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The effects of arousal reappraisal on stress responses, performance and attention

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ABSTRACT

Background and Objectives: This study examined the effects of arousal reappraisal on cardiovascular responses, demand and resource evaluations, self-confidence, performance and attention under pressurized conditions. A recent study by Moore et al. [2015. Reappraising threat: How to optimize performance under pressure. *Journal of Sport and Exercise Psychology*, *37*(3), 339–343. doi:10.1123/jsep.2014-0186] suggested that arousal reappraisal is beneficial to the promotion of challenge states and leads to improvements in single-trial performance. This study aimed to further the work of Moore and colleagues (2015) by examining the effects of arousal reappraisal on cardiovascular responses, demand and resource evaluations, self-confidence, performance and attention in a multi-trial pressurized performance situation.

Design and Methods: Participants were randomly assigned to either an arousal reappraisal intervention or control condition, and completed a pressurized dart throwing task. The intervention encouraged participants to view their physiological arousal as facilitative rather than debilitative to performance. Measures of cardiovascular reactivity, demand and resource evaluations, self-confidence, task performance and attention were recorded.

Results: The reappraisal group displayed more favorable cardiovascular reactivity and reported higher resource evaluations and higher self-confidence than the control group but no task performance or attention effects were detected.

Conclusion: These findings demonstrate the strength of arousal reappraisal in promoting adaptive stress responses, perceptions of resources and self-confidence.

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Challenge; threat; psychophysiology; cardiovascular; attention

Introduction

Individual responses to pressure situations vary considerably which, according to the Biopsychosocial Model (BPSM; Blascovich, 2008) of challenge and threat, may be explained by individuals' evaluations of their personal coping resources and the situational demands (e.g., skills, uncertainty, psychological danger). The BPSM postulates that when individuals are engaged in a task, as evidenced through an increased heart rate (Seery, 2011), and are motivated to perform well, they enter into conscious, unconscious and dynamic demand and resource evaluation processes. When task demands are deemed to outweigh personal coping resources, a threat state occurs, whereas when coping

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resources are judged to match or outweigh demands a challenge state occurs; these states do not act as two dichotomous entities but are instead two ends of a bipolar spectrum (Blascovich, 2008).

A crucial component of the BPSM is that the demand and resource evaluation process results in distinct neuroendocrine and cardiovascular responses. Catecholamines (adrenaline and noradrenaline) are released in both challenge and threat states which results in an increase in sympathetic-adrenomedullary (SAM) activation. This, in turn, causes increased blood flow to the brain and muscles due to increased cardiac activity and vasodilation of blood vessels. However, a threat state is proposed to also cause a release of cortisol, resulting in pituitary-adrenocortical (HPA) activation, which causes a dampening of cardiac activation. A challenge state in comparison to a threat state is therefore characterized by relatively higher cardiac output (CO) and lower total peripheral resistance (TPR) (Blascovich & Tomaka, 1996). These indices suggest that challenge is characterized by more efficient mobilization and transportation of energy as compared with threat (Scheepers, de Wit, Ellemers, & Sassenberg, 2012).

The relationship between challenge and threat evaluations and the aforementioned physiological markers has been demonstrated in past research (Seery, 2011). For instance, challenge and threat evaluations were experimentally manipulated via instructional sets in the first of a three part study by Tomaka, Blascovich, Kibler, and Ernst (1997). The physiological responses described above were consistent with each state. Parts two and three of this research tested whether challenge and threat evaluations would follow on from the distinct physiological responses described above. As hypothesized, physiological manipulations did not result in the corresponding cognitive evaluations (Tomaka et al., 1997). This reinforces that cognitive processes may result in physiological responses which underpins the idea that changing such processes can thus influence physiological outcomes.

The BPSM further asserts that a challenge state is associated with improved performance in comparison to a threat state (e.g., Moore, Vine, Wilson, & Freeman, 2012; Vine, Freeman, Moore, Chandra-Ramanan, & Wilson, 2013). However, challenge/threat and closed skill task performance is still relatively under researched. This is surprising considering the number of instances in which such skills are performed particularly in competitive settings; they range from taking a basketball free throw to performing a tennis serve. Not only did this research aim to illustrate the performance benefits of being challenged but aimed to do so under pressure conditions. The mechanisms behind these proposed performance benefits have yet to be fully identified however, it is hypothesized that attentional control could be a key component (Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004; Turner, Jones, Sheffield, & Cross, 2012; Vine et al., 2013). Vine et al. (2013) investigated the effects of challenge and threat states on attentional control in a novel surgical task. Their findings showed that evaluating the task as a challenge, at both baseline and pressurized stages, was associated with superior attentional control and improved performance. Further support for challenge and threat states resulting in differential attention control was demonstrated by Moore et al. (2012). They found that challenged individuals reported more favorable attentional focus than threatened individuals as evidenced by an increase in their quiet eye (QE) duration (Moore et al., 2012). The QE is the final fixation or tracking gaze that occurs prior to the final movement of a task and a longer QE duration has been associated with higher levels of performance in numerous tasks (Vickers, 2009). Indeed, it is proposed to represent the time period in which critical visual information is processed (Vickers, 2009).

Limited research has explicitly tested interventions aimed at promoting challenge from a state of threat with even fewer examining such in high pressure sporting scenarios or the mechanisms behind why they might work. One promising line of research has indicated that arousal reappraisal may be an effective intervention in promoting challenge states, particularly in such pressure situations. The process of arousal reappraisal focuses on reinterpreting bodily signals such as increased heart rate, "butterflies" in the stomach, and tense muscles as being facilitative rather than debilitative. This reappraisal has been consistently linked to a more adaptive stress response, more favorable emotions, more favorable interpretation of emotions and superior task performance

(Jamieson, Peters, Greenwood, & Altose, 2016). An important factor in arousal reappraisal is that it promotes the reconceptualization of stress as a coping mechanism (Jamieson et al., 2016). By increasing perceptions of coping resources, individuals may experience elevations in their situational self-confidence regarding performance. Increases in self-confidence may therefore be a direct effect of arousal reappraisal as well as a possible mediating factor in the challenge and performance relationship.

Additional support for arousal reappraisal comes from a recent study by Moore et al. (2015) who investigated the effects of arousal reappraisal on pressurized golf putting performance. They found that following a pressure manipulation, those who received the reappraisal intervention reported more favorable cardiovascular responses, a more favorable interpretation of physiological arousal and also performed better on a pressurized single-trial golf putting task (Moore, Vine, Wilson, & Freeman, 2015). The abovementioned is the only study so far to investigate an arousal reappraisal intervention as an aid to motor performance. However, though the cardiovascular response equated to a medium effect size, it was not statistically significant. Additionally, performance was assessed via only one putt following the intervention limiting the generalizability of the performance finding among other motor tasks that may require several trials in a row such as in darts and snooker. Recent debate by authors about the replicability crisis in social psychology (e.g., Earp & Trafimow, 2015; Ioannidis, 2005; Loken & Gelman, 2017) highlights the importance of direct and conceptual replication of studies in the discipline. It is therefore of importance to test the robustness of current findings on arousal reappraisal interventions.

Furthermore possible underlying mechanisms such as self-confidence and attention were not examined in Moore et al.'s aforementioned research. Our study therefore extends their research in a novel way by examining why arousal reappraisal may facilitate and even enhance motor performance specifically under pressure conditions. Indeed, such research is not only important in academia but in applied settings as well, particularly for practitioners who may employ such interventions to enhance sporting performance. The bolstering and extension of current theory not only affects the likelihood of use but the delivery of such interventions as well.

Aims and hypotheses

The aims of the present study were to examine the influence of arousal reappraisal on challenge and threat states and pressurized motor performance as well as to identify the potential mechanisms through which these states operate (self-confidence and attention). We predicted that the intervention group would display cardiovascular measures more akin to a challenge state and report more favorable resource evaluations and higher self-confidence as compared with the control group. Further, the intervention group was predicted to outperform and display longer QE durations than the control group on the pressurized task. Finally, to explore if differences in self-confidence and QE duration mediated any between-group differences in performance, mediation analyses were conducted (Hayes, Preacher, & Myers, 2011).

Methods

Participants

Fifty-four undergraduate students (33 male, 21 female) with a mean age of 21.72 years (*SD* 3.31) agreed to take part in the study. A required sample size of 50 was calculated using G*power 3.1 software, setting power (1-β err prob.) at .8, alpha (α err prob.) at $p = .05$, and using the effect size ($d = .46$) from Moore et al. (2015). All participants were self-reported novice darts players, who had no prior formal coaching or playing experience. In addition, all participants were right handed, nonsmokers, had normal or corrected vision and had not performed vigorous exercise or ingested alcohol 24 hours before testing.

Measures

Arousal intensity and interpretation

The Immediate Anxiety Measurement Scale (IAMS; Thomas, Hanton, & Jones, 2002) was used to measure the intensity and direction of somatic anxiety. After a definition was provided, participants completed two items on a 7-point Likert scale to asses intensity (1 = not at all, 7 = extremely) and again to assess direction (−3 = a very negative effect on performance, +3 = a very positive effect on performance).

Cardiovascular

A morphology-based impedance cardiology device (Physioflow, PF05L1, Manatec Biomedical, Paris, France) was used to collect cardiovascular data during the experiment while blood pressure measurements were taken using an automatic blood pressure monitor (A&D Medical, UA-767PC, California, USA). Heart rate has been found to be a strong indicator of task engagement and both CO and TPR have been found to be viable indicators of challenge and threat states (Moore, Wilson, Vine, Coussens, & Freeman, 2013; Seery, 2011). Unlike CO values, which were taken directly from the Physioflow, TPR values were derived by using the formula: mean arterial pressure/CO * 80 (Sherwood, Dolan, & Light, 1990). Mean arterial pressure was calculated using the formula [(2 * diastolic blood pressure) + systolic blood pressure/3] (Cywinski & Tardieu, 1980). To differentiate challenge and threat states, an index was created by converting each participant's CO and TPR residualized change scores into *z* scores and summing them (as in Seery, Weisbuch, & Blascovich, 2009). Residualized change scores were calculated in order to control for baseline values. TPR was assigned a weight of −1 and CO a weight of +1, such that a larger value corresponded with greater challenge (Moore et al., 2015).

Demand and resource evaluations

The cognitive appraisal ratio (Tomaka, Blascovich, Kelsey, & Leitten, 1993) was used to assess demand and resource evaluations. Participants answered two separate questions, "How demanding do you expect the upcoming dart throwing task to be?" and "How able are you to deal with the demands of the dart throwing task?" For each question, participants rated their responses on a 6-point Likert scale (1 = not at all, 6 = extremely).

Self-confidence

The IAMS (Thomas et al., 2002) was also used to measure the intensity of self-confidence following the same procedure as the measurement of arousal intensity.

Performance (mean radial error)

Mean radial error (the average distance that the dart finished from the bullseye in cm) was recorded as a measure of performance. All throws were performed from the regulation distance (236 cm) to the facing wall where the dartboard was fixed at the regulation height (172 cm). A dart which landed in the bullseye was given a score of 0 cm. For any attempts that missed the dartboard, a maximum score of 22.5 cm (the radius of the dartboard) was recorded.

Attention

An Applied Science Laboratories (ASL; Bedford, Massachusetts, USA) mobile eye tracker was used to collect gaze data during the study. This particular make and model of mobile eye tracker has previously been used in the challenge and threat literature (Moore et al., 2013; Vine et al., 2013). The system utilizes two features: the pupil and corneal reflection (determined by the reflection of an infrared light source from the surface of the cornea) to calculate a point of gaze (at 30 Hz) relative to the eye and scene cameras. A circular cursor, representing 1° of visual angle with a 4.5 – mm lens, indicting the location of gaze in a video image of the scene, was viewed by the co-experimenter in real time on a laptop screen.

The *quiet eye duration* (QE) was operationally defined as the final fixation on the dartboard's bullseye prior to the initiation of elbow extension (Vickers, Rodrigues, & Edworthy, 2000). QE onset occurred before this extension and QE offset occurred when the gaze deviated off the bullseye by 1° or more for longer than 100 ms. Each dart thrown was analyzed using Quiet Eye Solutions software (www.QuietEyeSolutions.com) which allows frame-by-frame analysis to occur. Unfortunately, due to calibration issues (related to inadequate recording speed of the motor camera), gaze data could only be collected for 26 participants (intervention = 13, control = 13).

Procedure

The method was approved by the university ethics committee, and written informed consent was obtained from each participant prior to testing. Participants were randomly assigned to either a control ($n = 26$) or arousal reappraisal intervention ($n = 28$) group prior to entering the laboratory using an online research randomizer tool (https://www.randomizer.org). Height, weight and blood pressure measurements were recorded, after which participants were instrumented to the noninvasive cardiovascular and eye tracking devices. Following another blood pressure measurement, participants performed six baseline dart throws during which gaze measurements were recorded. Upon completion, cardiovascular data were measured in one minute intervals during a five minute baseline period (five minutes has been extensively used as a measure of true baseline in previous challenge/threat research with the last minute of baseline used for reactivity calculations e.g., Blascovich et al., 2004; Turner et al., 2013). Cardiovascular data were measured while participants were seated in an upright position. Measurements were not taken during the task due to possible movement artifacts (Siebenmann et al., 2015). Blood pressure measurements were taken alongside self-report measures at each stage of cardiovascular recordings. Following baseline recording, all participants received a pressure manipulation followed by one minute of cardiovascular recording and self-report measurements (arousal intensity and direction, demands and resources). The arousal reappraisal group then received the reappraisal intervention while the control group completed a non-demanding task designed to match for time. Another minute of cardiovascular recordings and self-report measurements (arousal intensity and direction, demands, resources and self-confidence) were taken followed by six pressurized dart throws during which gaze measurements were also recorded. Following completion, all equipment was removed and participants were thanked and debriefed about the study.

Pressure manipulation and reappraisal instructions

All participants received the pressure manipulation following their baseline set of dart throws. This manipulation was previously used by Moore et al. (2015) and was largely adapted from the manipulations used by Moore et al. (2012). To ensure an increase in pressure and task engagement, all participants were advised about the importance of the experiment; that they were going to be compared against other individuals (through an online leader board); that the top performers would be awarded prizes; and that very poor performers would be interviewed about their performance. Participants were also instructed that, following their previous six throws, they were in the bottom 30% of those tested so far, and that if they were to perform the same way again, their data would not be useable.

The control task consisted of reading a non-threatening nature article about birds which was matched for time with the delivery of the reappraisal instructions. Participants were informed that they would not be tested about the article. The reappraisal instructions were the same as those used in Moore et al. (2015), adapted from previous studies investigating arousal reappraisal (Jamieson, Mendes, Blackstock, & Schmader, 2010; Jamieson, Mendes, & Nock, 2013) and are as follows:

> In stressful situations, like sporting competition, our bodies react in very specific ways. The increase in arousal you may feel during stressful situations is not harmful. In fact, recent research has shown that this response to stress

can be beneficial and aid performance in stressful situations. Indeed, this response evolved because it helped our ancestors survive by delivering oxygen to where it was needed in the body to help address stressors. Therefore, before and during the upcoming dart throwing task, we encourage you to reinterpret your bodily signals and any increases in arousal as beneficial and remind yourself that they could be helping you perform well.

Statistical analysis

In order to check for task engagement, a dependent *t*-test was used to compare heart rate reactivity at baseline and post-pressure manipulation, and show that across both groups task engagement was present (Blascovich, 2008). To examine the effects of the intervention, a 2 (time: post-pressure manipulation, post-intervention/control) × 2 (group: control, intervention) mixed ANOVA was conducted with the challenge and threat index (CTI) as the dependent variable. A further two 2 (time: baseline, pressurized) × 2 (group: control, intervention) mixed ANOVAs were conducted with mean radial error and QE duration as the dependent variables. A MANOVA was conducted on the self-report data: arousal intensity, arousal interpretation, demands, resources and self-confidence. Effect sizes were calculated using partial eta squared ($\eta(2/\rho)$). Finally, to determine if differences in self-confidence and QE duration mediated any between-group differences in performance, mediation analyses were performed using the PROCESS add-on for SPSS (version 2.16) (Hayes, 2013). Recent developments in statistical analyses software, like PROCESS for example, have allowed for the implementation of inferential tests of indirect effects of *X* (group) on *Y* (performance) without making unnecessary assumptions about the shape of its sampling distribution (Hayes, 2013). Furthermore, this add-on allows for the testing of indirect effects regardless of the significance for the individual paths in the mediation model (Hayes, 2013).

Results

Cardiovascular responses

The dependent *t*-test showed that both groups' heart rates significantly increased from baseline, $t(51) = 6.04$, $p < .001$, $d = 1.18$, confirming task engagement and permitting the subsequent investigation of challenge and threat states. The ANOVA on the CTI[1] data revealed no significant effect for Time, $F(1, 43) = .00$, $p = .98$, $\eta(2/\rho) = .00$, and no significant effect for Group, $F(1, 43) = .18$, $p = .66$, $\eta(2/\rho) = .00$. However, a significant interaction between group and time was found, $F(1, 43) = 5.63$, $p = .02$, $\eta(2/\rho) = .11$. *Post-hoc t*-tests with a Bonferroni correction to the alpha revealed that there was no significant difference between groups following the pressure manipulation, $t(46) = 1.92$, $p = .06$, $d = 0.53$ but there was a significant difference between groups following the intervention/control task, $t(44) = -3.08$, $p < .025$, $d = 0.90$ with the intervention group displaying a significantly higher CTI than the control group (see Table 1).

Self-report data

The multivariate result was significant for group, Wilks' Lambda = .78, $F(5, 48) = 2.72$, $p = .03$, $\eta(2/\rho) = .22$ indicating a difference in self-report data by group following the intervention. The univariate *F*-tests showed there was a significant difference between the intervention and control groups for resource evaluations, $F(1,52) = 8.71$, $p = .01$, $\eta(2/\rho) = .14$ and self-confidence, $F(1, 52) = 7.43$, $p = .01$, $\eta(2/\rho) = .13$ with the intervention group reporting both higher resources and self-confidence than the control group (see Table 1).

Performance – mean radial error

The ANOVA revealed that there was a significant main effect for Time, $F(1, 48) = 12.21$, $p = .001$, $\eta(2/\rho) = .20$, with participants performing better at the pressurized time point (see Table 1.).

Table 1. Means and standard deviations of demands, resources, self-confidence, cardiovascular reactivity, performance and QE data for control and intervention groups.

	Control		Intervention	
	M	*SD*	*M*	*SD*
Demand evaluation	2.88	1.28	2.64	1.16
Resource evaluation	3.92	1.02	4.68*	0.86
Self-confidence	3.23	1.45	4.21*	1.2
Post-pressure manipulation CTI	0.44	1.63	−0.43	1.50
Post-intervention/Control CTI	−0.26	0.98	0.61**	0.91
Baseline mean performance (cm)	11.05	2.84	9.29	3.28
Pressurized mean performance (cm)	9.80	3.68	7.65	2.82
Baseline QE duration (ms)	392.03	241.78	540.68	324.32
Pressurized QE duration (ms)	638.52	511.57	687.75	350.33

Note: Significantly different from control group.
*$p < .05$; significantly different from control group.
**$p < .01$.

There was also a significant main effect for Group, $F(1, 48) = 5.02$, $p = .03$, $\eta(2/\rho) = .95$, with the intervention group participants performing better at both time points. However, there was no significant interaction effect, $F(1, 48) = .12$, $p = .72$, $\eta(2/\rho) = .00$.

QE duration

The ANOVA, revealed that there was no significant effect for Time, $F(1, 22) = 2.15$, $p = .16$, $\eta(2/\rho) = .09$. There was also no significant effect for Group, $F(1, 22) = 1.82$, $p = .19$, $\eta(2/\rho) = .08$ and no significant interaction effect either, $F(1, 22) = .002$, $p = .96$, $\eta(2/\rho) = .00$.

Mediation

A significant total effect of *X* (group) on *Y* (performance) is not a prerequisite for examining the significance of indirect effects (Preacher & Hayes, 2004) permitting the testing of such. In other words, the significance of the total effect of group on performance is not pertinent to whether the indirect effect is significant. Therefore, to test if the effect of group on performance was indirectly affected by any of the process variables, experimental group (coded challenge = 1, threat = 0) was entered as the independent variable, mean radial error was entered as the dependent variable, self-confidence and QE duration were entered separately. Based on a 10,000 sampling rate, the results from bootstrapping revealed no significant indirect effects for self-confidence 95% CI = −3.44 to 0.65 or QE duration, 95% CI = −5.34 to 0.71 (see Table 2).

Discussion and conclusions

Facilitative stress responses, such as challenge states, have been consistently linked with a number of positive physiological, psychological and performance outcomes (Blascovich, 2008). Interventions which help to promote such responses are therefore highly beneficial to performers across a range of situations and tasks. One such intervention which has previously received support, arousal reappraisal, was investigated here. The current study aimed to add to the robustness of

Table 2. Mediation results for self-confidence and QE duration.

	Effect	SE	LL95% CI	UL 95% CI
Self-confidence	−1.39	1.02	−3.44	0.65
QE duration	−2.31	1.46	−5.34	0.71

Note: LL: lower limit; CI: confidence interval; UL: upper limit.

previous findings which have supported the effectiveness of this intervention (e.g., Moore et al., 2015). Further, this research is novel in its investigation of why arousal reappraisal might positively influence performance through the examination of potential underlying mechanisms namely, self-confidence and attention. Compared to a control group, the arousal reappraisal group displayed cardiovascular markers indicative of a challenge state and reported more favorable resource evaluations as well as higher self-confidence. There were no effects of the intervention on performance or attention. Furthermore, neither self-confidence nor attention mediated the group and performance relationship.

Following the intervention, the arousal reappraisal group was significantly more challenged than the control group. The arousal reappraisal intervention therefore resulted in a more efficient and adaptive cardiovascular response for this group. Arousal reappraisal is proposed to break the link between negative affective experiences and malignant physiological responses by reframing the meaning of the physiological signals that accompany stress (Jamieson et al., 2013). Interestingly, there were no differences between groups in the interpretation of arousal following the intervention/control task. However, resource evaluations were significantly higher for the intervention group than the control group suggesting that arousal reappraisal's effectiveness in promoting challenge may be via its positive consequences on coping. Indeed, research recent on arousal reappraisal in educational settings has supported this conclusion (Jamieson et al., 2016).

The intervention group also reported higher self-confidence as compared with the control group. This increase in self-confidence is in line with the predictions of the Theory of Challenge and Threat states in Athletes (TCTSA; Jones, Meijen, McCarthy, & Sheffield, 2009) which suggests that self-efficacy, state self-confidence, is a critical determinant of challenge and threat.

The arousal reappraisal intervention did not improve performance, above that achieved by the control group. Indeed, both groups performed better during the pressurized trials. According to the Attentional Control Theory (ACT; Eysenck, Derakshan, Santos, & Calvo, 2007), anxiety may not impair quality of performance when it leads to the use of compensatory strategies. Such strategies may range from increased effort to the increased use of processing resources (Eysenck et al., 2007). Therefore, both groups may have utilized compensatory strategies in order to prevent performance decrements in the pressurized performance situation. On the other hand, it may be that other factors, such as perceptions of control and achievement goals, are more instrumental in the challenge/threat and athletic performance relationship (as suggested in the TCTSA; Jones et al., 2009). Indeed, modifying the pressure manipulation in order to manipulate goal orientations may yield differential performance outcomes in future research. Additional future research should examine possible compensatory strategies, employ another type of motor task or utilize different measurement outcomes.

The ANOVA on QE duration revealed no significant effects for time, group or an interaction. Though QE duration has been previously shown to be a gaze measure affected by high levels of performance pressure and anxiety (e.g., Behan & Wilson, 2008; Wilson, Wood, & Vine, 2009), it is probable that it is not a sensitive enough measure of attention in novices. Standard deviations of QE durations were high in both groups indicating high variability amongst participant measures across groups. Furthermore, on a methodological note, *post-hoc* power analyses indicated that the study was underpowered ($1-\beta$ err prob. = 0.3) to find QE effects meaning there is scope for future research to reexamine this avenue with a larger sample.

Mediation analyses revealed that neither levels of self-confidence nor QE duration mediated the relationship between challenge/threat and performance. Therefore, while self-confidence may be an antecedent of challenge and threat, it may not result in performance consequences. While similar conclusions may also be made for QE duration, discounting attention as an underlying mechanism of challenge/threat and performance would be ill-advised. Utilizing a differential on-line attentional measure such as target locking (e.g., Vine et al., 2013) may provide better evidence for these relationships.

The current study has several theoretical and practical implications. The reappraisal intervention was successful in leading to more efficient cardiovascular adaptations. As aforementioned, the proposed theoretical view that arousal reappraisal influences stress responses via reframing physiological arousal may not fully explain this relationship. It may however, be explained via an increase in the perception of an individual's coping resources among other factors. This leaves scope for future research to assess possible moderators such as social support; validation for such has recently come from work by Slater, Evans, and Turner (2016) who highlighted the importance of social support in promoting a positive reappraisal of stress. The authors proposed that psychological factors such as social identity and social support may enhance resource appraisals and/or reduce demand appraisals thereby increasing the chances of evaluating stressful situations as challenge states rather than threat states (Slater et al., 2016). From a practical viewpoint, our findings suggest that arousal reappraisal could act as a low-resource intervention to help promote challenge states. Arousal reappraisal can be incorporated into performer-focused cognitive behavioral therapy to promote adaptive stress responses (Baron, Baron, & Foley, 2009). Finally, as the cardiovascular responses associated with recurrent threat evaluations may be adverse to health (Blascovich, 2008), arousal reappraisal may be a protective factor via its role in promoting challenge.

Limitations of the current study include the lack of measures of compensatory strategies which would have allowed for a better understanding of challenge/threat and performance. Furthermore, additional measures of attention should have been recorded and analyzed in order to more systematically assess whether attention is an underlying mechanism of the challenge/threat-performance relationship.

To conclude, the current study demonstrated the benefits of arousal reappraisal in leading to more facilitative cardiovascular responses, perceptions of resources and self-confidence. Findings support the notion that arousal reappraisal is effective in promoting a more adaptive stress response in pressurized motor performance situations. Future research should examine the intricacies of how arousal reappraisal leads to challenge/threat and how this subsequently affects motor-task performance in pressurized situations.

Note

1. CO means for the control and intervention groups were $M = 0.25$, $SD = 0.39$ and $M = 0.14$, $SD = 0.44$ respectively while TPR was $M = -94.17$, $SD = 119.88$ and $M = -33.5$, $SD = 160.36$ respectively. Following the intervention/control task, CO means for the control and intervention groups were $M = -0.45$, $SD = 0.98$ and $M = 0.01$, $SD = 0.66$ respectively while TPR was $M = 87.07$, $SD = 118.7$ and $M = 1.16$, $SD = 272.18$ in that order.

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