. Another limitation is that the present study was cross-sectional meaning the findings cannot imply causation. Imagery ability is a skill that can be improved with training and practice (Cumming & Williams, 2012). It is therefore important that future research examines the extent to which improving mastery imagery ability can lead to lower levels of stress and physiological arousal intensity in response to a stress task, and the extent to which such increases in mastery imagery ability can lead to greater heart rate reactivity being associated with more facilitative interpretations of stress and physiological arousal. Lastly, the present sample were healthy young adults and further research should include samples of a broad age range and should include relevant clinical populations (e.g., individuals with anxiety disorders).

In conclusion the present study aimed to investigate the role that mastery imagery ability has on moderating the relationship between heart rate reactivity and psychological responses to stress. The present study demonstrates that when exposed to acute psychological stress, higher mastery imagery ability may possibly help with experiencing lower levels and more positive interpretations of perceived stress and physiological arousal, as well as higher heart rate being associated with more positive interpretations of stress and physiological arousal. As such, mastery imagery ability may possibly be a modifiable individual disposition that can have benefits for better coping with stress, which may have wider performance and health benefits. Future research should investigate whether increasing mastery imagery ability can bring about more adaptive interpretations of responses to stress.

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Table 1. Means (M) and standard deviations (SD) of variables measured during data collection according to gender.

	Gender			
	Males		Females	
	M	SD	M	SD
Mastery Imagery Ability	5.56**	1.10	4.98	1.17
Heart Rate Reactivity (bpm)	9.65*	10.22	12.06	11.03
Stress Intensity	4.92**	1.44	5.77	1.20
Stress Interpretation	-0.98**	1.59	-1.51	1.50
Physiological Arousal Intensity	4.52**	1.44	5.15	1.28
Physiological Arousal Interpretation	-0.46**	1.49	-1.19	1.45

Note, **p* <.05, ***p* < .001 = significantly different to females.

Table 2. Mastery imagery ability and heart rate reactivity correlations with perceived stress intensity, perceived stress interpretation, perceived physiological arousal intensity, and perceived physiological arousal interpretation.

	Mastery Imagery Ability	Heart Rate Reactivity
Stress Intensity	-.277*	.050
Stress Direction	.186*	-.003
Physiological Arousal Intensity	-.216*	.063
Physiological Arousal Direction	.180*	-.016
Heart Rate Reactivity	-.087	-

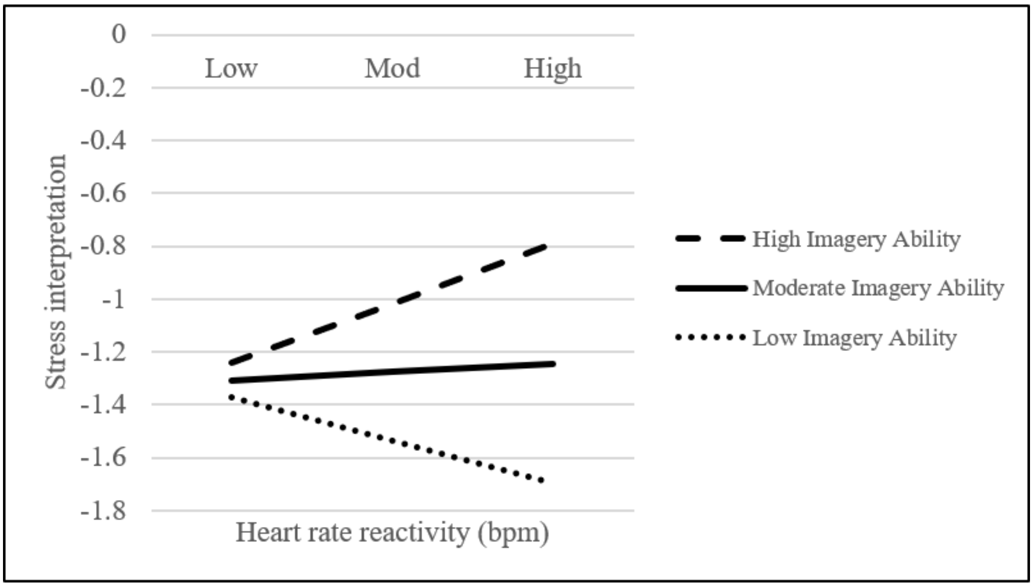
Note, **p* < .001.

Table 3. Results of the four, independent moderation analyses examining the extent to which mastery imagery ability moderates the relationship between heart rate reactivity and perceived stress and physiological arousal intensity and interpretation.

	Gender		Baseline Heart Rate		Mastery Imagery Ability		Heart Rate Reactivity (bpm)		Heart Rate Reactivity × Mastery Imagery Ability		Model Summary
Outcome Variables	β	*p*	β	*p*	β	*p*	β	*p*	β	*p*	
Stress Intensity	.701	<.001	.002	.739	-.251	<.001	<.001	.944	-.004	.399	*F*(5, 437) = 13.99 p <.001, R^2 = .14
Stress Interpretation	-.415	.009	-.001	.850	.220	<.001	-.003	.667	.015	.005	*F*(5, 438) = 6.37, p <.001, R^2 = .07
Physiological Arousal Intensity	.514	<.001	.007	.248	-.198	<.001	.003	.636	-.005	.282	*F*(5, 438) = 8.64, p <.001, R^2 = .09
Physiological Arousal Interpretation	.616	<.001	.009	.150	.168	.004	.002	.751	.013	.011	*F*(5, 438) = 9.27, p <.001, R^2 = .10

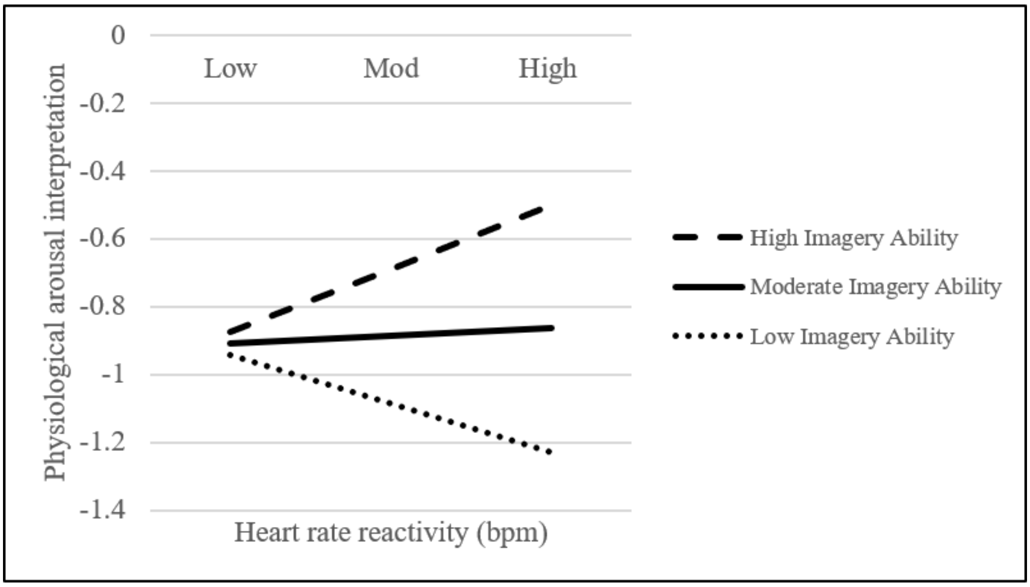
Note. Beta values are unstandardized.

Figure 1. Interaction plot depicting the moderating effect of mastery imagery ability on the relationship between heart rate reactivity and stress interpretation.



Note, Simple slope for high mastery imagery ability significant ($p < .05$).

Figure 2. Interaction plot depicting the moderating effect of mastery imagery ability on the relationship between heart rate reactivity and perceived physiological arousal interpretation.



Note, Simple slope for high mastery imagery ability significant ($p < .05$).