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Mindfulness, reinvestment, and rowing under pressure: Evidence for moderated moderation of the anxiety-performance relationship

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ABSTRACT

Objectives: Our study had two objectives. First, we examined the relationship between dispositional sport-specific mindfulness and rowing performance. Second, we investigated whether dispositional sport-specific mindfulness moderated the moderating effect of conscious processing on the anxiety-performance relationship.
Design: Cross-sectional field study. Participants took part in a competitive race and completed a survey after the race.
Method: Rowers ($N = 270$) completed post-race measures of mindfulness, rowing specific reinvestment, perceived performance, anxiety and demographics. We also determined actual rowing performance.
Results: Mindful refocus was positively associated with perceived and actual performance, whilst non-judgemental thinking was only positively associated with perceived performance. Rowing specific Conscious Motor Processing (RS-CMP) moderation effect on the anxiety-performance relationship was attenuated by high levels mindful awareness, this was true for both actual and perceived performance. Rowing specific movement self-consciousness (RS-MSC) moderation effect on the anxiety-performance relationship was moderated by non-judgmental thinking but only for perceived performance.
Conclusion: Our findings provide initial support that dispositional mindfulness may benefit performance under pressure and that this may be through the attenuation of reinvestment processes. Furthermore, the result demonstrated that mindful awareness and non-judgmental thinking may act on distinct reinvestment processes.

1. Introduction

Competitive athletes face demands that heighten pressure to perform successfully, such as evaluative audiences, fear of failure, not living up to expectations, and monetary rewards for the winners. Pressure increases anxiety, which can negatively impact performance (Ford et al., 2017). Athletes, sport psychologists and researchers have sought ways to prevent poor performance. One such candidate is mindfulness. *Mindfulness,* defined as paying attention to the present moment in a non-judgemental and non-reactive way (Kabat-Zinn., 2013), has been associated with better performance under pressure (Gooding & Gardner, 2009; Moen et al., 2015; Röthlin et al., 2016; Thompson et al., 2011). Nevertheless, the exact the link between mindfulness and performance is still up for debate, with many candidates (Birrer et al., 2012; Röthlin et al., 2016; Shaabani et al., 2019). Building upon this literature, the current field study was designed to examine the link of mindfulness on performance during sporting competition.

1.1. Anxiety–performance relationship

Competition can be a demanding context, with many performance stressors, including audience, coach and team expectations, self-presentation and rivalry, that can induce anxiety (Mellalieu et al., 2009). Nevertheless, the research exploring anxiety and performance in competition has been fairly inconsistent, with beneficial, detrimental, and no effects reported (Ford et al., 2017). Personality psychologists have proposed that the inconsistent evidence may be explained by an interactionist perspective, where situational demands interact with individual characteristics to determine how someone acts (Tett & Guterman, 2000). Therefore, the effect of anxiety on performance is determined by both the situation and the person (Ford et al., 2017).

Every athlete is characterized by personality traits that are relatively stable across different situations (Tett & Guterman, 2000). Recently, researchers have proposed that personality-trait-like individual differences (PTLID) influence our coping response to stress, consequently

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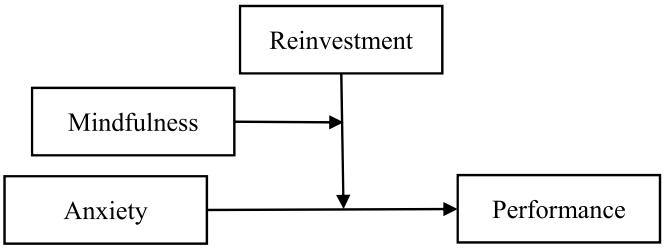

Fig. 1. Hypothesised moderated moderation of the anxiety-performance relationship by reinvestment and mindfulness.

determining whether an athlete's performance is better or worse under pressure (Laborde & Allen, 2015). According to trait-activation theory, traits are not always activated, and only traits relevant to the situation are activated by the specific context-dependent factors and cues (Geukes et al., 2013). In sum, performance depends on both the athlete and the situation. Therefore, whether an athlete performs poorly in competition is a function of specific situational cues, traits, and/or their interaction.

One such PTLID is reinvestment. Dispositional reinvestment captures an athlete's tendency to recall rule-based knowledge of the skill to consciously control their movements, which disrupts automatic (unconscious) motor processes thereby impairing performance (Masters & Maxwell, 2008). Research evidence suggests that anxiety combined with trait reinvestment negatively impacts performance (Chell et al., 2003; Masters et al., 1993; Masters & Maxwell, 2008). High reinvestors are less likely to perform motor skills successfully, such as golf putting (Masters et al., 1993), hockey dribbling (Jackson et al., 2006), football volleying (Chell et al., 2003), and basketball free throwing (Orn, 2017). Furthermore, they are more susceptible to disrupted performance under pressure (Iwatsuki & Wright, 2016; Masters et al., 1993). Reinvestment may be associated with choking under pressure, a phenomenon defined as a significant and sudden drop from one's typical performance level (Baumeister, 1984; Mesagno & Hill, 2013). For instance, squash and tennis club players rated as 'chokers' by their club captains or presidents reported higher reinvestment scores than non-chokers (Masters et al., 1993). Similarly, baseball players who suffer from the yips, considered a chronic form of choking, where the athlete suffers from a lack of ability to execute a specific movement pattern due to increased level of self-focus (Bennett et al., 2016), are higher reinvesters (Gutierrez, 2018). Overall, these findings suggest that reinvestment is an

Table 1
Descriptive statistics and pearson correlations between reinvestment, mindfulness, anxiety, and performance.

Variable	*M*	*SD*	α	ω	1	2	3	4	5	6	7	8	9
1. RSRS	4.84	.92	.89	.86									
2. RS-CMP	5.07	.91	.88	.83	.79***								
3. RS-MSC	4.61	1.26	.87	.85	.90***	.44***							
4. Overall Mindfulness	4.51	0.70	.73	.70	-.19**	.09	-.34***						
5. MF Awareness	5.25	0.96	.73	.73	.11	.16**	.05	.51***					
6. MF Non-judgment	3.29	1.41	.84	.84	-.35***	-.14*	-.42***	.72***	.00				
7. MF Refocus	5.00	1,02	.79	.78	-.01	.22**	-.18**	.59***	.10	.10			
8. MRF-L	5.80	1.01	.76	.78	.26***	.05	.34***	-.29***	.10	-.24***	-.37***		
9. Race performance	47.0	31.4	N/A	N/A	-.12*	-.06	-.13*	.16**	.05	.10	.16*	-.11	
10. Perceived performance	4.92	1.07	.80	.80	-.06	.03	-.06	.33***	.11	.23***	.26***	-.34***	.19**

Note: *$p < .05$, **$p < .01$, ***$p < .001$. RSRS = Rowing-Specific Reinvestment Scale, MF Awareness = Mindful Awareness, MF Non-judgment = Mindful Non-judgment, MF Refocus = Mindful Refocus, MRF-L = State Anxiety. The possible range of scores for reinvestment, mindfulness and perceived performance were 1–7. The range for MRF-L was 1–11.

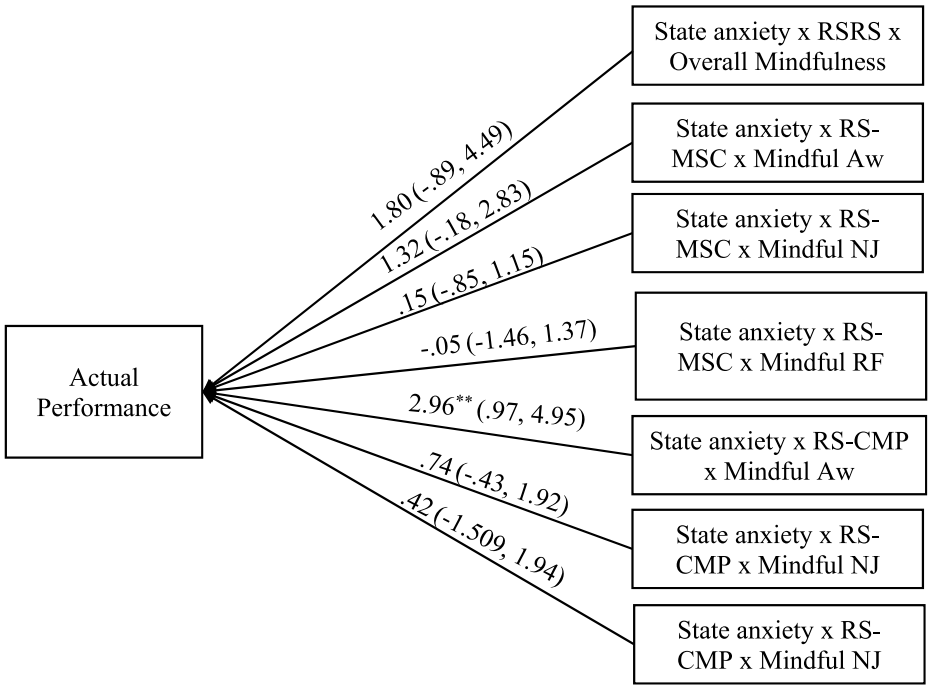

Fig. 2. Unstandardized regression coefficients for significant the moderated-moderation of rowing-specific reinvestment and mindfulness models on the relationship between state anxiety and actual performance. *$p < .05$; ***$p < .01$; p < .001***.

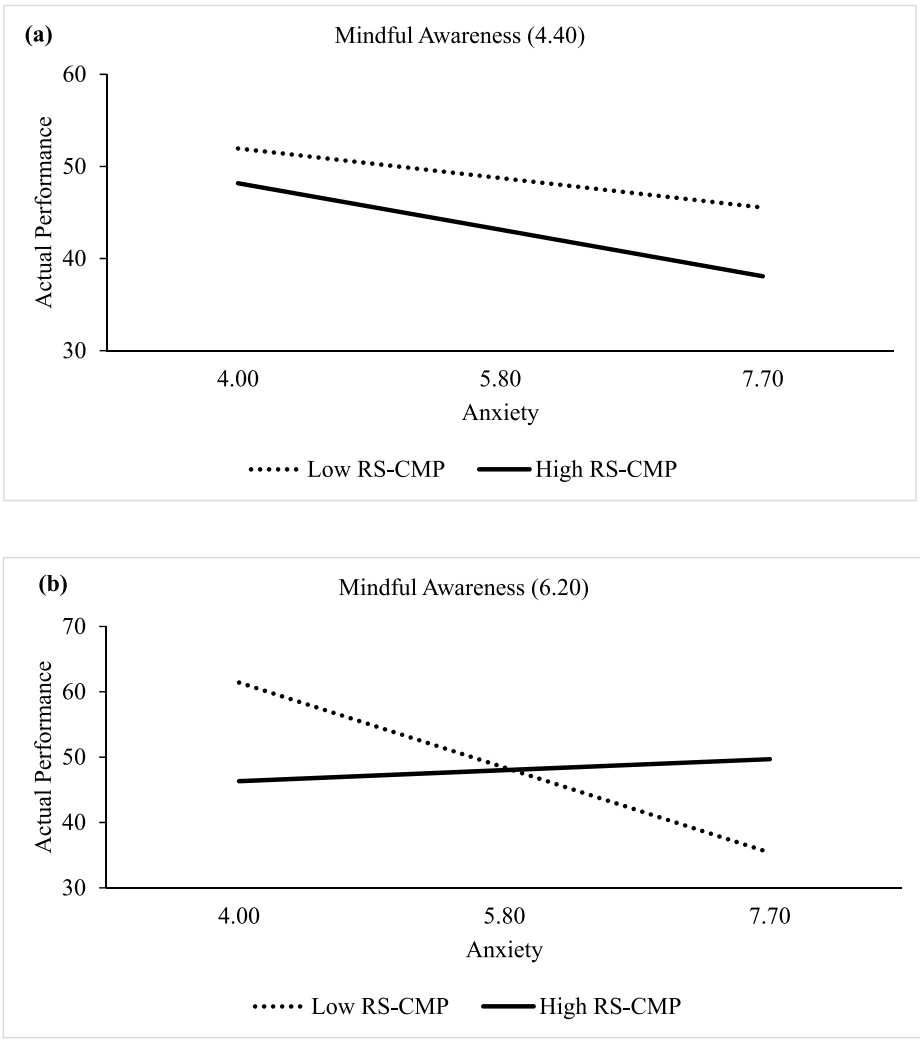

Fig. 3. a and b. Moderated Moderation of Mindful Awareness on RS-CMP for the Anxiety-Performance relationship. Low RS-CMP (4.24), High RS-CMP (6.02).

undesirable trait that increases an athlete's likelihood of underperforming.

Research studies have also demonstrated that state reinvestment, whereby an individual has explicit awareness and conscious control of their movement (i.e., conscious processing), is associated with poor performance. For instance, participants who reported high conscious processing exhibited poor putting performance under competitive pressure (Cooke et al., 2011; Gallicchio et al., 2016). Moreover, cortical measures of conscious processing, based on electroencephalographic cortico-cortical communication between temporo-frontal regions of the cortex, have been implicated in poor performance under competitive and evaluative pressure (Gallicchio et al., 2016; Zhu et al., 2011). High coherence between the left temporal region, which has been associated with verbal-analytical processing (cf. Bellomo et al., 2020), and the frontal region, which controls motor planning, is claimed to reflect high levels of conscious processing. This manifests in an athlete excessively consciously controlling their well-learnt skills leading to an impairment of their automatic motor processes, and subsequently to poor performance.

These studies suggest that conscious processing of movements during skill execution under pressure, similar to that witnessed in sporting competition, can impair performance. However, we still do not know what interventions (e.g., by coaches and sport psychologists) can be used to prevent reinvestment. Mindfulness could form the basis for such an intervention, as it promotes the capacity to automatically engage with the motor skills rather than reinvest (Röthlin et al., 2016).

1.2. *Mindfulness*

Mindfulness is a Buddhist and Eastern spiritual concept, cultivated through religious and meditative practices (Kabat-Zinn, 2013), that has been adapted for use in a non-spiritual Western context. It is described as both a state and a trait and is characterized by attending to present moment experiences in an accepting non-judgemental and non-reactive manner (Kabat-Zinn, 2013; Thienot et al., 2014). Mindfulness, although a single construct, comprises different components, these have been found to have distinct roles in psychological functioning (Baer, 2016). Three components of mindfulness have been proposed to be key for sport performance: non-judgement, refocus, and awareness (Gardner & Moore, 2007; Thienot et al., 2014). Non-judgemental thinking allows performers to possess experiential acceptance therefore they accept a poor movement or decision or an unexpected situation without self-castigation (Birrer et al., 2012). Mindful refocus enables the athlete to shift their attention away from task-irrelevant information, thereby permitting them to focus on present relevant stimuli and to avoid distraction (Thienot et al., 2014). Lastly, mindful awareness promotes present-moment awareness, as it allows for individuals to de-centre from their thoughts and emotions, therefore they are able to observe them from a distance without interacting with them (Röthlin et al., 2020). Although, all three components may have a distinct impact on

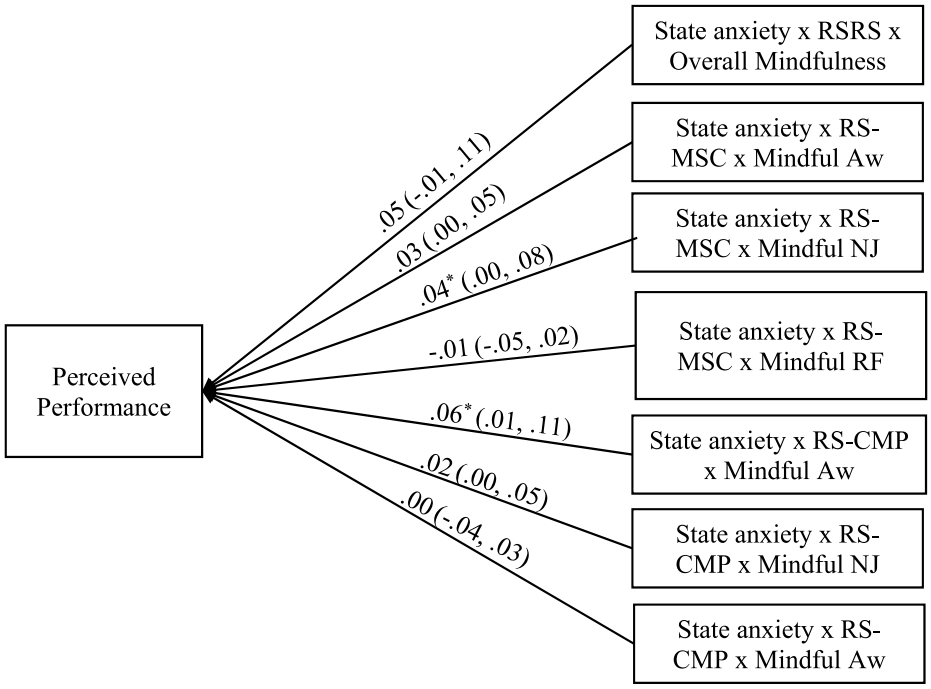

Fig. 4. Unstandardized regression coefficients for significant the moderated-moderation of rowing-specific reinvestment and mindfulness models on the relationship between state anxiety and perceived performance *$p < .05$; ***$p < .01$; p < .001***.

performance, the majority of studies have investigated mindfulness as a single construct, therefore limiting our understanding of mindfulness on performance.

Mindfulness interventions, such as Mindful Sport Performance Enhancement (Kaufman et al., 2009) and Mindfulness-Acceptance-Commitment (Gardner & Moore, 2007), have been used to enhance sport performance (Röthlin & Birrer, 2020; Röthlin et al., 2020). These interventions reduce competitive trait anxiety (Kaufman et al., 2009; Scott-Hamilton et al., 2016) and task-irrelevant thoughts (Bühlmayer et al., 2017). They also increase flow which is a state of consciousness in which an individual is completely absorbed by their actions (Thompson et al., 2011). People who experience flow often report a sense of automaticity, control, confidence and superior performance under pressure (Scott-Hamilton et al., 2016). In many ways, flow is opposite to reinvestment, especially in terms of reduced verbal-analytic processing and increased performance-related automaticity (Harris et al., 2017). Therefore, it is unsurprising that direct links have been noted between mindfulness interventions and improvements in performance (Zhang et al., 2016).

Mindfulness interventions cultivate athletes' trait mindfulness (Bühlmayer et al., 2017), with studies finding that increases in trait mindfulness were associated with improved performance (Gooding & Gardner, 2009; Thompson et al., 2011), flow (Kee & Wang, 2008; Perry et al., 2017; Scott-Hamilton et al., 2016) confidence (Kaufman et al., 2009), and decreased anxiety (Scott-Hamilton et al., 2016). An emerging body of literature on the mindfulness-performance relationship has demonstrated that trait mindfulness was associated with better perceived performance in sports, such as hockey, cycling, and athletics (Moen et al., 2015), and perceived performance in highly demanding situations in sports, such as cycling and athletics, over the past three months (Röthlin et al., 2016).

One limitation of the two trait mindfulness studies discussed above (Moen et al., 2015; Röthlin et al., 2016) is that they examined only perceived performance not actual performance. Perceived performance is not always accurate, as it is a subjective measure that can be influenced by various factors, for example, the athlete's performance outcome: if their team has won, they may rate their performance high even if they had not individually performed well. Therefore, actual performance is important as it is objective and therefore provides a more valid measure of performance. Consequently, the association between trait mindfulness and performance in competition, warrants further investigation.

1.3. Mindfulness and reinvestment

Mindfulness is related to sport success under pressure, but the process underlying this relationship has yet to be established (Birrer et al., 2012). One of the proposals is that mindfulness reduces reinvestment's (conscious processing) moderating effect on the anxiety-performance relationship. This attenuating effect may be due to mindfulness, unlike reinvestment, enables individuals to regulate their inward attention to avoid step-by-step processing of their movements thereby maintaining automaticity of movement execution (Josefsson et al., 2017). Alternatively, mindfulness facilitates increased experiential acceptance, which manifests as non-judgmental acceptance of unexpectedly poor performance. Consequently, the athlete should not ruminate about the cause of the poor performance (i.e., the fault) and try to excessively consciously control (reinvest) their movements to prevent a reoccurrence (Birrer et al., 2012; Shaabani et al., 2019). Therefore, through regulation of attention or/and increased experiential acceptance, automaticity is facilitated rather than disrupted during skill execution, minimising reinvestment.

1.4. Current study

Research on the anxiety-performance relationship has yielded inconsistent results (Ford et al., 2017). Nevertheless, performance is negatively impacted when anxiety is combined with reinvestment (Chell et al., 2003; Masters et al., 1993; Masters & Maxwell, 2008). Researchers have sought ways to reduce or stop reinvestment. One such candidate is mindfulness. Trait mindfulness has been found to play a positive role in performance, however, most research has been in precision sports and perceived performance (Bühlmayer et al., 2017). Despite this, it has been proposed that mindfulness may reduce the influence of

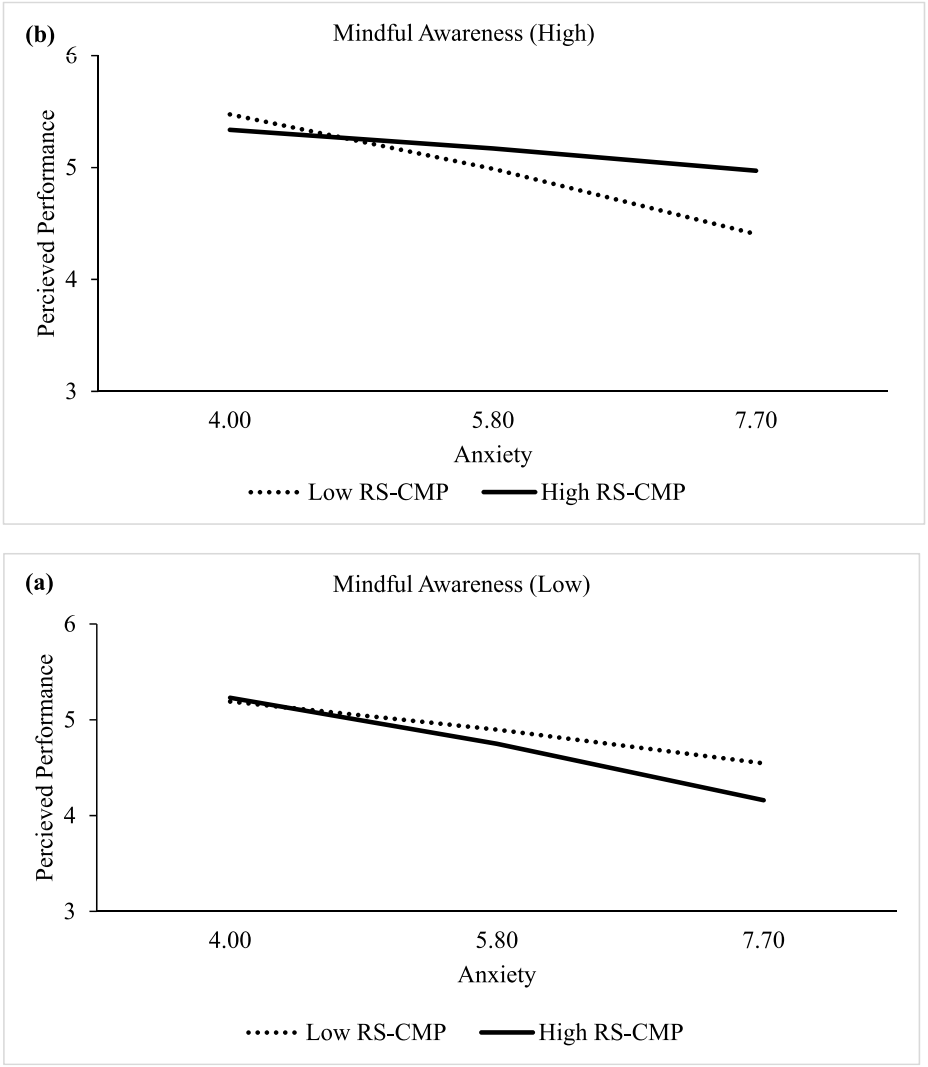

Fig. 5. a and b. Moderated Moderation of Mindful Awareness on RS-CMP for the Anxiety-Perceived Performance relationship. Low RS-CMP (4.24), High RS-CMP (6.02).

reinvestment on the anxiety-performance relationship (Birrer et al., 2012; Perry et al., 2017).

Our study purposes were twofold. Our first study purpose was to examine the relationship between trait sport-specific mindfulness and rowing performance. Consistent with the limited evidence exploring trait mindfulness on performance (Jones et al., 2020), we hypothesised that trait sport-specific mindfulness would be positively related to performance during rowing races on the water. Our second study purpose was to investigate whether trait sport-specific mindfulness moderated the moderating effect of reinvestment on the relationship between anxiety and performance. Based on arguments that mindfulness should reduce reinvestment (Birrer et al., 2012; Röthlin et al., 2016; Shaabani et al., 2019) and evidence that mindfulness regulates attentional processes (Röthlin et al., 2020), we hypothesised that higher trait mindfulness would attenuate the amplifying effect of rowing-specific state reinvestment on the anxiety-performance relationship (see Fig. 1).

2. Method

2.1. Participants

The sample included 270 competitive rowers (175 females, 95 males), 74% senior age (18–26 years) and 26% masters age (M = 43–49 age category, SD = 1.9 age categories) with at least one year of experience (M = 5.40, SD = 6.13 years). Competitive standards ranged through novice (22%), intermediate (67%), and elite (11%). These standards based on the British Rowing race classification categories (https://www.britishrowing.org/wp-content/uploads/2015/09/Rules-of-Racing-2016-Final.pdf?41e6e6). All rowers gave informed consent to participate.

2.2. Measures

2.2.1. Mindfulness

The Mindfulness Inventory for Sport (MIS) scale (Thienot et al., 2014) was used to measure sport-specific trait mindfulness. The MIS is a 15-item scale that consists of three subscales, each formed by five items measuring mindful awareness (e.g., "I am able to notice the sensations of excitement in my body"), non-judgemental thinking (e.g., "When I become aware that I am really upset because I am losing, I criticise myself for reacting this way"), and refocusing (e.g., "When I become aware that I am tense, I am able to quickly bring my attention back to what I should focus on"). Participants were asked to indicate how much each statement was generally reflective of what they experienced during a typical race, on a scale of 1 (not at all) to 7 (very much). The non-judgemental subscale items were reverse scored. The scale has

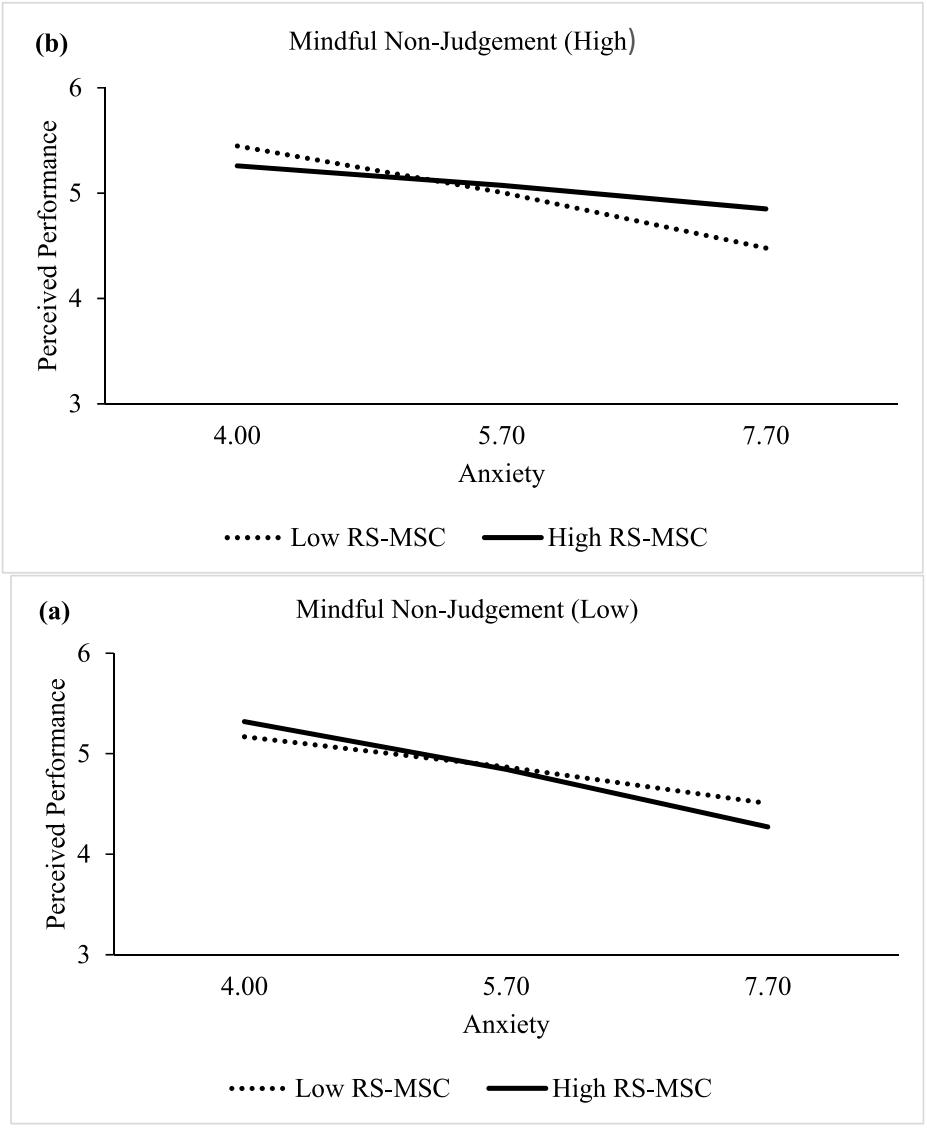

Fig. 6. a and b. Moderated Moderation of Mindful Non-Judgement on RS-MSC for the Anxiety-Perceived Performance relationship. Low RS-MSC (3.43), High RS-MSC (6.00).

demonstrated good validity and reliability with alpha coefficients above 0.70 the subscales and overall scale (Thienot et al., 2014). The mean of the items for each subscale were calculated to measure Mindful Awareness, Mindful Non-judgement, and Mindful Refocus.

2.2.2. Rowing-Specific Reinvestment Scale (RSRS)

A sport-specific state version of the Movement Specific Reinvestment Scale (MSRS) (Masters et al., 2005) was used to measure the conscious processes of rowing movements (Sparks et al., 2021). This 12-item scale is comprised of two subscales, the RS-CMP and RS-MSC. Six items form the RS-CMP subscale (e.g., "I paid attention to how I carried out my rowing movements"), and six items form the RS-MSC subscale (e.g., "I believed that everyone was just looking at me and scrutinising my rowing"). Items were rated on a 7-point Likert scale, anchored from 1 (strongly disagree) to 7 (strongly agree). The mean of the items for each subscale were calculated to measure RS-CMP and RS-MSC.

2.2.3. Anxiety

The Mental Readiness Form-Likert (MRF-L, Krane, 1994) was used to measure state somatic and cognitive anxiety. The MRF-L consists of three-items, which include cognitive anxiety (my thoughts were: Calm – Worried), somatic anxiety (my body felt: Relaxed – Tense), and self-efficacy (I felt: Confident – Scared). Individuals rated their levels of each item on an 11-point Likert scale with the low end of the scale reflecting desirable ratings (i.e., very calm and not worried) and the upper end depicting undesirable ratings (i.e., very worried and not calm). The MRF-L has previously demonstrated good convergent validity, with larger positive correlations between the MRF-L items and the CSAI-2 subscales (Martens et al., 1990), namely, 0.68 for self-confidence, 0.69 for somatic anxiety, and 0.76 for cognitive anxiety (Krane, 1994).

2.2.4. Perceived and actual performance

Perceived performance was measured using a rowing-specific version of the perceived performance scale used in previous research (e.g., Al-Yaaribi et al., 2016). The measure used a 7-point Likert scale, requiring participants to rate themselves between 1 ("very poor") and 7 ("excellent"). The perceived performance measure consisted of technical (i.e., stroke, timing, optimal catches), tactical (i.e., positioning, race awareness), physical (i.e., acceleration, power, endurance), psychological (i.e., focus, mental toughness, confidence), and overall performance. The perceived performance measure has previously, in other

sports, demonstrated very good reliability with an alpha coefficient of 0.87 (Al-Yaaribi et al., 2016). The mean of the items was calculated to measure overall perceived performance.

Actual performance was measured using race finishing positions. Although based on performance of the boat (i.e., the whole crew) this measure is representative of each rower's contribution to overall performance, as every single crewmember contributes equally to the speed of the boat (Cuijper et al., 2017). If one rower makes a fault or inefficient stroke, then this impacts the overall speed. Each participant provided information about their race, which enabled us to identify their boat's finishing position (e.g., second out of six boats) by examining the official race results. Using Sparks et al. (2021) relative ranking system to standardize across races (i.e., the number of boats in the race) the information was used to compute actual performance. The ranking system was expressed as a percentage score using the following formula: score = (100/(total number of boats in the race – 1) × (total number of boats in the race – finish position of the boat in the race)). For example, if a boat came third out of six, that boat would receive a percentage score of 60%, as the formula would be: ((100/(6–1) x (6–3)) = 60. Using a ranking system over objective finish times allowed for races to be compared across different regattas and race formats, as some events only had two boats whilst others had up to eight. Therefore, a boat finishing second out of two boats arguably has not done as well as a boat that finishes second out of five boats, as the latter boat has held off three other boats.

2.3. Procedure

Following ethical approval, clubs that were hosting or competing in regattas were emailed a recruitment poster. The poster specified the study's aim, information about participant involvement, and a link to the questionnaire that they could advertise on social media platforms or email to club members after competing in or hosting a regatta. In addition, the researcher visited a number of national regattas, ranging from 500 m to 2000 m races, in the West Midlands and administered a hard paper copy of the questionnaire after a race. Therefore, following their race, participants completed the questionnaire online ($n = 132$) or by paper copy ($n = 138$).[1] Before completing the questionnaire, rowers were provided with written information, which described the research aims, confirmed that all responses would be confidential, and explained that participants had the right to withdraw from the study at any time. Recruitment occurred between May and September 2019.

2.4. Data analysis

We examined the internal consistency of the scales by using SPSS to compute Cronbach's alpha coefficient (Cronbach, 1951) and the MBESS package for R to compute McDonald's omega coefficient with bootstrapping of 10,000 (Dunn et al., 2014; McDonald, 1999). GPower 3.1.5 (Faul et al., 2007) indicated that with a sample size of 270, our study was powered at .80 to detect significant ($p < .05$) associations between variables using Pearson correlations corresponding to a small-to-medium ($r = 0.17$) effect size (Cohen, 1992). It was also powered to detect a small effect size ($f^2 = 0.04$) using multiple regression, with three predictor variables.

Our main data analysis was performed analysed using SPSS Version 26 (IBM). To examine our first study purpose, we conducted Pearson correlations to examine the relationships between reinvestment, RSRS, RS-CMP, RS-MSC, overall mindfulness, the three components of mindfulness, anxiety, and performance. To examine our second study purpose, we used the PROCESS macro for SPSS, a path analysis modelling tool that is based on regression (Hayes, 2017). It performs mediation, moderation and conditional process analysis. We performed moderated moderation analyses using Model 3 (see Fig. 1). In this analysis, we controlled for experience and racing status because they can influence reinvestment (Capio et al., 2018) and impact performance (Malhotra et al., 2015).

Using PROCESS, we examined whether the relationship between anxiety and performance was conditional upon state rowing-specific reinvestment, and whether the two-way interaction between anxiety and rowing-specific reinvestment was conditional upon trait mindfulness. Our strategy was twofold. First, we examined whether the relationship between anxiety and performance was moderated by RSRS alone, mindfulness alone, and/or RSRS and mindfulness combined. Second, we reran the same anxiety-performance moderated model but used each reinvestment subscale (i.e., RS-CMP, RS-MSC), and each mindfulness subscale (i.e., awareness, non-judgemental, refocus). We used the Johnson-Neyman technique (Hayes, 2017) to further explore the moderating effect that mindfulness was having on the moderated effects of reinvestment on the anxiety-performance relationship. This technique probed the 3-way interaction between reinvestment, mindfulness and anxiety on performance. The technique revealed the level of mindfulness needed to have a significant moderating effect on the moderating effect of reinvestment on the anxiety-performance relationship.

3. Results

3.1. Descriptive statistics, reliabilities and validity

Descriptive statistics and scale reliabilities are presented in Table 1. All scales showed good internal consistency, with all alpha and omega coefficients above 0.70 (Kline, 2005; Dun et al., 2014). Furthermore, the concurrent validity of the RSRS was evidenced by the negative associations between actual performance and both RSRS and RS-MSC (Table 1). Moreover, its convergent validity was demonstrated by the positive correlations between the RSRS subscales and the corresponding MSRS subscales (Cohen, 1992; Post, 2016) (see Table 1).

3.2. Correlation analysis

Our first study purpose was to examine the relationship between components of mindfulness and perceived and actual performance. The correlations for mindfulness and performance are shown in Table 1. It can be seen that: overall mindfulness and mindful awareness were positively related to both perceived and actual rowing performance; mindful nonjudgement was positively related to perceived but not actual rowing performance; and mindful refocus was unrelated to performance.

3.3. Anxiety, overall reinvestment and overall mindfulness

Our second study purpose was to investigate the moderating role of reinvestment and mindfulness on the anxiety-performance relationship. The conditional effects for each of the moderated moderation models are summarised in the Supplementary Material (Table S1, S2 and S3). We first examined the moderated moderation effects of overall reinvestment and overall mindfulness on the relationship between state anxiety and both actual and perceived performance. However, the three-way interaction (state anxiety by reinvestment by mindfulness) was not significant for perceived performance or actual performance.

3.4. Anxiety, conscious motor processing and mindfulness components

Next, we examined whether the mindfulness components (awareness, refocus, nonjudgement) conditioned the moderating effect of RS-CMP on the anxiety-performance relationship. PROCESS yielded a state anxiety by RS-CMP by mindful awareness three-way interaction for actual performance (Figs. 2, 3a and 3b). The Johnson-Neyman method indicated that the state anxiety by RS-CMP two-way interaction was

[1] The collection mode (paper or online) did not influence the results.

significant when mindful awareness scores were lower than 3.24 ($b = -4.15$, 95% CI = −8.31, 0.00, $p = .05$) or higher than 5.29 ($b = 1.93$, 95% CI = 0.00, 3.86, $p = .05$). The results show that at low levels of mindful awareness (Fig. 3a), RS-CMP potentiated the effect of anxiety on actual performance, whereas at high levels of mindful awareness (Fig. 3b) the anxiety-performance relationship held for low but not high RS-CMP.

PROCESS also revealed a comparable three-way interaction for perceived performance (Fig. 4). The Johnson-Neyman method indicated that the two-way interaction between state anxiety and RS-CMP was significant when mindfulness awareness scores were higher than 5.86 ($b = 0.06$, 95% CI = 0.00, 0.12 $p = .05$). These results indicate that the moderating influence of RS-CMP on the relationship between state anxiety and overall performance was buffered when mindful awareness was very high but not when mindful awareness was low (Fig. 5a and b).

3.5. Anxiety, movement self-consciousness and mindfulness subscales

Last, we examined whether the mindfulness components (awareness, refocus, nonjudgement) conditioned the moderating role of RS-MSC on the state anxiety-performance relationship. The moderation analyses yielded no three-way interactions for actual performance. There was only one three-way interaction for perceived performance, state anxiety x RS-MSC x non-judgemental thinking. The Johnson-Neyman method indicated that the two-way interaction between (state) anxiety and RS-MSC was only significant when mindful non-judgement scores were higher than 4.62 ($b = 0.05$, 95% CI = 0.00, 0.09, $p = .05$). Here, the moderating influence of RS-MSC on the relationship between state anxiety and overall performance was buffered when mindful non-judgemental was high but not when mindful judgement was low (Fig. 6a and b).

4. Discussion

Competitive sport creates pressure to perform well. Therefore, it is important that athletes and their support personnel understand factors that cause, and interventions that prevent, under-performance. Recently, it has been suggested that mindfulness may attenuate the potentiating effect of reinvestment on the anxiety-performance relationship (Birrer et al., 2012; Perry et al., 2017). To investigate this possibility, the present study examined whether the anxiety-performance relationship was moderated by state rowing-specific reinvestment and whether this moderation, in turn, was moderated by trait sport-specific mindfulness.

4.1. Mindfulness and rowing performance

The hypothesis that mindfulness would be positively related to performance was supported for overall mindfulness. In agreement with previous studies (Bühlmayer et al., 2017; Röthlin et al., 2016; Zhang et al., 2016), overall mindfulness was related to both perceived and actual performance. Nevertheless, examining individual mindfulness components revealed a nuanced relationship between mindfulness and performance and therefore only partially supported our hypothesis: perceived performance was related to mindful refocus and non-judgemental mindfulness but unrelated to mindful awareness; actual performance was related to mindful refocus but unrelated to non-judgemental mindfulness and mindful awareness.

Our results show that mindful refocus and non-judgmental thinking were associated with superior performance. The literature suggests that individuals with non-judgmental thinking, exhibit experiential acceptances of mistakes or poor performance, therefore they are more likely to let go and move on (Birrer et al., 2012). Consequently, performance proficiency is maintained because disruptive reinvestment processes are not activated. Mindful refocus enables the athlete to shift their attention away from task-irrelevant information and focus on the relevant components of the task (Thienot et al., 2014). This increased focus is a prominent characteristic of flow-based peak performance (Kee & Wang, 2008).

Mindful awareness was the only component of mindfulness not related to performance. It has been argued that assessing this construct can be difficult if the individual is not an experienced mindfulness practitioner, because the items can be misinterpreted as reflecting self-focus attentional processes (e.g., conscious motor processing) rather than meta-cognitive monitoring (Grossman, 2011).

4.2. Mindfulness and rowing-specific reinvestment

The hypothesis that mindfulness moderates the moderating effect of reinvestment on the anxiety-performance relationship was partially supported. Mindfulness did not attenuate the aggravating influence of reinvestment on perceived or actual performance, suggesting that mindfulness did not influence the reinvestment processes. Nevertheless, we explored this phenomenon by examining whether individual components of mindfulness (i.e., awareness, refocus, non-judgemental) moderated the moderating effects of the rowing-specific reinvestment components (i.e., RS-CMP, RS-MSC) on competitive performance.

Only mindful awareness weakened the effect of one of the reinvestment processes, RS-CMP, on the anxiety-actual performance. This result suggests that mindful awareness may play an integral role in helping to maintain performance proficiency. This may happen through a couple of processes. Mindful awareness can promote present-moment awareness, which is linked to a reduction in rumination, a process similar to conscious motor processing, potentially helping athletes to perform autonomously (Birrer et al., 2012; Josefsson et al., 2017; Röthlin et al., 2016). Alternatively, mindful awareness may reduce the level of consciousness that CMP tends to exert on motor processes. It has been speculated that extreme levels of this conscious or autonomous processing may detrimentally influence performance. Instead, athletes should exhibit a 'mindful attention' or 'somaesthetic awareness' of their movements in order to perform successfully (Toner et al., 2015). Emerging evidence and theory have suggested that these types of cognitive processes enable the athlete to adapt their movements in an ever-changing performance environment and maintain skill proficiency (Toner et al., 2015).

In relation to perceived performance, mindful awareness also weakened the moderating effect of RS-MSC and RS-CMP on the anxiety-perceived performance relationship. These findings further support the beneficial role of mindful awareness, compared to the other mindful components, on reinvestment processes. Additionally, mindful non-judgmental thinking attenuated the effect of RS-MSC on the anxiety-perceived performance relationship. Non-judgmental thinking has been found to reduce self-consciouses due to the individual being less self-critical of themself and more accepting of one's thoughts (Evans et al., 2009). Furthermore, according to Birrer et al. (2012), it enables the athlete to accept and not react to performance discrepancies. Therefore, they do not begin to consciously control their movements to prevent errors from occurring again, and instead, they have experiential acceptance (i.e., accept and move on), meaning that the automaticity of the movement is less likely to be disrupted (Birrer et al., 2012).

Lastly, mindful refocus did not interact with either RS-MSC or RS-CMP to influence the anxiety-performance relationship. This suggest that mindful refocus does not attenuate reinvestment, which may be due to this mindful component reflecting focus on attention paid to emotional and physiological stimuli, such as excitement, tiredness, and sore muscles, rather than the mechanics of the skill (Thienot et al., 2014). Therefore, mindful refocus may not act directly on reinvestment processes but instead prevent distraction from irrelevant stimuli and thereby enable the rower to maintain proficient performance (Eysenck et al., 2007). Clearly, the moderation moderating effect which mindfulness benefits or restores performance proficiency needs further exploration.

4.3. Applied implications

Psychologists and coaches are interested in being able to help athletes deal with the pressures of competition and prevent underperformance (Röthlin et al., 2020). Our results reveal that mindful awareness and nonjudgement may attenuate the impact of reinvestment on the anxiety-performance relationship in competition. Therefore, including mindful practices into training programs should have desirable performance effects, as these practices have proven to cultivate the mindfulness trait (Bühlmayer et al., 2017).

4.4. Study limitations and directions for future research

Although this study provided novel evidence for a moderated moderation effect of anxiety on performance, it has limitations that should be considered. First, the use of self-report measures may have resulted in common method bias due to social desirability, the use of the similar anchors throughout the questionnaire (agree-disagree), and context-induced mood which may have resulted in recall bias (Podsakoff et al., 2012). For instance, rowers who won but had not performed well individually, would probably still rate themselves highly on the perceived performance scale. The problem with common method bias is that it can inflate or deflate relationships between variables (Podsakoff et al., 2012). Therefore, future studies could use procedural strategies to minimise common method bias, such as removing common scale properties by altering the scale anchors, so they are not all the same. Alternatively, statistical strategies could be used, such as including a marker variable rather than conducting Harman's one factor test, which suffers from insensitivity (Podsakoff et al., 2003, 2012). In addition, studies could include psychophysiological measures. For instance, ratings of reinvestment could be supplemented by ambulatory EEG measurements while rowing to assess temporal-frontal cortico-cortical connectivity (e.g., Gallicchio et al., 2016; Zhu et al., 2011). Moreover, performance could be assessed using peer and coach ratings of performance (Masters et al., 1993) to corroborate the self-ratings.

Although the actual performance measure used in the current study meant a large sample size could be captured which is important when exploring a new area, this measure does not fully capture individual performance. This may have contributed to the discrepancies between perceived and actual performance. Accordingly, kinematic measures of technical performance, such oar telemetry (Kleshnev, 2016), could be used in future research. In addition, due to participants racing in crews, it would be better to cluster the data into crews and analyse the data. Unfortunately, in our study, whole crews did not complete the survey.

Finally, the study employed a cross-sectional design, so causal effects cannot be inferred. These all have an impact on the complex three-way interaction models revealed in this study, therefore there is a probability that mindfulness did not moderate the moderated effect of reinvestment on the anxiety-performance relationship.

5. Conclusion

The present study provides initial support for the speculation that trait mindfulness can help prevent the deleterious effects of rowing-specific reinvestment during competitive racing. Only mindful awareness and mindful non-judgement moderated the moderating effects of reinvestment on the anxiety-performance relationship. Mindful awareness and mindful non-judgemental thinking appear to be better at preventing reinvestment-related conscious processes because they stop rumination, self-consciousness, and conscious control of movement (Birrer et al., 2012). Nevertheless, further exploration of the act of mindfulness on conscious processes is needed.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.psychsport.2021.101998.

Author statement

Katherine Sparks: Conceptualization, formal analysis, investigation, writing, project administration, Maria Kavussanu: Conceptualization, formal analysis, investigation, writing., Rich Masters: Conceptualization, formal analysis, investigation, writing. Christopher Ring: Conceptualization, formal analysis, investigation, writing.

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