Impact of Reinvestment and Mindfulness on Rowing Performance

By

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Abstract

Athletes are consistently striving for successful performance, especially in high-stake situations such as competitions. At times athletes will succumb to pressure leading to poor performance. Understanding the underlying cause of such underperformance and how to prevent this from occurring comprise an important research area. This thesis explores the effect of rowing-specific reinvestment on competitive race performance and how mindfulness can prevent this process and thereby aid performance. The thesis comprises of four empirical studies. The first study developed and validated the rowing-specific reinvestment scale. This scale was then employed in the second study and showed that rowing-specific reinvestment was associated with poor race performance. Furthermore, mindfulness attenuated the negative effect of reinvestment on performance. The third study demonstrated that a rowing-specific brief mindful meditation activity increased rowing specific movement self-consciousness but had no effects on mindfulness or how rowers dealt with failures. In the last study, a rowing-specific mindfulness intervention was developed, which increased flow-state and performance in rowers compared to control. Overall, this thesis has furthered the understanding of reinvestment, through the development of a rowing-specific reinvestment scale and confirming an effect of mindfulness on reinvestment and performance. Finally, the research developed a sport-specific mindfulness intervention, and provided promising evidence for its benefits for athletes.

Dedication

I would like to dedicate my thesis to my beloved Grandad, Alan Denton, although he never always knew what I was doing, he was always so proud of his granddaughter and enjoyed reading her epitaphs. I am sure he would have enjoyed this one too.

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First, a special thanks to my family, no matter the venture, they have always been my number one support. Mum, thank you for letting me use the kitchen as an office, keeping me well fuelled and listening to all my worries. Dad, thank you for being the best barista, proof-reader and sounding board. Also, thanks to Poppy (sorely missed) for giving me unconditional love and always giving me that helpful distraction of a ball to my feet - Cassie is now doing a great job.

I would also like to say thank you to my friends, the ‘rowing girls’, you all kept me sane throughout the process. Thank you to my best friend, Robbie Smith, for always believing in me even when I did not, keeping me in check and having my corner. You will always be my most supportive friend. I am also very grateful for my partner, Sofie, although you’ve only witnessed two years of this, in the last year you have truly seen the intense thesis mode. You have looked after me in my most stressed out times and given me the advice I needed to hear.

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Content Listing

Publications that are part of the thesis

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Conference Presentations

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Sparks, K. (2021, April). 10-minute talk at BASES Student Conference. T*he influence of Conscious Processing on Rowing Performance.*

Sparks, K. (2021, May). *Mindfulness, reinvestment, and rowing under pressure: Evidence for moderated moderation of the anxiety-performance relationship.* 10-minute presentation and talk at the ESAN conference. (Best Student Oral presentation)

Sparks, K. (2021, June). *Mindfulness, reinvestment, and rowing under pressure: Evidence for moderated moderation of the anxiety-performance relationship.* 10-minute presentation and talk at the ESRC student conference.

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Abbreviations

ACT[1]	Attentional Control Theory
ACT[2]	Acceptance Commitment Theory
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
ASOAF6	Action Orientation After Failure and State Orientation After Failure
CFA	Confirmatory Factor Analysis
CFI	Comparative fit index
CMP	Conscious Motor Processing
CONSORT	Consolidated Standards of Reporting Trials
CSAI-2	Competitive State Anxiety Inventory-2
DSRS	Decision Specific Reinvestment Scale
EEG	Electroencephalogram
EFA	Exploratory Factor Analysis
FFMQ	Five Facet Mindfulness Questionnaire
KMO	Kaiser-Meyer-Olkin
MAAS	Mindful Attention Awareness Scale
MAC	Mindfulness-Acceptance-Commitment
MANOVA	Multivariate Analysis of Variance
MBCT	Mindfulness-Based Cognitive Therapy
MBESS	Methods for the Behavioral, Educational, and Social Sciences
MBSR	Mindfulness-Based Stress Reduction
MIS	Mindfulness Inventory for Sport

ML	Maximum Likelihood
MMS	Mindfulness/Mindlessness Scale
MMTS	Mindfulness Meditation Training for Sport
MRF-L	Mental Readiness Form-Likert
MSC	Movement Self-Consciousness
MS-CMP	Movement Specific Conscious Motor Processing
MS-MSC	Movement Specific Self-consciousness
MSPE	Mindful Sport Performance Enhancement
MSRS	Movement Specific Reinvestment Scale
PAF	Principal Axis Factoring
PET	Processing Efficiency Theory
PEQ	Programme Evaluation Questionnaire
PST	Psychological Skills Training
PTP	Perceived Technical Performance
RMSEA	Root Mean Square Error of Approximation
RS	Rowing Specific
RS-CMP	Rowing Specific Conscious Motor Processing
RS-MSC	Rowing Specific Movement Self-consciousness
RSRS	Rowing Specific Reinvestment Scale
SRMR	Standardised Room Mean Squared
TLI	Tucker-Lewis Index
WLSMV	Variance-adjusted Weighted Least Squares

Chapter 1: General Introduction

Anxiety-performance relationship

Athletes can suffer from anxiety, especially when it comes to competition, time and time again we see the adverse effects of anxiety for athletes not just in major but also local competitions. It is one of the most discussed areas in sport psychology and one that is continuously expanding (Ford et al., 2017). Anxiety refers to a trait or state-like response to a perceived immediate or an anticipated threat or stress (LeDoux, 2015), that results in a “range of cognitive appraisals, behavioural and physiological responses” (Ford et al., 2017, p. 206). One of the prominent triggers for anxiety in competitive sport is the pressure to perform to their optimal standard. Pressure is defined as any “factor or combination of factors that increases the importance of performing well on a particular occasion” (Baumeister, 1984, p. 610) and tends to be associated with elevated levels of anxiety in athletes (Causer et al., 2011; Cook et al., 2011). Empirical results have demonstrated inconsistencies with increases in anxiety being found to have debilitative and facilitative effects on sport performance (Ford et al., 2017; Woodman & Hardy, 2003). For instance, in recent research, some athletes have been found to thrive under pressure and experience a ‘clutch’ episode, whereby they have a superior performance under pressured circumstances (Swann et al., 2017). The exact mechanism behind a clutch performance is still unknown. Swann et al (2017) suggested that it was a similar but distinct psychological state to flow, whilst a recent systematic review (Schweickle et al., 2020) revealed several common themes that were related to all clutch episodes. The common themes are exhibiting a challenge appraisal, confidence, perceived control, specific goals and whether the athlete has completed simulated pressured practices. Nevertheless, just as clutch performance can occur, athletes have also been found to succumb to the pressure and experience a significant drop in performance, known as ‘choking’.

Defining Choking

‘Choking’ is frequently used in the sporting world but at times it is used to wrongly describe any type of inferior performance, which could be due to the lack of a universally agreed definition. For decades researchers have proposed a number of definitions, none of which have been universally agreed upon. Baumeister (1984) defined choking as an “inferior performance despite individual striving and situational demands for superior performance” (p. 610). However, many contributors considered this definition to be inadequate due to its lack of specificity and there was no identification of factors needed for this to occur such as the presence of pressure. Subsequently, Wang (2003) further developed the definition and clearly outlined the importance of pressure but also described the possible choking process; “deterioration in the execution of habitual processes of performance under pressure” (p. 274). Nevertheless, Baumeister’s and Wang’s definitions do not specify the type of ‘deterioration’ in performance that is needed for it to be distinguished as a ‘choke’ instead of a ‘slump’ or a simple fault (Hill et al., 2009). Hill et al. (2009) utilising grounded theory, which was different to the experimental designs taken previously, asked four expert athletes who had experienced choking first hand and concluded through qualitative analysis that choking was more than just a performance decrement but a ‘significant drop in performance’. This definition, however, failed to refer to the external factors needed for a choke, such as pressure or elevated anxiety. Another layer that Gucciardi et al. (2010) proposed to the definition was that an increase in pressure or anxiety was induced by a matter of perception of the situation i.e., the importance of the outcome, past experience and reactivity to stress. Without a universal definition there are difficulties in making comparisons between studies. Therefore, an operational definition was developed by Mesagno and Hill (2013) the definition covers the factors of choking identified by most authors, namely, “an acute and considerable decrease in skill execution and performance when the self-expected standard is normally achievable, which is the result of increased anxiety under perceived pressure” (p. 272) (for clarity this is the definition used throughout the thesis). Despite the lack of universal definition, it is a phenomenon that can have devastating consequences not just for the athlete’s performance but also their career, engagement and mental state (Hill et al., 2019). Consequently, researchers have extensively investigated the mechanisms behind individuals ‘choking’.

Choking Mechanism

The literature has postulated two prominent models to explain the mechanism behind this phenomenon, the distraction and self-focus models. Although both models suggest that choking occurs because of a disturbance of attention, the exact process behind that disturbance significantly differs between the two (Roberts et al., 2019).

Distraction Model

Ultimately the distraction model proposes that pressure causes an individual to focus on task-irrelevant (i.e., worrisome thoughts) rather than task-relevant information (i.e., opponent position). This irrelevant information then occupies resources of the working memory, a temporary storage component that retains small amounts of information in an active state for use in ongoing tasks (Furley & Memmert, 2010), therefore performance is disrupted as the working memory cannot store task-relevant knowledge that is needed for a proficient skill execution. There are two main distraction theories, Processing Efficiency Theory (PET) and the Attention Control Theory (ACT[1]), they are both very similar as PET was a precursor to ACT[1].

Processing Efficiency Theory (PET)

The PET (Eysenck & Calvo, 1992) suggests that task-irrelevant thoughts such as worry cause a reduction in the processing efficiency of working memory, but this does not always result in a poor performance. The processing efficiency is the relationship between the number of resources needed to achieve performance and the performance quality (Eysenck et al., 2007). Individuals processing efficiency can be reduced by task-irrelevant thoughts such as performance concerns or environmental distractors, but this does not necessarily mean their performance will deteriorate. Instead, the individual may increase their effort, which results in additional resources, if available, being allocated to the task in hand to maintain performance (Wilson, 2008). However, if there are not enough resources then the extra effort will be in vain and the performance will deteriorate. The PET also suggests that primarily it's the central executive of the working memory that is affected by the irrelevant thoughts, therefore in dual tasks where both require resources of the central executive, anxious individuals will perform poorly in both tasks (Eysenck et al., 2005). There are a number of criticisms in relation to the PET such as the idea that anxiety impairs the efficiency of the central executive. The central executive completes many functions, such as selective attention and inhibition, coding and switching of attention (Eysenck et al., 2007) but not all of them are affected by anxiety.

Attention Control Theory (ACT)

ACT[1] is an extension of PET; this theory states that attentional control functions are affected by anxiety. Anxiety results in a dominance of the bottom-up stimulus-driven system, whereby there is hampering of the individual ability to focus on relevant task stimuli (top-down attentional system) and an attentional bias for threatening stimuli

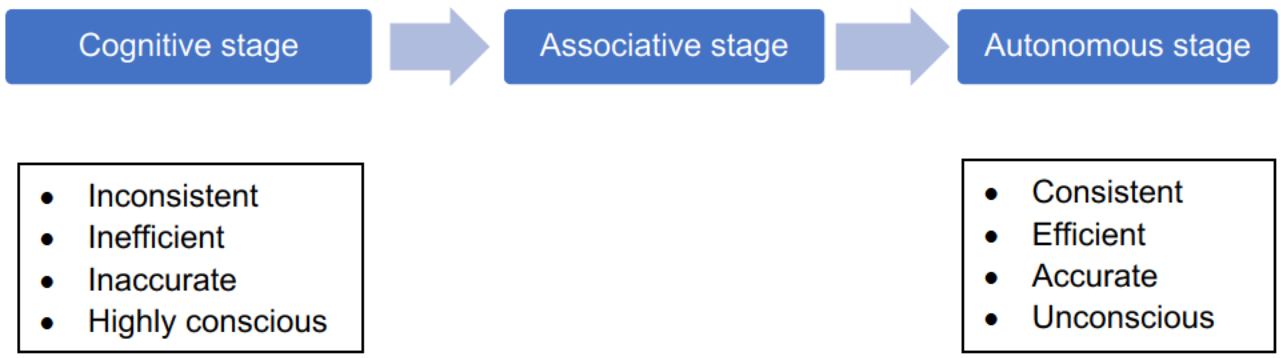
(Eysenck et al., 2007). Several empirical studies have supported these distraction models with the shift in attention to task-irrelevant stimuli and poor performance under high anxiety conditions as demonstrated in basketball free-throwing (Wilson et al., 2009), biathlon athletes' gaze control (Vickers & Williams, 2007) and police shooting studies (Nieuwenhuys & Oudejans, 2010; 2011). Further support has come from studies that have measured gaze behaviour to infer processing efficiency, as it reflects the athlete's attentional control. Studies that have explored 'quiet eye', which refers to the final eye fixation before motor execution (Vickers, 2016), it was found in golf-putting and darts that those who exhibited longer quiet eye fixations were more successful under pressure than those who did not (Nibbeling et al., 2012; Vine & Wilson, 2010). However, the problem with the attentional model is that it fails to explain why chokes sometimes occur when executing well-learnt skills, as these have become consolidated and therefore no longer rely on the working memory (Fitts & Posner, 1967).

Self-focus Model

The self-focus model proposes that individuals under pressure allocate their focus internally to the skill execution, disrupting the automaticity of the movement. Central to this model is Fitts and Posner's (1967), Skill Acquisition Model whereby individuals' transition through three distinct learning stages (cognitive, associative and autonomous stage) (Fig 1.1). During the cognitive stage, the individuals are testing different motor strategies, whereby they are consciously adjusting their movements to execute the skill optimally and develop a basic movement pattern. At this stage the working memory is highly active, as it "temporarily stores and manipulates knowledge" (Gathercole et al., 2019, p. 20) of the skill. Once the basic movement pattern has been learned, the individual then transfers to the associative stage of learning, whereby the movement is still being adjusted, inefficient contractions are being reduced, but the skill becomes more automatic and less consciously controlled. Following extensive practice, the individuals proceed to the autonomous stage, whereby the movement is accurate, consistent, effortless and performed autonomously (with little or no conscious control). At this stage, the performer, is said to experience ‘expert amnesia’ (Beilock & Carr, 2001) whereby they cannot recall sufficiently the exact motor movements made during the execution of the skill, whilst at an earlier stage they could recall the movement step-by-step.

Fig 1.1.

Fitts and Posner’s, (1967) ‘Skill Acquisition model’.



Similar to Fitts and Posner’s (1967) progression-regression hypothesis, both theories suggest this transition through the learning stages can be bi-directional, in other words an individual’s performance can revert back to an inferior stage of performance. The self-focus model suggests that under pressure individuals may start to utilise controlled processes that interfere with the automatic processing of skill execution resulting in the athlete choking. There are two key perspectives, Explicit monitoring hypothesis (Beilock & Carr, 2001) and Reinvestment theory (Masters, 1992).

Explicit Monitoring

The Explicit Monitoring Hypothesis proposed that choking occurs due to conscious monitoring of the step-by-step processes of execution resulting in the poor performance as automaticity is disrupted (Beilock et al., 2002). Support for this theory has been found through dual-task paradigms (Beilock et al., 2002; Gucciardi & Dimmock, 2008; Jackson et al., 2006). Beilock et al (2002) found when skilled participants were manipulated into paying attention to the exact moment their golf club-head stopped moving during the follow through in a golf putting task or the exact foot that was touching the ball during the dribbling task compared to paying attention to an auditory tone their performance deteriorated. Gucciardi and Dimmock (2008) extended this study and added a pressured condition. 20 experienced golfers completed putts in three different conditions, explicit knowledge, task-irrelevant and swing-thought condition, all conditions were also performed under high and low anxiety. The explicit knowledge condition asked participants to break their swing techniques into three key movement parts that would act as cues to focus on. The task-irrelevant condition required them to focus on non-sport-specific cues, like colours, while the third swing-thought condition required the golfers to think about their swing. Performance deteriorated only in the explicit knowledge condition, with an increased putting error; therefore, further supporting the explicit monitoring hypothesis. Similar results have also been demonstrated in pressured hockey dribbling (Jackson et al., 2006) and baseball swinging (Gray, 2004). Nevertheless, Jackson et al (2006) suggested that explicit monitoring may not always necessarily lead to ‘choking’. For instance, research has found that experts tend to consciously monitor their online performance, so they identify and alter any movements to maintain their high-performance proficiency

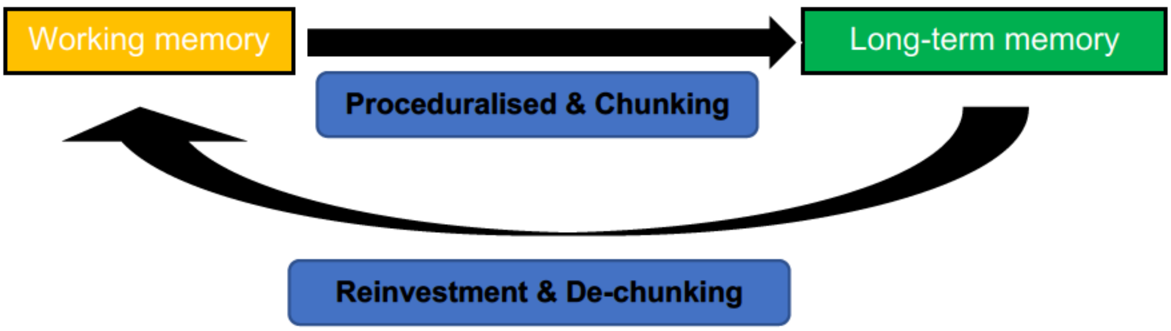
(Toner & Moran, 2014). Jackson et al (2006) proposed that for explicit monitoring to result in 'choking' there needs to be a conscious control of the movement as well.

Reinvestment Theory

In comparison the 'reinvestment theory' suggests that with heightened anxiety individuals 'reinvest' or 'recall' declarative knowledge of the skill from the long-term memory back into the short-term working memory (Masters & Maxwell, 2008). The working memory is a multi-component system that manipulates information for more complex cognitive uses, it also has a short-term and limited capacity (Chai et al., 2018). Therefore, this process of reinvesting declarative knowledge into the working memory results in the performer to have conscious access to their movements which causes a 'de-chunking' and 'de-automatization' of the learnt movement (Deikman, 1996). The learnt skill is therefore restructured from a single motor unit into several smaller units (Bellomo et al., 2018), resulting in the performance reverting to a cognitive style whereby it is disjointed, inaccurate and inconsistent (Masters & Maxwell, 2008) (Fig 1.2).

Fig 1.2.

Learning and Reinvestment



The implicit versus explicit learning paradigms provide initial support for the reinvestment theory. Implicit learning, is where the skill is learnt sub-consciously and without technical instruction, therefore it bypasses the working memory limiting the declarative knowledge accumulated as the movement is consolidated and ‘chunked’ faster into the long-term memory compared to explicit learning. Explicit learning is where the skill is learnt consciously, with technical instruction and is a working memory-dependent process therefore there is an accumulation of declarative knowledge before it is processed and ‘chunked’ into a single motor unit into the long-term memory (Maxwell et al., 2006). Masters et al (1993) proposed that if automatic processes are encouraged from early on in learning, then the individual will not be able to ‘reinvest’, as they will not accumulate the same amount of declarative knowledge. The majority of implicit versus explicit learning paradigms have supported this hypothesis. Implicit techniques have included learning through analogies, errorless paradigms or an external focus. Analogy learning is where a biomechanical metaphor is used in place of technical instruction, for instance an analogy for a push-pass in hockey would be “move the hockey stick as if you are sloshing a bucket of water over the floor” (van Duijn et al., 2019, p. 6), whilst for a bat swing it would be “swing your bat like you are breaking a tree in front of you with an axe” (Capio et al., 2019, p. 10). Learners accumulate less declarative knowledge, which leads to more stable performance under pressure compared to explicit learners. This has been demonstrated in golf-putting (Maxwell et al., 2000), top spins in table tennis (Liao & Masters, 2001) and football penalties (Navarro et al., 2018). Similar successful results have been found in the errorless learning of golf-putting (Poolton et al., 2004; Zhu et al., 2011). Performers learn in a constrained environment to reduce errors being made, for instance in a golf-putting, learners would start closer to the hole before moving further away after each successful putt (Poolton et al., 2004). During errorless learning individuals complete less hypothesis testing, which involves the generation of different movement strategies, therefore there is theoretically less declarative knowledge accumulated. Moreover, external focus learning is also described as a successful technique for implicit learning, where the individual focuses on the intended effect of the movement in contrast to an internal focus of their body movements (Wulf, 2013). External focus learning has been found to reduce the number of rules accumulated by the individual and the movement is more stable under pressure, as observed in surfing compared to the internal focus and control group in both novices and advanced surfers (Lawrence et al., 2019)

Further evidence for implicit learning reducing cognitive processing of motor skills has been found in electroencephalography (EEG) research (van Duijn et al., 2019; Zhu et al., 2011). EEG electrodes objectively measure the cross-cortical coherence between the left temporal (T3/T7) and frontal midline (Fz) area during performance, the coherence between these two regions indicate involvement of verbal-analytical processes (Hatfield & Hillman, 2001). Involvement of verbal-analytical processes during execution may reflect a 'dechunking' or reinvestment of the skill (Zhu et al., 2011). Zhu et al (2011) investigated the T3-Fz coherence in implicit versus explicit learners during a golf-putting task in a pressured and unpressured condition. Explicit learners exhibited higher levels of T3-Fz coherence and made less putts under pressure compared to implicit learners. Additionally, only the explicit learners T3-Fz coherence increased from the non-pressured condition to the pressured condition. These results demonstrate support for the reinvestment theory, as increased coherence reflects a reinvestment of declarative knowledge and therefore a poor performance, as there is a disruption in the individual's automaticity. Contrary to this, van Duijn et al (2019) found that although individuals who completed analogy learning had greater verbal-cognitive efficiency during the task, as they exhibited higher T7 power, but no difference in Fz was found suggesting that the type of learning strategy made no difference to their motor planning efficiency. However, explicit versus analogy performers were not examined under pressure, which may have influenced the conscious processing. Nevertheless, there is concern over the validity of the T7-Fz connectivity as a measure of just conscious motor processes, as it may in fact be capturing all sensory processes that are influencing the actions plans that are developed from the frontal lobe (Bellomo et al., 2020; Parr et al., 2019).

Individual differences

In addition to the mechanisms of choking, research has also focused on an individual's susceptibility to choke under pressure. An individual's susceptibility originates from their personality traits and predispositions; these are stable over time and have predictive validity for performance under pressure (Clarke et al., 2020). Reinvestment although described as a mechanism of choking has also been established as a personality trait. Masters et al (1993) hypothesised that individuals have different propensity to reinvest and therefore developed a Reinvestment Scale (RS) to quantify this.

The RS is formed of 20 items from multiple scales that the authors considered would predict an individual's propensity to reinvest. These items were drawn from the Emotional Control (Roger & Nesshoever, 1987), Cognitive Failures (Broadbent,1982) and Self-Consciousness Scales (Fenigstein et al., 1975). The RS scale has enabled researchers to predict performance, participants who rated themselves as high reinvesters exhibited a poorer performance under pressure compared to the relatively lower reinvesters in several laboratory-based sports such a golf putting (Kinrade et al., 2010;

Masters et al., 1993; Maxwell et al., 2006), hockey dribbling (Jackson et al., 2006) and football volleying (Chell et al., 2003). Moreover, the RS was further validated with individuals rating of their likelihood to choke under pressure was related to their RS scores i.e., high RS rating was associated with higher ratings of choking (Masters et al., 1993). Additionally, in a field study by Jackson et al (2013), netball and hockey players rated games on importance to represent whether the games were pressured or not. They also rated their own performance in the game and completed the RS. Results revealed that athletes who rated themselves relatively high on the RS were associated with lower performance ratings in more important games, therefore supporting the reinvestment theory. Although the RS has had extensive support, Jackson et al (2006) revealed validity concerns with the scale, as it was a collection of related items that predicted poor performance rather than explicitly reinvestment and the items were not specific to movement.

Movement Specific Reinvestment Scale

To eradicate these methodological concerns, Masters et al (2005), developed a scale to measure reinvestment specifically related to movement, called the Movement Specific Reinvestment Scale (MSRS). This scale captures two dimensions of conscious processing, conscious motor processing (CMP) and movement self-consciousness (MSC). CMP is the extent an individual controls their movement; in contrast MSC is the extent an individual monitors their movement style in relation to their concern of their style in public to make a good impression. Therefore, the MSRS is able to measure the individual’s total movement-specific reinvestment level but also their dimensional levels, CMP and MSC separately. Furthermore, although beyond the scope of this thesis, it is worth noting that a

Decision Specific Reinvestment Scale (DSRS) has also been developed, this measures decision reinvestment and decision rumination (see Kinrade et al., 2010).

Movement Specific Reinvestment on Pressured Performance

The MSRS in respect to predicting performance under psychological pressure has been examined across a number of different domains (i.e., surgical, sport and simple motor tasks) and has revealed mixed results. In sport, lab-based research has revealed that high levels of MSRS were associated with poorer basketball free throw performance, greater kinematic variability (Orn, 2017) and poorer golf putting performance for experts (Cooke et al., 2011) and novices (Zhu et al., 2011). In contrast, other lab-based studies found no association between the MSRS and performance in dart throwing (Mosley et al., 2017) and golf putting in novices (Malhotra et al., 2015b).

Most non-experimental cross-sectional field-based studies have yielded null findings, apart from Gutierrez (2018), they explored the difference in ratings between those professional baseball players that suffered from type 1 yips and those that did not. Yips are described as a chronic form of choking and are characterised by the athlete experiences psychological symptoms such as anxiety (type 1) or a combination of psychological and physical symptoms (focal dystonia) (type 2) (Clarke et al., 2020). Gutierrez (2018) found that yips sufferers obtained higher self-report ratings of MSRS (Gutierrez, 2018) than non yip sufferers. While other field-based studies demonstrated that MSRS was not associated with actual performance (Geukes et al., 2017; Iwatsuki et al., 2018; Jackson et al., 2013). Expert basketball and netball players' MSRS scores had no association with the number of successful basketball free-throws attempts measured in twelve games of the season (Geukes et al., 2017) or netball players' passing accuracy during the season (Jackson et al., 2013). Furthermore, in other non-experimental correlation research, Iwatsuki and Wright (2016) revealed that MSRS scores had no association with an athlete's rating to choke under pressure, as observed in a number of athletes from multiple sports.

The mixed results from the same sport (Malhotra et al., 2015b; Zhu et al., 2011) and skill level could be due to several methodological reasons. For instance, the pressure conditions not being potent enough, novices not accumulating enough declarative knowledge of the skill to reinvest (Masters & Maxwell, 2008) or the processes of reinvestment aiding performance through enabling athletes to develop successful motor strategies (Malhotra et al., 2015a). Subsequently future studies need to be conducted in the field context rather than a controlled setting, taking advantage of the natural pressure felt in competitions and therefore enabling results to be more accurate and generalisable. Furthermore, novices should not be included and instead athletes of low-skill levels with at least some experience of the sport should be included as they will have sufficient declarative knowledge to reinvest (Masters & Maxwell, 2008). Additionally, the scale may not be suited to the type and nature of the sport or skill being investigated. For instance, Jackson et al (2013) examined netball passing accuracy, which is predominantly a tactical and decision-making task rather than solely a motor task. Therefore, the DSRS was more suitable in predicting performance under pressure compared to the MSRS, which failed to do so. Consequently, the mixed results could reflect the genericity of the scale resulting in athletes misunderstanding the items in relation to their performance and therefore their ratings not reflecting their actual behaviour. Consequently, sport-specific scales have been developed to better capture the psychological construct occurring during performance (Gallicchio et al., 2016; Horn, 2008; Papaioannou & Hackfort, 2014). Although the MSRS has measured conscious processing in the sporting context, it may be missing the sport-specific conscious process that are disruptive and differs between sports. The MSRS focuses on general movement, which may explain the extensive support that has been found outside the sport domain (Capio et al., 2018; Uiga et al., 2020).

Differential effects of CMP and MSC

The majority of MSRS research measures the overall movement reinvestment, rather than examining the sub-scales of the scale, CMP and MSC, respectively. Separately, these have been found to have context-dependent influences on performance. This may be linked to the trait-activation theory, which is an extension of the interactionist perspective of personality psychology, whereby the interaction between the person and situation determines the individual’s behaviour (Geukes et al., 2013; Tett & Guterman, 2000). The trait-activation theory proposes that traits are activated depending if they are relevant to the specific context (Tett & Guterman, 2000). In relation to pressured performance, a personality trait would predict performance if the situation is relevant to that trait. Geukes et al (2013) demonstrated that public (audiences, competitors) and private (time, monetary) pressure activated different traits. Public self-consciousness predicted performance under public but not private pressure, whilst private self-conscious predicted performance under private but not public pressure. Similar patterns have been observed between CMP and MSC, in a time-pressured setting, like private pressure, CMP was found to slow laparoscopic task completion whilst MSC had no effect (Malhotra et al., 2014). In contrast in the competitive sporting environment, MSC but not CMP predicted choking likelihood under pressure in athletes from multiple of sports (Iwatsuki & Wright, 2016; Iwatsuki et al., 2018). These results support the proposal that CMP and MSC may be context-dependent and follow in line with the trait-activation theory, therefore should be analysed separately.

Furthermore, differential effects have also been observed at experience or skill level. Gallicchio et al., (2016) found that experts had lower putting-specific CMP compared to novices; MSC was not measured. Similarly, Douglass (2019) also found that less experienced athletes in low-risk sports such as golf, exhibited higher CMP and MSC than their more experienced counterparts. In contrast to the reinvestment theory, less experienced athletes that competed in high-risk sports such as surfing, skateboarding and climbing, had lower CMP and MSC, compared to the more experienced athletes. It was suggested that this was due to the skills complexity increasing as the performers progressed, therefore there was more risk of danger/harm, so the athletes were more consciously aware of their movement (Douglass, 2019; Kiemle-Gabbay & Lavelle, 2017). Other than these studies, no other studies have directly examined the association between MSC or CMP and sport performance under pressure relative to experience or skill level. Nevertheless, in a non-sport study, it was found that only MSC was associated with years of experience in physiotherapists: MSC decreased with experience (Capio et al., 2019).

On the other hand, EEG research has demonstrated a more consistent result with a reduction in conscious cortical activity shown between novice to expert, therefore suggesting that involvement of conscious control mechanisms gradually reduce as the performer becomes more proficient in the motor skill (Babiloni et al., 2010; Haufler et al., 2000; Wolf et al., 2015). Moreover, EEG coherence between T7-Fz has also been found to be lower in experts during motor execution compared to novices (Deeny et al., 2003; Gallicchio et al., 2016). Consequently, the EEG research clearly suggests that skill level determines conscious processing levels, with experts becoming more automatic compared to novices. However recent research has started to question whether expert or successful performance is truly automatic, as CMP and MSC have at times been found to be associated with good performance (Malhotra et al., 2015a).

Automaticity versus Consciousness

One of the characteristics that underpin peak performance is flow (Jackson & Roberts, 1992). Flow is defined as an intrinsically rewarding state characterised by a complete absorption and focus, with the exclusion of irrelevant thoughts and emotions, it is a sense of everything coming together or clicking into place even in challenging situations (Csikszentmihalyi, 2002). It is sometimes described as a state of enhanced automaticity (Harris et al., 2017) and tends to be associated with success under pressure (Jackson & Roberts, 1992). Various recreational to world-class elite athletes in semi-structured interviews, have described their flow experience as a feeling of being on 'auto-pilot' that is 'effortless' with no conscious effort (Swann et al., 2017). Csikszentmihalyi and Nakamura (2010) stated that the importance of automaticity during flow was that it enables motor sequences to take care of themselves so that more attention can be paid to other essential parts of performance. Furthermore, Wolf et al. (2015) found that flow during table tennis imagery was characterised by a reduction in verbal-analytic processing, which suggests that performers shifted to a more automatic mode of operating during their flow experiences. Nevertheless, recent research has demonstrated that flow states require attentional effort and staying in tune with the continuous changes, therefore contradicting the proposal that athletes are fully automatic during flow (Cappuccio, 2017; Harris et al., 2017). Additionally, elite athletes have reported exhibiting a heightened sense of bodily awareness (Bernier et al., 2009).

Moreover, authors have begun to challenge the benefits of exhibiting complete automaticity during performance. Firstly, automaticity can result in ‘habit lag’, whereby the performer unconsciously reverts back to an old, automated technique/response. This tends to occur when the performer cannot differentiate between the newer more proficient action response and the initial one.

Secondly, it has been proposed that it can cause lapses, as automaticity reduces one’s ability to respond to contextually contingent demands, for instance expert mountain bikers have come off their bikes after a drop when they neglect attention to their speed, causing a crash (Christensen et al., 2016). Christensen et al. (2016) argued that they usually use cues to maintain performance proficiency, meaning they do not go through the task mindlessly but use specific cues to guide their performance. Toner and Moran (2015) argued that athletes need to be aware of certain cues and kinaesthetic sensations, especially during execution, so they can consciously alter or adapt their movement depending on the environment to restore performance proficiency. For instance, Nyberg (2015) found elite free skiers use focal awareness to understand their ever-changing surroundings and alter their movement during jumps if the environment required it, so they could maintain performance proficiency.

Furthermore, recent theories have been established to explain the possible benefits of consciousness during skill movement and execution, although this perspective was proposed more than two decades ago. Ericson et al. (1996) developed the Deliberate Skills Practice theory, which suggested a performer at the autonomous learning stage should not become completely autonomous in their movements as this would be deleterious for their performance. Instead, performers should be somewhat conscious of their skill execution, so they can alter and improve their movements preventing a plateau in their performance. Similarly, the Mesh Theory (Christensen et al., 2016), suggests that individuals should shift between an automatic and a conscious state during performance depending on task demands. A greater conscious state is needed during the strategic aspect of performance, such as for tactical decision making, adjusting action appropriately and managing variable features of the action, while a more automatic state is needed for the implementation and execution of a movement. Therefore, the more challenging or novel the movement or environment is, the more conscious the athlete will need to be of their performance. Furthermore, the theory also supports the learning process, whereby early learning of a skill demands greater conscious processing even during movement execution, as extra effort is required due to the movement being novel. In contrast in later learning the movement is more automatic but the individual has a conscious awareness of their movement in relation to the environment in case the movement needs to be consciously adjusted to retain performance proficiency.

Empirical studies have also supported the benefits of consciousness over automaticity for performance. For instance, in a golf putting training study it was demonstrated that high levels of CMP and MSC were beneficial for performance during early learning, as these were associated will less swing variability (Malhotra et al., 2015a). The authors suggested that this might reflect the novices exhibiting an increase in conscious processing as they developed and tested motor strategies to find the most successful movement pattern. In comparison, in later learning CMP was no longer related to performance but MSC still positively influenced performance. This could reflect the participant still having an awareness of the movement but no longer needing to test motor strategies as they became proficient in the movement. Moreover, experts' have also proven to use conscious processes to retain performance proficiency in sports such as weightlifting and free skiing (Nyberg, 2015; Toner et al., 2016).

Overall, being able to alternate between automatic and conscious processing appears to be important for performance. Mindfulness has been suggested to improve a performer's ability to switch between these processes, with meditation and level of mindfulness being associated with greater cognitive flexibility (Toner et al., 2016).

Mindfulness

Origin and development

Mindfulness originates from Buddhism and the word 'mindfulness' is derived from the Pali word 'sati', meaning 'memory'. According to ancient Buddhist scripts it involves remembering to be attentive and "calling back to mind or bearing in mind" (Huxter, 2015, p.31). There are many manifestations of Buddhism such as Theravada, Mahayana, and Vajrayana, all having slight variances but similar principles (Shonin et al., 2014). The core of the Buddhist teaching and where we find the Buddha's first reference to mindfulness is in the Four Noble Truths, specifically in the seventh aspect ('right mindfulness') of the eight-fold path (Schidmt, 2011). According to Buddhism, right mindfulness is not an isolated concept, it needs the dynamic interplay and engagement of the different components of the full eight-fold (spiritual) path for the individual to achieve liberation and compassion for all-livings (Schmidt, 2011).

In Buddhism the teaching of right mindfulness is comprised of four foundations, including body, feelings, state of mind and dhammas (Bodhi, 2011) The first foundation, mindfulness of the body, concentrates on various aspects of the body to become present in the moment, while the second foundation, mindfulness of feelings, concentrates on what you are feeling in the moment. The third foundation, mindfulness of mind, is being present and recognising the three poisons (lust, aversion, and delusion) that cause suffering. The final foundation is the dhammas (Buddha's teachings), which teaches learners to be conscious to the nature of their reality.

Despite the roots of mindfulness dating back to more than 25 centuries ago (Bodhi, 2011) it was not until the late 1960s, early 70s that meditative practices began to be introduced into western culture. Tourism and cheaper flights made access to different cultures easier. This resulted in young westerners traveling over to places like Asia to study Buddhist meditation and spiritual masters travelling over to the western countries to teach their methods of meditation (Bodhi, 2011). Consequently, the popularity of meditation grew and caught the attention of medical professionals, one of these being the pioneer of western mindfulness, Dr Jon Kabat-Zinn (Bodhi, 2011; Kabat-Zinn, 1990).

Mindfulness was first introduced into the therapeutic context by Kabat-Zinn (1982), who developed the mindfulness-based stress reduction (MBSR), which was designed to be used with patients that were suffering from chronic back pain. To make mindfulness more accessible, Kabat-Zinn (1982) detached mindfulness from its Buddhist origins, language, and philosophical framework. Kabat-Zinn (1994) defined mindfulness as "paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally" (p.4). This set the tone for the definitions that followed and although there is no real consensus there are clear commonalities between them all – mindfulness is related to consciousness, specifically attention and awareness (Stratton et al., 2017). Secular mindfulness practice is no longer about achieving liberation and enlightenment (Schmidt, 2011) but reducing anxiety, stress and improving focus and attention (Gupta & Verma, 2019). Nevertheless, the mindful practices do tend to incorporate the elements of 'right mindfulness' such as bare attention, awareness to interpretative processes and insight (Monterio et al., 2015).

Furthermore, in contrast to Buddhist mindfulness, western psychology has also conceptualised it as a mental state and a stable trait, proving to vary between individual's naturally (Brown & Ryan, 2003; Grossman, 2011). There are a number of scales that have been developed to quantify an individual's mindfulness disposition such as the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2004), Five Facet Mindfulness Questionnaire (FFMQ, Baer et al., 2006) and Mindfulness/Mindlessness Scale (MMS, Pirson & Langer, 2015). Dispositional mindfulness has proven to be a desirable trait, it is positively associated with well-being and negatively correlated with psychological symptoms such as stress, depression, anxiety, and neuroticism (Tomlinson et al., 2017).

Dispositional mindfulness has also demonstrated to be beneficial for sport performance. For example, it has been linked to individuals exhibiting a better ability for emotional and self-regulation (Baer et al., 2006; Bishop et al., 2004). Therefore, under pressure, mindful athletes may approach these contexts with more acceptance and less negatively, subsequently lowering levels of trait anxiety compared to less mindful athletes (Anderson et al., 2007; Röthlin et al., 2016). Exhibiting less anxiety in competitive settings will prevent disruptions to performance such as reinvestment (Masters & Maxwell, 2008). Dispositional mindfulness has also been associated with less negative self-evaluation (Amemiya & Sakairi, 2021), rumination and self-consciousness (Kee & Wang, 2008; Raes et al., 2010) both of which has been found linked to poor performance and possible choking episodes (Amemiya & Sakairi, 2021; Kinrade et al., 2010). Furthermore, dispositional mindfulness has also been associated with a number of positive attributes such as mental toughness (Wu et al., 2021), less burnout (Li et al., 2019) and increased levels of flow state (Cathcart et al., 2014; Kee & Wang, 2008). Lastly, studies have also found direct associations between trait mindfulness and successful performance (Moen et al., 2015; Thompson et al., 2011), especially in pressured situations (Josefsson et al., 2017; Röthlin, et al., 2016).

Dispositional mindfulness is clearly a desirable characteristic for the general population and athletes. Furthermore, mindfulness-based interventions and practices have proven to cultivate the trait (Bühlmayer et al., 2017). Therefore, individuals with a low propensity to be mindful may also be able to acquire the psychological benefits that individuals with high dispositional mindfulness exhibit.

Mindfulness interventions

Mindfulness interventions teach individuals through meditations and mindful practices to concentrate moment-to-moment on their internal bodily sensations, thoughts, and emotions (Baer, 2003). For instance, the MBSR (Kabat-Zinn, 1982) consists of several different mindfulness techniques such as body scans where the individual mindfully explores their bodily sensations from head to toe, meditations, and mindful movement practices such as yoga and stretching (Shapero et al., 2018). Over the last three decades more mindful interventions based around a similar program structure to the MBSR (Creswell et al., 2019) have been established and successfully used in the therapeutic context (Rycroft-Malone et al., 2017). Despite this success, it took three decades for a mindfulness-based intervention to be officially introduced and researched within the sport context.

The two most prominent mindful interventions in sport are Mindfulness-Acceptance-Commitment (MAC) and Mindful Sport Performance Enhancement (MSPE). MAC was the first sport-related intervention to be formed, running over 7-12 weeks with 1 hour per week and includes principles from Acceptance and Commitment therapy (ACT[2]) (Gardner & Moore, 2004). ACT[2] alone has a similar theoretical foundation to mindfulness. Both types of therapy propose that trying to control or consciously avoid negative cognitions and emotions may exacerbate the problem. Instead, the individual should accept the thoughts and emotional states they have and focus on the task-relevant stimuli. MAC also implements the ACT[2] principle that individuals should view their thoughts as simply just thoughts that do not hold a true reflection of either self or reality. The MAC approach seeks to increase optimal performance and increase the experience of flow (Csikszentmihalyi, 2002) through heightening the athlete's present-moment awareness and decreasing their self-consciousness. In randomised controlled trials, MAC interventions have been shown to increase attention, flow, emotional regulation, perceived and actual performance over athletes that completed a control intervention (Gardner & Moore, 2007; Josefsson et al., 2017; Zhang et al., 2016). Case studies in springboard divers (Schwanhausser, 2009), female power lifters (Gardner & Moore, 2004) and golfers (Bernier et al., 2009) that completed MAC also demonstrated a performance enhancement.

MSPE is based on the MBSR (Kabat-Zinns, 1990) and Mindfulness-based cognitive therapy (MBCT) (Segal et al., 2002) and was created by Kaufman et al (2009) to enhance the athlete's mindfulness during their performance and in their day-to-day life. The intervention lasts 4-6 weeks with one 2.5-hour session per week. It includes exercises used by Kabat-Zin (1990) such as sitting meditations and body scans, but it also incorporates sport-specific mindful movement. The MSPE interventions have proven to increase an individual's trait mindfulness in golfers and runners from pre to post intervention (Kaufman et al., 2009; Thompson et al., 2011). Additionally, the MSPE increased state flow in archers and golfers (Kaufman et al., 2009). Furthermore, it has also been demonstrated to improve performance, as demonstrated in one-year follow up of runners that had completed the mindful intervention, their miles were significantly faster than pre-assessment (Thompson et al., 2011).

Other mindfulness interventions have either implemented components of MAC or MSPE or just included meditative sessions. The interventions have tended to be shorter than the official MSPE and MAC protocols. Shorter interventions may be more practical for the athlete as they already have demanding daily routines therefore the sessions can be more readily available to more athletes. These interventions also demonstrated to have a beneficial impact on the athlete and/or their performance (Bühlmayer et al., 2017). For instance, Baltzell and Summers (2018), implemented a 30-minute mindfulness meditation training for sport (MMTS) intervention for 12 sessions over six weeks whereby athletes were involved in breathing exercises, self-compassion, and non-judgmental acceptance of difficult experiences. After each session they would discuss how they could apply their learnt mindfulness to their sporting field. The athletes that were given this intervention increased their mindfulness, psychological well-being, and life satisfaction (Baltzell & Akhtar, 2014), however, there was no direct measure of performance. Aherne et al. (2011), on the other hand, found increases in aspects of peak performance for athletes that followed their mindful practice. In this study, athletes completed 6 weeks, 30 minutes, twice a week of mindfulness training with four specific exercises (breath, breath and body, standing yoga and body scan) aimed to increase body and breath awareness. The intervention resulted in increases in flow experience compared to the control group. Similar flow increases were also demonstrated in competitive cyclists that completed an 8-week mindfulness programme that incorporated weekly workshop sessions, home-meditation training, and group stationary spinning session (Scott-Hamilton et al., 2016). Compared to the control group, their flow and mindfulness levels were greater post mindfulness.

Nevertheless, the research to date has exhibited several limitations such as there being a small number of double-blind randomised trials, unknown level of commitment to interventions, lack of well-designed randomised control trails and inactive control groups, which have all reduced the internal validity and causal conclusions of the studies (Bühlmayer et al., 2017; Noetel et al., 2017). Consequently, the results from the studies may not be a true reflection of what happened. One way of maintaining internal validity, comes from brief, highly controlled mindfulness induction studies (Levin et al, 2012). Researchers have recently investigated the effect of brief mindful interventions; these have demonstrated mixed results. Perry et al. (2017) randomly assigned undergraduates with limited experience of golf to a mindful or control group. Those who completed 30-minutes of mindfulness, including the Brief Centering Exercise (3-5 minutes), putted more accurately, had greater flow state experiences and lower state anxiety, compared to the golfers in the control group. In contrast, Wolch et al. (2019), randomly assigned, using matched pairs, sixteen participants to a 15-minute guided mindfulness meditation and a further sixteen to a control exercise of listening to 15-minutes about the history of basketball. Following this, the basketball players were instructed to take 20 free-throws, whilst being observed and knowing there was a monetary incentive for the winner (pressured condition). There were no differences in performance between the groups, but the mindful group reported lower anxiety levels (cognitive and somatic) in the pressured condition. Limitations included sample size, varying experience levels and that they had to return for the high-pressure phase meaning there may be a confounding variable, such as the athletes may have practiced in between sessions. Nevertheless, Shaabani et al.

(2020) investigated the effects of 15-minutes of breath and body mindfulness, on the detrimental effects of ego-depletion, cognitive overload of the working memories resources, and basketball free-throw performance under pressure. Results demonstrated that brief mindfulness increased participants' mindfulness state, mitigated ego-depletion and maintained basketball free-throw performance under pressure compared to the control group that listened to 15 minutes of the natural history of Iran. This study suggests that brief mindfulness may reduce ego-depletion under pressure which is beneficial for performance. Nevertheless, the sham mindfulness intervention given to the control group may have also reduced ego-depletion, if the participants had switched off due to the sham audio being perceived as boring. Overall, there are limitations with each of the brief mindful interventions, but they do present promise in activating mindful states and possibly benefiting athletic performance under pressure.

Most mindfulness interventions are very general and not sport-specific, which may limit their effectiveness as individuals have described them as 'boring' and expressed a desire for more sport-specific mindful practices (Baltzell & Summers, 2018; Hopper, 2017; Misretta et al., 2017). Worthen and Luiselli (2016) examined the attitudes and perceptions of female high-school athletes after they had attended a sport focused mindfulness intervention. The volleyball players that were given sport-specific mindful exercises to do whilst serving or passing endorsed more mindfulness during competitive games and practice than the high-school athletes that were not given sport-specific mindfulness exercises. Furthermore, the players also stated that the sport focused mindfulness helped them stay focused, have more emotional awareness and aided effective team play. Therefore, suggesting the benefits of using sport-specific mindfulness meditations. The use of sport-specific mindfulness is not a recent concept as described earlier, Kabat-Zinn

(1990), the first author to apply mindfulness to the sporting context, rowing, utilised meditation sessions that were specific to their stroke cycle and techniques to stay focused during competition. Rowers who participated in the mindfulness meditation stated that they had an increased ability to concentrate and relax increased and their negative thought patterns decreased, additionally they believed they performed better than before the intervention, with winning many medals at the Olympic games. Nevertheless, there is no official reported evidence from this study. Despite this, Hoppler (2017) developed a sport-specific guide to mindfulness practices that can be used in continuous sports such as walking, running, cycling, and skating. For instance, runners are taught to concentrate on being aware of their bodily sensations and not let their mind wander during their run. Additionally, Hoppler (2017) outlined mindful practices that were drill-specific to shooting, passing and throwing. For example, one of the drills the author described to enhance awareness was for athletes to play with the lights off which forces them to increase their awareness of touch, hearing and communication with teammates. One study that has implemented a sport-specific mindfulness practice, is in competitive cycling, through mindful spinning (Scott-Hamilton et al., 2016). However, the cyclists did not complete mindful spinning alone, it was also accompanied by the Mindfulness-integrated cognitive behaviour therapy program (Cayoun, 2011). Although the mindfulness intervention was found to enhance cycling performance, the exact effect and whether sport-specific mindfulness exercises did further increase the benefits of mindfulness on sport performance could not be determined. Subsequently, the implementation of sport-specific mindful exercise warrants further investigation.

Mindfulness & Reinvestment

Mindfulness clearly has a beneficial effect on performance but the exact mechanism underlying this is yet to be understood (Birrer et al., 2012). The main objective of mindfulness is to help individuals to regulate their attention (Birrer et al., 2012). This is achieved through using mindful practices where individuals are told to try and draw their attention to sensations or experiences such as pain, a body part, breathing, to help bring the individual into the present moment. This present moment awareness is very similar to flow, as athletes tend to be completely absorbed and engaged in the present (Baltzell & Summers, 2018). There are many intervention studies that have documented that mindfulness training increases the levels or the likelihood of the athletes entering flow-state (Corbally et al., 2020). Nevertheless, mindfulness may also help athletes to regulate their self-focus, whereby it helps athletes to shift their attention to more helpful modes of thought (Birrer et al., 2012). Birrer et al. (2012), proposed that mindful athletes may be less likely to suffer from reinvestment, as they have increased experiential acceptance, this is where the athletes accept an unexpected fault or poor performance. Athletes will therefore not ruminate or consciously reflect on the consequence of their action preventing reinvestment processes being triggered. Josefsson et al. (2017), found that mindfulness reduced rumination, which is a similar process to reinvestment and improved the capacity of athletes to regulate negative emotions (emotional regulation). Although there have been proposals that mindfulness can prevent reinvestment, the research so far has only supported the act of mindfulness preventing the repercussions of reinvestment, consequently, this direct influence needs exploring.

Mindfulness versus Other Interventions to prevent Reinvestment

Implicit learning techniques have been used as the principal way to prevent reinvestment (Masters & Maxwell, 2004). These techniques have also provided mixed evidence to preventing reinvestment under pressure (Grospel & Mesagno, 2019). For instance, implicit learning techniques has been found to benefit golf-putting performance in novice golfers and shooting in basketball players under pressure (Lam et al., 2009). In contrast, explicit instruction in both novices and intermediates has proven to be beneficial for performance under pressure compared to using an analogy (Schlaphohl et al., 2012; Tse et al., 2017). Additionally, implicit learning techniques have proven to not be as universally beneficial as they were once stated (Masters & Maxwell, 2008). Van Duijn et al. (2019) found the performance of novices who exhibited a high verbal preference remained stable after receiving an analogy, compared to those with a low verbal preference, their performance deteriorated after the analogy. It was suggested that those with a high verbal preference could handle the cognitive load of the analogy and utilise it compared to those with a low verbal preference. Moreover, there are questions over the practicality and applicability of implicit learning techniques to all skills in a sport and researchers have suggested that some of the complexities of the skill could be missed (Poolton & Zachery, 2007). Furthermore, with the recent theory that consciousness over automaticity is beneficial for performance, if skills are learnt implicitly this may prevent a coherent mental representation of the skill being stored in a long-term memory (Meier et al., 2020), therefore athletes will not have the declarative information to tweak or adapt their motor movements effectively.

Psychological skills training (PST) has also been used to aid performance and prevent choking. However, PST has received mixed reviews in preventing choking, research has found they decrease negative internal states such as feelings of anxiety and increasing positive internal states like self-confidence, but the majority have found that the interventions have no direct effect on performance (Moore, 2009). Instead, authors have suggested that PST may be counterproductive, as it may inadvertently increase the likelihood of the athlete reinvesting. PST encourages the athlete to exhibit an internal mental control of their thoughts and feelings, which may in turn lead to the individual becoming too conscious and exhibiting too much self-focused attention on automatic movements, causing reinvestment and therefore deleterious effects on performance (Gardner & Moore, 2004; Masters & Maxwell, 2008). To conclude, mindfulness provides a superior alternative approach to the PST and implicit learning techniques previously implemented, nevertheless with mindfulness being a new concept within sport, this needs further investigation.

Thesis Research Aims

Successful performance is what athletes desire most, especially in moments where it really matters. Therefore, understanding the mechanism behind poor performance is vital moving forward. Reinvestment is one process that can cause poor performance; however, the research is mixed as to whether it causes poor (Iwatsuki & Wright, 2016), null (Malhotra et al., 2014) or aids (Malhotra et al., 2015a) performance, which may be due to the generic nature of the scale(s) and the limited field-based research. Consequently, there is a need for the development of a sport specific reinvestment scale and further exploration of the process in the competitive field. Once this is achieved, developing an intervention to prevent this process and increase the likelihood of an athlete achieving optimal performance is required. Mindfulness is a promising practice to reduce the likelihood of reinvestment and assist an athlete’s performance. It is a new concept within sport but a practice that has demonstrated good results in relation to performance-relevant variables such as flow-state (Bühlmayer et al., 2017). Therefore, the aim of this thesis was to examine the effect of reinvestment and mindfulness on performance.

The aim of Chapter 2 was to develop and validate a state rowing-specific reinvestment scale. This was achieved in a two-part study, firstly through discussing with coaches and rowers what their conscious processes were during performance. These discussions informed the adaptation of some of the Movement-Specific Reinvestment Scale (MSRS) items and addition of other items. Exploratory factor analysis was then conducted to form a two-factor model. In the second part of the study, the Rowing Specific Reinvestment Scale (RSRS) was evaluated through a confirmatory factor analysis and content validity of the scale was examined through evidence of convergent, discriminant, and predictive validity.

Following validation of the RSRS, Chapter 3 aimed to investigate whether sport-specific mindfulness could moderate the moderation effect of reinvestment on the anxiety-performance relationship. Rowers completed a state measure of anxiety, perceived performance, rowing-specific reinvestment and trait sport-specific mindfulness following their regatta race. Actual race performance was also recorded using a rank system depending on what position the rower's boat finished. It was hypothesised that 1) trait sport-specific mindfulness would be positively related to performance and 2) that higher trait mindfulness would attenuate the amplifying effect of rowing-specific state reinvestment on the anxiety-performance relationship.

Chapter 4 further explored the effects of mindfulness and reinvestment on performance. The aim of this study was to investigate the effectiveness of a brief sport-specific mindfulness meditation compared to a control condition on reinvestment, mindfulness and how an athlete deals with failures. Furthermore, we explored whether the different reinvestment processes were associated with the different orientations of dealing with failure. Rowers answered a pre intervention questionnaire that included rowing-specific reinvestment, sport-specific mindfulness and how they typically deal with failures scale. Following this, participants were allocated to the mindfulness or control group. In the mindfulness group they listened to a brief sport-specific mindful meditation, while in the control group they listened to rowing facts. Rowers then were given a typical race pressured scenario to imagine before answering the post intervention questionnaire, which included the same scales as the pre intervention questionnaire. It was hypothesised that the mindfulness group would have higher levels of action-orientation versus state orientation and lower levels of sport-specific reinvestment compared to the control group following the pressured scenario. Second, it was hypothesised that state-orientation would be positively associated with RS-CMP and RS-MSC, while action-orientation would be negatively associated with RS-CMP and RS-MSC.

Lastly, in Chapter 5 we aimed to develop a rowing-specific mindfulness intervention and explore its impact on mindfulness, flow, reinvestment and rowing performance. Rowers were either allocated into the 6 weeks rowing-specific mindfulness intervention or the control group. The control group received the mindfulness meditations following the 6 weeks. We hypothesised that the mindfulness intervention would increase mindfulness and flow, decrease reinvestment, and improve performance.

Chapter 2: Rowing-Specific Reinvestment Scale

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Introduction

Understanding the mechanism(s) underlying poor performance in sport competition has attracted considerable theoretical interest (for review see Mesagno & Beckmann, 2017). The theory of reinvestment proposes that conscious control of movements disrupts automaticity and thereby impairs performance (Masters & Maxwell, 2008). Surprisingly, some studies have found that trait conscious control and monitoring have no or beneficial effects on performance (e.g., Malhotra et al., 2015a; Mosley et al., 2017). Accordingly, the extent to which conscious control and monitoring of movements affect performance has yet to be established (Iwatsuki & Wright, 2016; Mosley et al., 2017; Orn, 2017). This uncertainty may be because (a) the scales used to measure these reinvestment processes (i.e., Reinvestment Scale, RS; Movement Specific Reinvestment Scale, MSRS) are general rather than sport-specific, and (b) most studies have assessed reinvestment as a trait rather than a state (Masters et al., 2005; Masters & Maxwell, 2008). Although traits are relatively stable, they are not always activated. This is because activation depends on the relevance of the trait to the situation, and specific situational cues activate specific traits (Tett & Guterman, 2000). Therefore, measuring the athlete’s state should reveal whether conscious control and monitoring of movements disrupts performance during competition. To date few studies have assessed state reinvestment and none have assessed state reinvestment in a field study or with a sport-specific scale that captures both conscious motor processing and movement self-consciousness. To address these gaps in our understanding of performance in sport, we developed a rowing specific state reinvestment scale and investigated rowing specific conscious processes during competition.

Dispositional reinvestment

Competitive sport creates pressure (Baumeister, 1984). This pressure may be private or public. Public pressure includes social evaluation from athletes, coaches, and spectators, whereas private pressure includes monetary incentives, medals or promotions for winning (Geukes et al., 2013). Athletes may thrive or struggle when facing the pressures of competition (Masters et al., 1993; Mosley & Laborde, 2015; Swann et al., 2017). One explanation for such individual differences in performance is personality (Baumeister, 1984; Mosley & Laborde, 2015); performance has been linked to stable dispositional characteristics or traits (Allport, 1937). Nevertheless, more recent research has proposed that traits are activated by specific situational cues and if those cues are not present the trait may not be activated (Geukes et al., 2013; Tett & Guterman, 2000). For instance, if self-presentational cues, such as an audience is present, this will activate self-presentation related traits, that is, public self-consciousness or fear of negative evaluation (Geukes et al., 2013; 2017). On the other hand, self-focus cues such as monetary rewards activate self-focus traits such as private self-consciousness (Geukes et al., 2013). In this way, performance will depend on the traits the individual exhibits and the nature of the trait by situation interaction.

One of the traits that may explain the variations in performance under pressure among athletes is reinvestment. Dispositional reinvestment describes an individual's tendency to consciously control their movements, which results in paradoxically poorer performance of the skill due to disruption of automatic control processes (Masters & Maxwell, 2008). To measure this tendency, Masters and colleagues developed the Reinvestment Scale (RS) using items from other scales that captured the reinvestment construct (Masters et al., 1993). Their scale included twelve items from the private self-consciousness and public self-consciousness subscales of the Self-Consciousness Scale (Fenigstein et al., 1975), seven items from the rehearsal subscale of the Emotional Control Questionnaire (Roger & Nesshoever, 1987), and one item from the Cognitive Failures Questionnaire (Broadbent et al., 1982).

Studies have found that trait reinvestment is related to performance under pressure (e.g., Masters et al., 1993; Maxwell et al., 2006; Poolton et al., 2004). For instance, Poolton and colleagues (2004) used RS scores to classify participants in a golf putting study as relatively high or low reinvestors. High reinvestors reported more declarative rules and performed worse under pressure than low reinvestors. Taken together, these experimental studies suggest that high reinvestors accumulate more rules about movement during learning and then reinvest this declarative knowledge resulting in poor performance under pressure. Trait reinvestment has also been associated with increased likelihood of choking under pressure – a substantial and sudden drop in performance relative to normal (Mesagno & Hill, 2013). Masters et al. (1993) conducted a correlational study and found that squash and tennis players with higher RS scores were also rated by their coach as more likely to choke under pressure. Overall, the studies suggest that those with high levels of dispositional reinvestment perform poorly under pressure. Nevertheless, the validity of the RS has been criticised on the grounds that it measures a number of traits that predict performance rather than movement reinvestment processes per se, therefore questioning interpretation of the findings (Jackson et al., 2006).

Movement-specific reinvestment

The Movement-Specific Reinvestment Scale (MSRS), developed by Masters et al. (2005), the scale measures two movement-specific conscious processes that cause reinvestment: conscious motor processing (CMP) and movement self-consciousness (MSC). The CMP subscale measures the extent an individual affords conscious control to their movement, whereas the MSC subscale measures the extent an individual is concerned about their movement style in front of others. Overall, studies have not always found that a movement-specific reinvestment is related to task performance. In experimental studies of laboratory-based skills, high movement reinvestment scores were associated with poorer performance under pressure in some golf-putting (Zhu et al., 2011) and basketball free-throwing (Orn, 2017) studies, but not other golf-putting (Malhotra et al., 2015a) and dart-throwing (Mosley et al., 2017) studies. These mixed findings may be due to a number of methodological issues, such as inexperienced participants and weak pressure manipulations (Geukes et al., 2017; Masters & Maxwell, 2008). For instance, inexperienced participants may have insufficient declarative knowledge to reinvest (Masters & Maxwell, 2008) or reinvestment processes may be aiding rather than hindering performance through enabling them to figure out successful motor strategies (Malhotra et al., 2015a). Consequently, less experienced performers tend to exhibit less automaticity of their movement compared to more experienced performers (Capio et al., 2018; Deeny et al., 2003; Kerick et al., 2004; Zhu et al., 2011).

Similarly, non-experimental, cross-sectional field studies have noted that trait movement reinvestment is not always associated with actual performance. In rowing, MSC but not CMP was related to actual rowing performance (Sparks et al., 2021a), however, most field-based studies have yielded null findings, such as those assessing netball passing accuracy during games (Jackson et al., 2013) and basketball free throw success during matches (Geukes et al., 2017). These studies suggests that trait movement-specific reinvestment may not always be relevant to competitive sport. Moreover, in non-experimental, correlational studies self-reported choking likelihood during competition was unrelated to MSRS (Iwatsuki et al., 2018) and CMP (Iwatsuki & Wright, 2016) scores. However, other non-experimental correlational research has found that choking was positively related to MSC scores (Iwatsuki & Wright, 2016), which provides some, albeit limited, support for the argument that athletes with higher MSC are more likely to underperform in competition.

Other researchers have investigated movement reinvestment in relation to the yips, a phenomenon characterised by a sudden loss of skill under pressure and a chronic form of choking (Clarke et al., 2020). Again, the findings are mixed. MSRS scores were not different between recreational golfers with and without the yips in an experimental laboratory-based study (Klämpfl et al., 2013). In contrast, in a non-experimental causal-comparative study, CMP and MSC scores were higher in expert baseball players with the yips compared to those without the yips (Gutierrez, 2018). Overall, it is unclear whether reinvestment is linked with choking. This issue warrants examination.

The aforementioned mixed findings may be explained by trait-activation theory (Tett & Guterman, 2000). According to this theory, trait-relevant situational cues/demands activate the trait and elicit the behaviour; the trait will not be activated without the specific situational cues (Mosley & Laborde, 2016). Consequently, athletes may exhibit high levels of trait reinvestment, however, they will not underperform if they do not express this trait because of the sterile performance environment. For instance, Geukes et al. (2013) found that the type of situational pressure can determine which traits are activated. Furthermore, similar to the trait-activation theory, researchers have found that individuals do not always express the behaviour of a certain trait they exhibit, unless a specific situation presents itself that activates the trait, a phenomenon known as intra-individual variability (Laborde et al., 2020). Consequently, it follows that a state measure of conscious processing should better capture reinvestment in sport and thereby examine its role in their competitive performance.

State conscious processing

Electroencephalography (EEG) has yielded a putative cortical measure of conscious processing during the execution of a motor task. Studies have measured the coherence between the left temporal region (T3 or T7), linked with language, and the frontal region (Fz), responsible for higher order cognitive functions, such as motor planning. Measuring the cortico-cortical communication between these regions seeks to assess verbal-analytical processing during motor planning and execution. Experts exhibit less T7-Fz coherence than less skilled performers during shooting (Deeny et al., 2003) and golf putting (Gallicchio et al., 2016) tasks. Moreover, T7-Fz coherence is reduced after learning, reflecting that performers become more automatic in executing their movements with learning (Gallicchio et al., 2017; Kerick et al., 2004). Taken together these findings are compatible with the proposal that conscious processing is reduced during the transition from the cognitive stage to the autonomous stage of skill acquisition. Building on this evidence, reinvestment theory proposes that conscious processing will be increased when the performer is confronted with pressure to perform, such as in competition. Support for this proposal comes from evidence that pressure increased left temporal-frontal coherence and impaired golf putting performance in experimental studies (Gallicchio et al., 2016; Zhu et al., 2011). In line with the concept of movement-specific reinvestment, these findings suggest that the more individuals engage in conscious processing during movement execution the worse their performance.

The contrasting findings between studies using the EEG measure and self-reported MSRS measure of conscious processing may be because the EEG is a real-time state measure. The former captures the conscious processing that occurs during the task, whereas the latter is a trait measure that captures the general disposition to engage in conscious processing. In a key experimental lab-based study, Gallicchio et al. (2016) measured conscious processing using both T7-Fz EEG coherence and a putting-specific state CMP scale and found evidence that golfers with high T7-Fz coherence reported high state CMP. Using the same putting-specific scale to assess state CMP, a previous study found that individuals reporting high CMP while putting performed worse under pressure than individuals reporting lower CMP (Cooke et al., 2011). Collectively, these studies suggest that engaging in conscious processing during skill execution in a pressurised context deleteriously impacts performance. Furthermore, a sport-specific measure may better capture conscious processing, which is consistent with other scales in sport psychology (e.g., Gallicchio et al., 2016; Horn, 2008; Papaioannou & Hackfort, 2014). Sport-specific measures help athletes to understand and relate to items compared to a generic measure and therefore improve the results (Horn, 2008; Papaioannou & Hackfort, 2014). Therefore, with the reinvestment literature demonstrating equivocal findings, a sport-specific measure is needed to further improve our understanding of the phenomenon and consequences of reinvestment in different sports. For instance, the literature is saturated with investigations conducted on discrete skills, such as ball pass, a dart throw, and a golf putt (e.g., Jackson et al., 2013; van Ginneken et al., 2017; Zhu et al., 2011), but these may be influenced by reinvestment differently compared to continuous skills.

Continuous motor skill – rowing

To further explore conscious processing, the present study examined a continuous motor skill in a field-based study. Performers choke in continuous motor skills, such as swimming, running, biking and rowing, but the mechanism behind choking or underperformance in these sport has been neglected (Roberts et al., 2019). Consequently, it is an issue that needs further exploration, so strategies can be developed to prevent underperformance in these sports. For instance, if rowers reinvest, then strategies, such as mindfulness (Birrer et al., 2012) or implicit learning techniques (Liao & Masters, 2001), could be implemented to prevent this. Furthermore, the majority of reinvestment studies have been laboratory-based. However, laboratory-based pressure manipulations may not be potent enough to equal the pressures felt in competitive sport (Mesagno & Hill, 2013). To address this potential limitation, the present study examined athletes under race conditions at county and national rowing events.

Rowing is typically a crew-based sport that requires both intra-personal and inter-personal coordination that imposes both self-focus and self-presentational pressures (Geukes et al., 2013). Self-focus pressures include incentives to win, such as medals and selection for a seat in the top boat (Geukes et al., 2013), while self-presentational pressures include the self-conscious evoking nature of the environment, as rowers tend to row in crews of between two and eight rowers plus a cox (who is responsible for steering the boat and directing the rowers). A rower’s strokes can be observed by the cox and any crewmates who sit behind them in the boat. Consequently, there is potential to reinvest in competition.

One possible performance-related consequence of reinvestment in rowing is crabbing. A ‘crab’ describes what happens when the blade of the oar is trapped underneath the water, acting as brake to slow or stop the boat, and forcing the handle of the oar back into the rower. Crabbing has been deemed a type of choke, a significant drop from typical performance and technical fault (a mistake), because it tends to occur in pressure situations due to over-gripping of the blade and falling out of synchrony with the stroke and crew. Consequently, exploring the difference between crabbers and non-crabbers in relation to conscious processes should improve our understanding of its aetiology, treatment and further validate our reinvestment measure as predictive of disrupted performance under pressure.

Present research

In summary, the evidence reviewed above is mixed regarding the extent to which movement-specific conscious processing affects performance and plays a role in choking under pressure. This heterogeneity is in part due to the MSRS scale being a generic trait measure. Traits are not always activated (Geukes et al., 2013) and athletes may not relate to the general movement items in the context of their sport. Therefore, a sport-specific state measure should better capture these conscious processes and subsequently aid the exploration of these processes on performance. The primary purpose of the present research was to develop a rowing specific state reinvestment scale. This was assessed in our first sub-study, where we examined the content and factorial validity of the new scale. A secondary purpose was to further validate the scale, investigating the factorial, internal and external validity of the new scale with a different sample.

Sub-Study 1: Development of the rowing specific reinvestment state scale (RSRS)

First, we generated 25 items for rowing specific reinvestment state scale and tested the content validity of the items chosen. Second, we tested the factorial structure of the items using Principal axis factoring (PAF) to discover their higher-order structure and remove any problematic items. Finally, we computed the internal consistency of the items that comprised the final factors.

Methods

Stage 1: Scale construction

The first step when developing a scale is to define the construct and elements that comprise it (Clark & Watson, 2019). The theoretical basis for the scale was derived through an extensive literature review of reinvestment, using major search engines (e.g., PsycINFO, Taylor & Francis Online, ScienceDirect). Once the definition of the construct and elements were formed, we then took an inductive approach to scale construction. We discussed with coaches and rowers about their conscious thoughts, feelings and evaluative apprehensions whilst rowing. Using both inductive and deductive approaches is recommended when developing a new scale to better capture the construct being measured (Boateng et al., 2018). A total of 25 items were developed, which was deemed an appropriate number as it should be at least twice as long as the final scale (Schinka et al., 2012). Three of the items were modified from the MSRS (Masters et al., 2005) as they were deemed appropriate and related to rowing by the coaches and rowers. For example, the CMP item “I am aware of the way my body works when I am carrying out movements” was adapted to “I was aware of how I controlled my body while I was rowing”.

Stage 2: Content validity

Content validity refers to the extent to which a group of items reflect a specific construct (DeVellis, 2016), and is best evaluated by experts in the research domain (Bolarinwa, 2015). Therefore, seven sport psychology academics, with experience in reinvestment theory and scale development, completed the content validity questionnaire. These academics were provided with a definition of each subscale construct, shown items relating to each construct, and told to rate them on a 5-point Likert scale, with anchors of −2 (*not at all representative*) and +2 (*very representative*). Additionally, they were asked to write comments about each item to explain their score and how they would change or alter the item. Next, items were removed or altered, and the revised items were sent out again to the experts until every item was judged to be representative. During this process of scale development eight items were removed due to the items deemed not representative of rowing-specific conscious motor processing or movement self-consciousness.

Stage 3: Pilot test

A sample of 25 intermediate level rowers and coaches then completed the scale following a competitive race. The aim of this stage was to assess the items to see whether they were coherent and to ensure that items for each subscale were positively related (Clark & Watson, 2017). This is an essential part of scale development as it enabled us to harvest respondents' opinions of the items and eliminate or change any problematic items before being evaluated by in a larger sample (Morgado et al., 2018). Two of the items were removed for being too complex, as they were double-barrelled items with the use of "and/or", therefore making it awkward for the respondent to answer, as they may have performed one of the actions but not the other (Clark & Watson, 2017). Furthermore, 10 items were reworded slightly but their original content was preserved. A 7-point Likert scale, anchored by 1 (*strongly disagree*) and 7 (*strongly agree*), was chosen due to 7-point Likert scales yielding more reliable responses than other scale lengths, as they reduce potential biases, such as acquiescence or extreme response bias (Chyung et al., 2017).

Stage 4: Exploratory Factor Analysis (EFA)

Participants

Following ethical approval, rowers (175 females, 107 males) with at least one year's experience of rowing (*M* = 14.48, *SD* = 12.21 years) completed the post-race questionnaire. Their competitive standard was beginner (6%), intermediate (85%) and elite (9%). These categories were taken from British Rowing, the competitive standard that a rower competes at depends on their Personal Ranking Index (https://www.britishrowing.org/events/competition-framework/ranking-points/).

Procedure

Worldwide English-speaking rowing clubs that competed during the regatta season, were contacted through recruitment letters or posters via email or social media platforms (i.e., facebook, twitter). Club presidents or captains were asked to contact the lead investigator if they were interested in facilitating the advertisement and administration of the 15-item rowing specific reinvestment state scale in their club (Appendix 2A). Each rower was provided with written information that explained the research aims, that all responses would be confidential, and that participants had the right to withdraw at any time. Rowers that wished to take part then provided informed consent before completing RSRS following a regatta race (Appendix 1A).

Results

Exploratory Factor Analysis

Before proceeding with the EFA, we first analysed the inter-item correlations between the 15 items, and any items that had several correlations below .15 (not representing the same construct) or above .50 (multicollinearity) were removed (Clark & Watson, 2017; Field, 2013). This led to the removal of two CMP items. Two *a priori* analyses were conducted to examine the factorability of the items: Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity. KMO analysis revealed that the sample was adequate for the model with a score of .90, representing a meritorious score and indicating that partial correlations among variables were small (Kaiser, 1974). Bartlett's test of sphericity was significant indicating that linear combinations existed and variables within the population correlation matrix were uncorrelated (Watson, 2017). The results of these tests signalled that we could proceed with the EFA (Kaiser, 1974; Tabachnick & Fidell, 2013).

PAF was chosen, as it has proven to generate reliable solutions (Watson, 2017). Additionally, we employed the oblique rotation method of direct oblimum, as this allows factors to freely correlate. The initial unrestricted EFA revealed no initial communalities that were below <.30, therefore, suggesting that the sample size was adequate (Leech et al., 2014). The EFA revealed a two-factor solution with eigenvalues for both factors exceeding 1.0 (Kaiser, 1960). Following this, these items were removed if they were deemed problematic, namely, they had cross-loadings of >.32 (Tabachnick & Fidell, 2013) or a poor loading of below ≤.40 (Matsunaga, 2010). One RS-MSC item was problematic, as it obtained a poor loading of .22 on both factors. In sum, the analyses yielded 12 items that loaded on two distinct factors, with six rowing specific MSC items and six rowing specific CMP items. The results for the oblimin rotation are shown in Table 2.1. Internal consistency of the subscales was assessed using Cronbach alpha analysis and Omega H on each subscale, with very good consistency scores for both, above .70 (Table 2.2).

Table 2.1

Principal axis analysis with oblimin rotation for 12 items of the RSRS

Items	Factors	
	RS-CMP	RS-MSC
I was conscious of how I coordinated all of my rowing movements	.81	
I thought about whether I was implementing the correct body movement sequence	.72	
I thought about whether my movements were technically correct	.71	
I was aware of how I controlled my body while I rowed	.65	
When I made a bad stroke I immediately tried to figure out why my technique failed so I could correct my mistake	.60	
I used conscious effort to adjust my movement to synchronise with my crew	.54	

I was concerned about what people (e.g., coach, crew) thought about my rowing	.83
I was concerned about how my style of rowing looked to others	.79
I was conscious about how my rowing technique looked to others	.75
I was mindful that my rowing needed to make a good impression on my coach and squad	.74
I believed that everyone was just looking at me and scrutinising my rowing	.66
I was concerned my crew (e.g., cox, seat behind) thought I had poor technique when something went wrong (e.g., I fell out of synch)	.65

Note: N = 282

Table 2.2.

Descriptive statistics, alpha coefficients, and zero-order correlations between conscious motor processing, movement self-consciousness, private and public self-consciousness, state-anxiety and perceived performance (N = 270).

Variable	*M*	*SD*	α	O	RS-CMP	RS-MSC	CMP	MSC
RS-CMP	5.06	.91	.72	.83				
RS-MSC	4.72	1.27	.88	.85	. 45^{***}			
CMP	4.51	1.06	.75	.84	$.22^{***}$	.06		
MSC	3.95	1.37	.83	.83	$.14^{*}$	$.38^{***}$		
Actual Performance	47.00				−.07	$−.12^{*}$	−.03	-.06
RS Overall perceived performance	4.70	.77			.01	$−.20^{***}$	.03	$-.16^{**}$
Overall perceived performance	4.92	.84		.80	.04	$−.14^{*}$	.02	$-.27^{***}$
Perceived Technical Performance	4.67	.82			.01	$−.23^{***}$		
Perceived Strength	4.89	1.17			−.01	−.09	.03	$-.17^{**}$

Perceived Tactical	5.09	1.24			.06	.02	−.01	.08
Perceived Psychological	5.05	1.27			.08	−.18**	.03	-.22**
Private Self-Consciousness	2.58	0.36	.44	.73	.17*	.17*		
Public Self-Consciousness	2.84	.68	.84	.78	.13*	.44***		
State Anxiety	5.80	1.20	.76	.78	.05	.35***		

Note. The response scales for Rowing Specific State Reinvestment Scale (RSRS), Movement Specific Reinvestment Scale (MSRS), Rowing Specific (RS) and perceived performance were 1–7, self-consciousness was 1–4, and state-anxiety was 1–10. Rowing Specific Conscious motor processing = RS-CMP; Rowing Specific Movement Self-consciousness = RS-MSC; Conscious motor processing = CMP; Movement Self-consciousness = MSC. *$p < .05$, $p < .01$**$p < .001$***.

Sub-Study 2: Confirmatory Factor Analysis (CFA) and construct validity of RSRS

This study had two purposes, first we explored the adequacy of the factorial structure of the newly developed 12-item scale with a new sample, using CFA. Second, we investigated the construct validity of the scale by assessing the scale's convergent, discriminant and predictive validity. Convergent validity is the degree to which a measure relates to a scale that measures a theoretically similar construct (Struwig et al., 2001). To evaluate the convergent validity of the RSRS we computed the correlations between the established MSRS and RSRS subscales, respectively. We also used the Self-Consciousness Scale, as previous reinvestment research has suggested that a component of reinvestment is self-awareness; hence, the original reinvestment scale included items from the Self-Consciousness Scale, and, therefore, the scales should correlate positively (Geukes et al., 2012; Masters et al., 1993). Following this, we considered the discriminant validity of the scale, which considers how theoretically dissimilar two constructs are and therefore low correlations between the two would support this form of validity (Clark & Watson, 2017). With this in mind, we examined the relationship between RSRS and state anxiety, based on previous research showing that anxiety is unrelated to reinvestment (Laborde et al., 2015).

Finally, we investigated predictive validity. This is where the developed scale predicts the outcome of another criterion variable recorded at a different time point (Kline, 2015). We examined this by computing the associations between the scale and perceived performance, actual race performance, rowing experience, and examining the difference between levels of rowing specific conscious processing between rowers who did or did not crab during the race. Further, we conducted multiple linear regressions between RSRS and MSRS subscales to compare the predictive validity of the subscales in relation to actual performance and crabbing. In line with previous reinvestment research showing that a propensity to reinvest is related to poor performance under pressure (Gutierrez, 2018; Iwatsuki & Wright, 2016; Zhu et al., 2011) we expected a negative relationship between the RSRS, actual and perceived race performance and a significant difference in RSRS between those that crabbed and those that did not, to thereby demonstrate its predictive validity. Furthermore, we anticipated that RSRS subscales would better predict performance over the MSRS subscales due to sport-specific scales exhibiting a better ability to capture conscious processing (Horn, 2008; Papaioannou & Hackfort, 2014). Based on previous research showing that more experienced and skilled individuals scored lower self-reported MSC (Capio et al., 2018) and displayed less EEG T7-Fz connectively (Gallicchio et al., 2016), we expected a negative relationship between RSRS and rowing experience, and differences among skill-levels for RSRS scores, providing further support for the predictive validity of the scale.

Methods

Participants

Rowers (175 females, 94 males) ranged from senior and masters racing bracket, with 78% of the sample characterised as senior (18–26 years old), and 22% as masters (27–100 years old) (*M* = 43–49 age category, *SD* = 1.9 age categories) gave consent and participated (Appendix 1A). The age brackets are used to make sure rowers do not have an age advantage and that they race against similar ages. All rowers had at least one year of rowing experience (*M* = 14.63, *SD* = 12.20 years) and similar to Study 1, were categorised depending on their competitive racing standard (6% beginner, 81% intermediate, 13% elite).

Procedure

Following ethical approval, we sent recruitment emails to over 100 clubs that were hosting or competing in regattas (ranging from 500 to 2000 m). Clubs were provided with an information sheet that explained the nature of the study and were requested to contact the lead investigator if they agreed to participate or would facilitate the distribution of questionnaires at their regatta. The 83 clubs that agreed were given a recruitment poster, participant information sheet and an online link to the questionnaire to be released by the club online after they had competed or hosted. The questionnaire was hosted on an online platform (SmartSurvey), the first page stated information about the study and collected informed consent. The following pages included demographic and race information, after this each psychological scale was on a new page. The principal investigator also visited five regattas in the Midlands and administered a hard paper copy of the questionnaire during the event and only after the rowers had competed in a race (same day). Before completing the questionnaire, rowers were provided with written information that explained the research aims, that all responses would be confidential, and participants had the right to withdraw at any time. Any rower who had competed in the regatta, in any size boat (single to eight), coxless or coxed boat and had at least one year's rowing experience were eligible to participate. Following informed consent, the rower completed the questionnaire. Overall, participation took 20 minutes.

Measures

Rowing Specific Reinvestment State Scale (RSRS)

The 12-item RSRS was used to measure state rowing specific CMP and MSC (Appendix 2B).

Movement-Specific Reinvestment Scale (MSRS)

The 10-item scale measures the conscious processes of movement; it is comprised of two subscales the CMP and MSC (Masters et al., 2005). Five of the items form the CMP subscale (e.g., "I am aware of the way my body works when I am carrying out a movement") and five of the items belong to the MSC subscale (e.g., "I am concerned about what people think about me when I am moving"). Rowers were asked to think about their everyday movements (e.g., walking down the street, driving car, eating a meal) and indicate the extent to which they agreed with each of the statements. Both subscales' items are rated on 7-point Likert Scale, anchored by 1 (*strongly disagree*) and 7 (*strongly* *agree*). Both subscales possessed good test–retest reliability and acceptable internal reliability. Cronbach alpha (Cronbach, 1951) and Omega H (McDonald, 1999) coefficients were all above .70 (see Table 2.2).

Perceived performance

Perceived post-race performance was measured using a rowing specific version of a measure of perceived performance used in previous research (e.g., Al-Yaaribi et al., 2016) and a rowing specific perceived measure of technical performance (which was developed from discussions with coaches about parts of the stroke cycle that were likely to break down under pressure). Factor analysis for the rowing specific technical perceived performance scale demonstrated that all items loaded onto one factor (Appendix C). Both measures were 7-point Likert scales, where participants would rate themselves between 1*(very poor*) and 7 (*excellent*). The perceived performance measure consisted of five items including technical (i.e., stroke, timing, optimal catches), tactical (i.e., positioning, race awareness), physical (i.e., acceleration, power and endurance), psychological (i.e., focus, mental toughness and confidence), and overall performance. The rowing specific perceived technical performance measure included nine items about technical rowing performance that tend to deteriorate under pressure. Rowers were asked “Please rate aspects of your technical performance in today’s race?” on items such as “catch placement”, “body position at the catch”, “squaring of blades with crew”, and “synchronicity with your crew” (See Appendix 2C). For both measures, athletes were asked to rate their level of perceived performance in relation to the race they had just completed. Both scales possessed good internal consistency, with Cronbach alpha and Omega H coefficients all above .70 (see Table 2.2).

State anxiety

State anxiety was measured using the Mental Readiness Form-Likert (MRF-L) (Krane, 1994). This multi-dimensional scale 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 were asked to rate themselves on each item depending on how they felt during their race 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 demonstrated high validity and reliability (Krane, 1994) compared to longer and more extensive anxiety scales such as the Competitive Sport Inventory (Martens et al., 1990). MRF-L possessed good internal consistency, with Cronbach alpha and Omega H coefficients all above .70 (see Table 2.2).

***Self-consciousness scale (*Fenigstein et al., 1975)**

This 23-item scale consists of three subscales measuring private self-consciousness, public self-consciousness, and social anxiety. Private self-consciousness analyses covert aspects of oneself, so the extent that an individual reflects on oneself and their feelings, motives and cognitive processes. Public self-consciousness assesses the tendency an individual may reflect on oneself in relation to the social world, that is, the impression they make on others. Individuals rate themselves on a 4-point Likert from 1 (*extremely uncharacteristic*) to 4 (*extremely characteristic*). Self-consciousness subscales possessed good internal consistency, with Cronbach alpha and Omega H coefficients all above .70 (see Table 2.2).

Crabbing

Crabbing was measured by rowers declaring whether they crabbed during their race with a "*yes*" or "*no*" answer. This was also measured using a 5-item scale: 1 (did not crab), 2 (mini crab), 3 (near full crab), 4 (full crab), and 5 (ejector crab).

Actual performance

Actual performance reflected the performance of the boat (i.e., the whole crew). It was recorded by using information that each participant provided regarding their race, which enabled us to identify their boat's finishing position (e.g., second out of six boats) from the official race results. Using a relative ranking system to standardise the variability across races (i.e., number of boats taking part in a 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 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. 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 crew member 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.

Data analysis

Confirmatory Factor Analysis (CFA)

The two-factor structure of the RSRS was assessed using CFA in M*plus* 8 software package (Muthén & Muthén, 2018). First, we examined the univariate skewness and kurtosis and multivariate kurtosis of the data using AMOS (26.0). Both univariate skewness and kurtosis of the items was minimal, with scores below 3 (Kline, 2015). However, the normalised Mardia's coefficient of multivariate kurtosis value was high (38.20), indicative of departure from multivariate normality (Bentler & Wu, 2005). Therefore, to compensate for this, we chose to use the diagonally weighted least squares estimator (WLSMV in M*plus*) instead of the popular maximum likelihood (ML). WLSMV was chosen as one of ML's assumptions is that the data exhibit a multivariate normal distribution, whilst WLSMV is more robust when there is non-normalised data (Sellbom & Tellegen, 2019). Additionally, ML tends to be used with continuous data; therefore, if implemented with Likert data, this can yield biases and overestimations, whilst WLSMV is recommended to use and has proven to outperform ML in these conditions (Li, 2016; Sellbom & Tellegen, 2019).

Absolute and incremental fit indices were used to estimate the adequacy of the model's fit. Overall fit of the model was first examined, using chi-squared statistic (χ^2), where a small value relative to the degrees of freedom with an insignificant *p* value indicates a good fit (Kline, 2015). However, there are a number of limitations to this test, as it assumes multivariate normality and it is very sensitive to sample size (Kline, 2015; McIntosh, 2007). Therefore, there is a possibility that this test may reject a perfectly adequate fitting model. To minimise this scenario, several commonly used fit indices were also calculated, including the standard root mean square residual (SRMR), Tucker–Lewis index (TLI), Comparative fit index (CFI), and root mean square error of approximation (RMSEA) (Hu & Bentler, 1999; Kline, 2015). The SRMR reveals the absolute model fit as it tests the average difference between the sample's variance and covariance, a score of <.08 reflects an adequate fit (Hu & Bentler, 1999). The TLI and CFI provided incremental indices, and scores of greater than 0.90 and 0.95 are regarded as acceptable and excellent fit, respectively (Afthanorhan, 2013). Finally, RMSEA was used to understand to what extent the model approximates the observed data compared to a saturated model, with <0.5, 0.05–0.08, 0.08–1 and 1.0< reflecting a good, acceptable, marginal, and poor fit, respectively (Fabrigar et al., 1999).

Construct and Predictive validity

The data were analysed using SPSS 25. First, to explore the internal consistency of the scale, we computed the coefficient alpha of each MSRS and RSRS subscale (Cronbach, 1951). Second, to evaluate the construct validity, we examined the convergence and divergence of the RSRS scale with MSRS, Self-consciousness scale and MRF-L. We computed the bivariate Pearson correlation coefficients between RSRS, MSRS, Self-consciousness scale and MRF-L. Third, to investigate the criterion validity, we analysed the bivariate Pearson correlations between RSRS, perceived performance measures, experience levels (years) and actual performance. Effect sizes for correlation coefficients of 0.1, 0.2 and >0.3 corresponded to small, medium, and large, respectively (Gignac & Szodorai, 2016). Additionally, we explored a one-way Analysis of Variance (ANOVA) between crabbers (n = 38) and non-crabbers (n = 232) for RS-CMP and RS-MSC.

Lastly, we assessed the predictive ability of RSRS subscales over the corresponding MSRS subscales in relation to actual performance and crabbing. We ran four multiple linear regressions, with CMP, RS-CMP, MSC and RS-MSC as predictors and crabbing and actual performance as outcomes.

Results

CFA

The two-factor model demonstrated a poor overall model fit according to chi-square, (χ^2 (53) = 190.93, $p < .001$) but adequate fit indices for SRMR (.050), RSMEA (.09, CI = 0.08 to 0.11) and excellent fit indices for CFI (.94) and TLI (.92). Together, these results demonstrated that the model had an acceptable fit to the data.

Internal reliability

Similar to before, Cronbach alpha reliability analysis was conducted on each subscale in this new sample, again revealing good internal consistency scores for CMP (α = .72) and MSC (α = .89) subscales.

Convergent and discriminant validity

First, convergent validity was demonstrated between the RSRS subscales and the corresponding MSRS subscales, with correlations between .22 and .38 (Cohen, 1992; Post, 2016) (see Table 2.2). Furthermore, both RS-CMP and RS-MSC showed a small-to-medium positive correlation with private self-consciousness. RS-CMP also showed a small-to-medium correlation, whilst RS-MSC presented a medium-to-large positive correlation with public self-consciousness. Discriminant validity was revealed between RS-CMP and state-anxiety, with a small-medium correlation, whilst RS-MSC presented a large correlation with state-anxiety (see Table 2.2).

Predictive validity

Predictive validity was partially supported. Negative medium-to-large correlations with technical and elements of the rowing specific perceived performance for RS-MSC, and RS-MSC also revealed a similar association with psychological perceived performance. In contrast RS-CMP was not associated with any of the perceived performance measures. Similarly, actual performance was related to RS-MSC, $r(269) = .13$, $p < .05$, but not RS-CMP, $r(269) = -.06$. Rowing experience was negatively related to RS-MSC, $r(269) = -.17$, $p < .01$ but there was no significant correlation with RS-CMP, $r(269) = -.08$, $p = .22$.

ANOVAs comparing the RS-CMP of crabbers ($n = 38$) and non-crabbers ($n = 232$) demonstrated that rowers who reported crabbing during their race had higher RS-CMP scores ($M = 5.45$, $SD = .80$) compared to non-crabbers ($M = 5.00$, $SD = 1.04$), $F(1, 269) = 7.106.$, $p < .01$, $\eta_p^2 = .02$. Similarly, crabbers had higher RSRS scores ($M = 5.20$, $SD = 0.78$) compared to non-crabbers ($M = 4.84$, $SD = 1.01$), $F(1, 269) = 4.803$, $p < .05$, $\eta_p^2 = .02$. There was no difference in RS-MSC between crabbers ($M = 4.94$, $SD = 1.07$) and non-crabbers ($M = 4.69$, $SD = 1.30$), $F(1, 269) = 1.68$, $p = .20$, $\eta_p^2 = .01$.

Predictive power analysis

The models demonstrated that only RS-CMP significantly predicted crabbing, $\beta = .07$, $p < .01$, over CMP, $\beta = .02$, $p = .60$. While in the RS-MSC and MSC regression model, neither significantly predicted crabbing over the other (Table 2.3). Furthermore, neither RS-CMP versus CMP or RS-MSC versus MSC predicted actual performance.

Table 2.3.

Multiple linear regression analysis for RSRS versus MSRS on actual performance and crabbing (N = 270)

	Actual performance							Crabbing						
Variables	t	B	SE B	β	*F*	*p*	Adj. R^2	t	B	SE B	β	*F*	*p*	Adj. R^2
RS-MSC x MS-MSC														
Overall					1.95	.15	.01					.57	.57	−.00
RS-MSC	−1.73	−2.83	1.64	−.11				.73	.02	.03	.05			
MS-MSC	−.21	−.32	1.51	−.01				.43	.01	.02	.03			
RS-CMP x MS-CMP														
Overall					.71	.50	.01					2.77	.07	.01
RS-CMP	−1.06	−2.07	1.95	−.07				2.08*	.07	.13	.13			
MS-CMP	−.25	−.47	1.90	−.02				.53	.02	.03	.03			

Note. RS-MSC = Rowing-Specific Movement Self-consciousness, MS-MSC = Movement-Specific Movement Self-consciousness, RS-CMP = Rowing-specific Conscious Motor Processing, MS-CMP = Movement-Specific Conscious Motor Processing. *$p < .05$, $p < .01$**$p < .001$***

General discussion

The present programme of research developed and validated a new scale for measuring sport-specific reinvestment. In the first sub-study, the scale items were developed and a PAF conducted to determine the factorial structure for the scale. Following this, a new sample was used to retest the adequacy of the scale's factorial structure using CFA. The second sub-study also examined the construct validity of the scale, including the convergent, divergent and predictive validity, and examining the scale in relation to a number of other scales and performance measures.

EFA, CFA and internal consistency

The content validity of the RSRS was supported by some of its items being developed from a similar model used for the movement-specific reinvestment scale and new items being derived from interviews with rowers and coaches (Morgado et al., 2018). Furthermore, the items were then reviewed by academic experts in reinvestment and scale development. Our exploratory factor analysis revealed a two-factor solution, identical to the MSRS, but with six MSC and six CMP items. The confirmatory factor analysis deemed the factorial structure adequate and demonstrated acceptable distributional properties (i.e., kurtosis) as a state measure. Furthermore, the internal consistency of the RSRS exhibited high internal reliability, similar to the MSRS. Our analyses revealed that the RS-CMP and RS-MSC had high internal reliability, comparable with that of MSRS subscales, with scores greater than the Cronbach .70 cut-off in both samples (Tavakol & Dennick, 2011). Overall, these outcomes suggest good internal validity of the RSRS scale.

Construct validity

Firstly, the convergent validity of the RSRS subscales was evaluated relative to their respective MSRS subscales and the Self-Consciousness Scale. The RSRS subscales revealed acceptable convergent validity with their respective MSRS subscales (Cohen, 1992; Post, 2016), suggesting that although the subscales measured similar constructs because they shared variance, they nonetheless measured distinct psychological constructs. Similarly, the RSRS and both of its subscales demonstrated acceptable convergent validity with private self-consciousness. However, RS-MSC only demonstrated moderate convergent validity as it exhibited a correlation above .40 with public self-consciousness (Post, 2016).

Discriminant validity

Discriminant validity was only partly supported (Clark & Watson, 2017). RS-CMP was weakly associated with state anxiety, suggesting that these two scales measured different constructs. RS-MSC was strongly associated with state anxiety, suggesting that these scales measured a similar construct.

Predictive validity

The predictive validity of the scale was examined in relation to rowing experience, actual and perceived performance. Firstly, only RS-MSC was related to actual performance. Nevertheless, this is not uncommon, as previous research has also found that one of the dimensions has a stronger relationship with performance than the other dimension (Iwatsuki & Wright, 2016; Malhotra et al., , 2015b). For instance, Iwatsuki and Wright (2016) reported that higher MSC but not CMP scores predicted which athletes were perceived to choke in competition. These results suggest that athletes who are concerned with their movement style may be more likely to underperform under pressure.

Trait-activation theory argues that the type of pressure or situational cue, whether it is public or private, can determine which traits are activated (Geukes et al., 2012; Mesagno et al., 2012). Therefore, it is worth noting that our study was conducted during a regatta, a real competition that has both situational cues; public pressures, such as large audiences and fellow competitors, and private pressures, with winners being rewarded medals or gifts (Geukes et al., 2012). Consequently, both RS-CMP and RS-MSC had the potential to be activated, nevertheless this was not the case. Geukes et al (2012) suggested that when both situational cues are present, one can have a greater impact than the other, the cue that is perceived as more important or salient is one that has the impact. In a regatta, races function similar to a knockout league, therefore, only the boats that make it to the final will have the immediate potential to win a medal or tanker. On the other hand, the audience and competitors are the situational cues that are present throughout, therefore, this suggests why RS-MSC was activated and RS-CMP was not activated.

This is further supported by the finding that RS-MSC but not RS-CMP was negatively related to general and rowing specific technical perceived performance, suggesting that activated RS-MSC may have disrupted performance. Furthermore, the RS-MSC association with technical performance is unsurprising, because a rower who makes a technical mistake with their oar, such as loses control of it, will be noticed by onlookers in this racing context as crowds tend to span the whole of the river bank adjacent to the race. The null findings relating to RS-CMP do not contradict all previous reinvestment research, as other studies have found similar relationships for movement-specific CMP (Iwatsuki & Wright, 2016; Malhotra et al., 2015a, 2015b). Indeed, research has suggested that conscious awareness and control of movement may be needed by the performer, especially when altering or adapting movement during performance to maintain proficiency (Toner & Moran, 2014).

The RSRS's predictive validity was also examined by analysing whether RSRS subscales predicted performance over the MSRS subscales. Negative relationships between RSRS and these variables would help establish the predictive (and external) validity of the scale. RS-MSC but not RS-CMP was associated with actual performance. This may be in-line with the trait-activation theory, as RS-MSC over RS-CMP may have been switched on due to the potency of public over the private situational cues due to the constant evaluative context of the regatta (Geukes et al., 2012; Mesagno et al., 2012). However, RSRS or MSRS subscales did not predict performance over the other.

We also analysed whether the self-reported crabbing results could be better predicted by the RSRS over the MSRS subscales. This was demonstrated between RS-CMP versus CMP but not RS-MSC versus MSC, further supporting the importance of a sport-specific scale (Horn, 2008; Papaioannou & Hackfort, 2014).

Furthermore, the ANOVA demonstrated that there was a significant difference in RS-CMP between those who identified they had crabbed during the race and those who had not. Nevertheless, there was no difference between crabbers and non-crabbers in RS-MSC. This is somewhat surprising as crabbing can lead to a noticeable detrimental effect on performance, therefore, we assumed out of the two that RS-MSC would have revealed the significant difference and not RS-CMP. However, as none of the rowers experienced an ejector crab and the majority only reported a mini crab, where the spoon of the blade gets temporarily stuck but they can recover it quickly, they may have felt that others (i.e., crew members, coaches and audience) would not notice and that it could be easily disguised within their other crew-members (Iwatsuki & Wright, 2016). This is similar to Iwatsuki and Wright (2016) findings, where MSC was significantly higher in athletes that play an individual sport compared to the athletes who played a team sport due to them feeling they could hide among their teammates. Furthermore, the lack of association with RS-MSC, may be due to our study involving a range of experienced rowers, from 1 to 60 years' experience; therefore, all experience levels may have the potential to crab but for differing reasons. For instance, more experienced rowers may exhibit more automaticity and therefore quieter verbal-analytic cognitive processes (Wolf et al., 2015), subsequently if they then increase their conscious processing due to anxiety, this would possibly result in a crab. Whilst, a less experienced rower may be less automatic and consciously processing as they are still becoming proficient in the rowing movement (Wolf et al., 2015); therefore, they may crab due to a technical mistake rather than a choke. Subsequently, it is a phenomenon that needs further investigation especially in relation to conscious processing.

Lastly, we analysed the relation between the RSRS and experience (years), the results for which were mixed, with experience being negatively related to RS-MSC and overall RSRS score. This is somewhat supported by previous EEG research that has demonstrated experienced golfers, baseball batters and shooters exhibit lower levels of T3/7-Fz coherence compared to their less experienced counterparts, which is a reflection of lower levels of state conscious processing (Deeny et al., 2003; Gallicchio et al., 2016; Kerick et al., 2004; Zhu et al., 2011). In regard to only RS-MSC decreasing with more experience, and RS-CMP revealing null results, this may be due again to the evaluative regatta setting. Compared to experienced rowers, the regatta environment may evoke rowing self-consciousness in less experienced rowers due to these rowers being unfamiliar with the presence of huge audiences and side-by-side racing, a stark contrast to head racing, where one boat competes at a time in a time-trial. Furthermore, Capio et al. (2018) found similar results to ours but at a trait-level, more experienced physiotherapists exhibited lower levels of MSC than less experienced, but no significant difference was demonstrated in regard to CMP. The authors suggested that because MSC, reflects conscious monitoring, that less experienced physiotherapists were still figuring out successful motor strategies to perform effectively and ultimately look professional. This similarly could be occurring with the less experienced rowers. On the other hand, RS-CMP may be a conscious process that is needed at all skill levels in rowing. For instance, intermediate and elite rowers may need to respond to the ever-changing environment, such as adjusting to the rate to maintain their synchronicity with the crew (Nyberg, 2015). Nevertheless, this was the first study to investigate the association between experience and sport-specific reinvestment scores in a sport, and, therefore, further exploration is warranted.

Applied implications

Overall, the results confirm the benefit of using sport-specific over generic scales to understand the possible impact of different psychological processes on performance. Therefore, future research should develop more sport-specific scales, especially for bridging the gap between academics, coaches and athletes. Sport-specific scales are better for all parties: athletes are able to understand the scale items, and coaches are able to comprehend the findings and develop strategies to help their athletes. For instance, coaches could use mindfulness training to help rowers who are reinvesting during competition as mindfulness has proven to attenuate this process, this may similarly help those that crab (Sparks et al., 2021b, Chapter 2). Nevertheless, using sport-specific scales may lead to greater social desirability bias as the athletes understand the items relevance on performance. Furthermore coaches may use the sport specific scales to determine whether athletes should be selected or not.

Limitations & future directions

The following limitations of the present study should be considered when interpreting the findings. First, most measures were self-report, which may be influenced by social desirability bias. Therefore, subsequent studies need to include more objective measures, such as psychophysiological measures (i.e., EEGs, electromyography and heart rate) or have external individuals (e.g., coach, expert) rating the rower on their performance as athletes cannot fabricate objective results or ratings from others. Furthermore, using a combination of different measures of the same construct facilitates validity of results (Kline, 2015). Furthermore, to validate the ratings of state anxiety, perceived pressure could also be measured. Second, state-anxiety and RS-MSC were correlated, and, therefore, RS-MSC may have captured another aspect of anxiety. Consequently, the scale needs further construct validation with other scales that measure conscious processing, such as mindfulness. Third, the objective performance measure was based on the boat’s finishing position. Therefore, race outcome is determined by more than one rower for those rowers competing in a crew boat. A boat can have between one and eight rowers (and sometimes a cox), all of whom play a role in determining the speed of the boat and consequently the race result. Accordingly, the performance measure is not an accurate reflection of each individual rower’s performance but that of the whole crew. Future research should include kinematic measures of technical performance of each rower to better capture individual performance (Kleshnev, 2016). Additionally, future studies, with large numbers of full crews, could allow crew to be included as a factor in any analyses. Lastly, crabbing may or may not be a choke. Therefore, seasonal racing data could be used to further establish whether or not rowers did choke under pressure or not, as this racing result could be compared to seasonal averages to determine whether there was a significant drop in performance.

Conclusion

The present study provides initial support and validity for a sport-specific state measure of conscious processing (i.e., CMP and MSC) in the context of rowing. The scale presented good internal validity and promising external validity but needs to be further validated using objective individual performance measures. RS-MSC exhibited a stronger link with performance, particularly in relation to the perceived performance measures, which may partially support trait-activation theory and the importance that situational cues from certain environments have on switching on specific traits and states (Geukes et al., 2012). In addition, our study offered field-based support for conscious processing negatively impacting performance under pressure and discriminating between crabbers and non-crabbers (Gutierrez, 2018; Masters & Maxwell, 2008). Moreover, in line with previous research, conscious processing decreased with greater skill experience (Capio et al., 2018). However, rowing specific conscious motor processing did not change with experience, which may support the view that athletes need to be somewhat aware of their movement during performance to retain proficiency (Toner & Moran, 2014). This issue warrants closer examination.

Chapter 3: Mindfulness, Reinvestment, and Competitive Rowing: Evidence for Moderated Moderation of the Anxiety-Performance Relationship

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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, 1990), 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., 2020). Building upon this literature, the current field study was designed to examine the link of mindfulness on performance during sporting competition.

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 characterised 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 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 & Maxwell, 2008; Masters et al.,1993). 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 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).

Mindfulness

Mindfulness is a Buddhist and Eastern spiritual concept, cultivated through religious and meditative practices (Kabat-Zinn, 1990), that has been adapted for use in a non-spiritual Western context. It is described as both a state and a trait and is characterised by attending to present moment experiences in an accepting non-judgemental and non-reactive manner (Kabat-Zinn, 1990; 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 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 (MPSE) (Kaufman et al., 2009) and Mindfulness-Acceptance-Commitment (MAC) (Gardner & Moore, 2007), have been used to enhance sport performance (Röthlin et al., 2020; Röthlin & Birrer, 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 (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.

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, it 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., 2020). Therefore, through regulation of attention or/and increased experiential acceptance, automaticity is facilitated rather than disrupted during skill execution, minimising reinvestment.

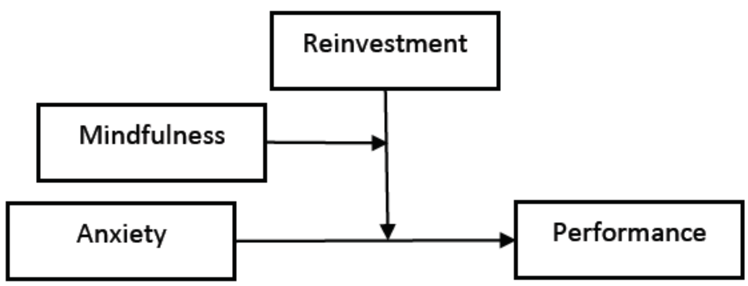
Current Study

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 & Maxwell, 2008; Masters et al.,1993). 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 reinvestment on the anxiety-performance relationship (Birrer et al., 2012; Perry et al., 2017).

Our study purposes were twofold. Our first 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 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., 2020) 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 Figure 3.1).

Figure 3.1

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



Method

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 rowing 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 (Appendix 1A).

Measures

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 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 demonstrated good validity and reliability with alpha coefficients above .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.

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., 2021b, Chapter 2). 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.

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 Competitive State Anxiety Inventory-2 (CSAI-2) subscales (Martens et al., 1990), namely, .68 for self-confidence, .69 for somatic anxiety, and .76 for cognitive anxiety (Krane, 1994).

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 .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 crew member 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 (2021a) relative ranking system to standardise 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.

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. Following their race, participants completed the questionnaire online (n = 132) or by paper copy (n = 138)[1].Prior to 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.

Data Analysis

We examined the internal consistency of the scales by using SPSS to compute Cronbach's alpha coefficient (Cronbach, 1951) and the Methods for the Behavioural, Educational, and Social Sciences (MBESS) package for R to compute McDonald's omega coefficient with bootstrapping of 10,000 (Dunn et al., 2014; McDonald, 1999). The GPower 3.1.5 (Faul et al., 2007) macro for SPSS 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 = .17) effect size

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

(Cohen, 1992). It was also powered to detect a small effect size ($f^2 = .04$) using multiple regression, with three predictor variables.

Our main data analysis was 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 Figure 3.1). In this analysis, we controlled for rowing 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.

Results

Descriptive Statistics, Reliability and Validity

Descriptive statistics and scale reliabilities are presented in Table 3.1. All scales showed good internal consistency, with all alpha and omega coefficients above .70 (Kline, 2005; Dun et al., 2014). Furthermore, the predictive validity of the RSRS was evidenced by the negative associations between actual performance and both RSRS and RS-MSC (Table 3.1). 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 3.1).

Table 3.1.

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.

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 3.1. It can be seen that: overall mindfulness and mindful refocus were positively related to both perceived and actual rowing performance; mindful non-judgement was positively related to perceived but not actual rowing performance; and mindful awareness was unrelated to performance.

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 Appendix 3 (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.

Anxiety, conscious motor processing and mindfulness components

Next, we examined whether the mindfulness components (awareness, refocus, non-judgement) 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 (Figure 3.2, 3.3a and 3.3b). The Johnson-Neyman method indicated that the state anxiety by RS-CMP two-way interaction was 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 (Figure 3.3a), RS-CMP potentiated the effect of anxiety on actual performance, whereas at high levels of mindful awareness (Figure 3.3b) the anxiety-performance relationship held for low but not high RS-CMP.

Figure 3.2.

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

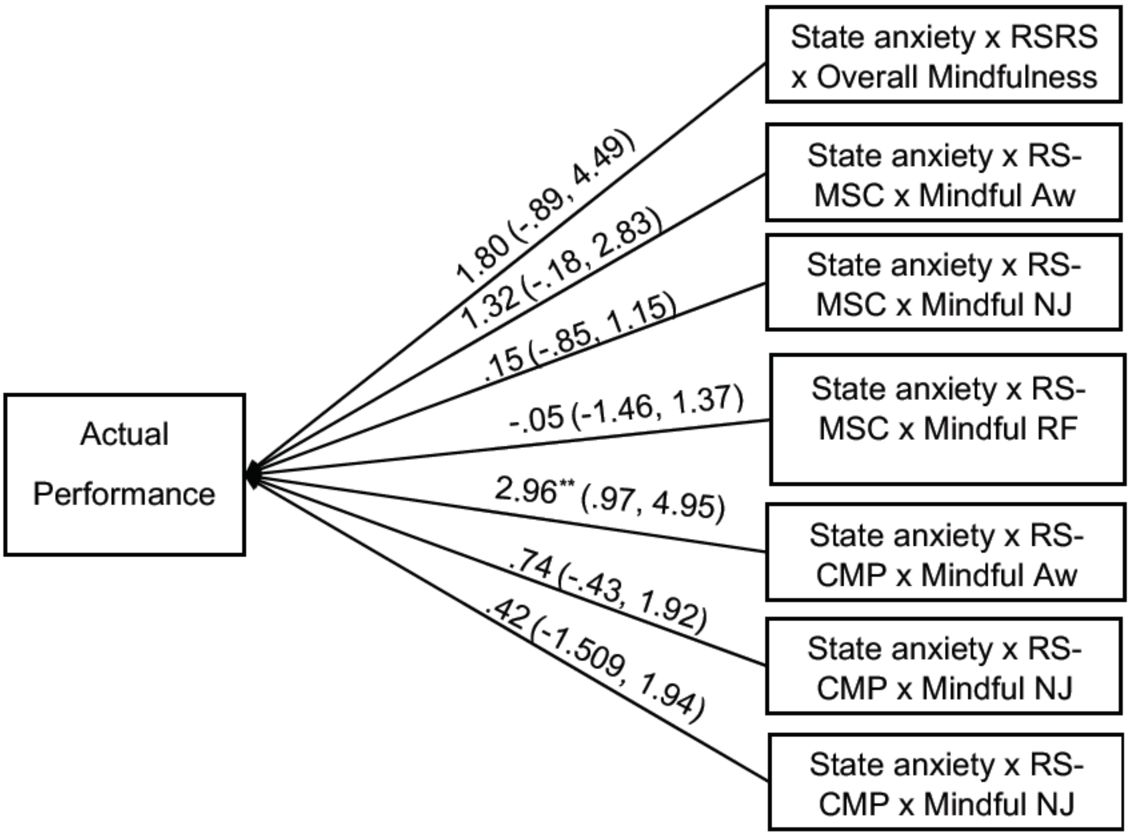
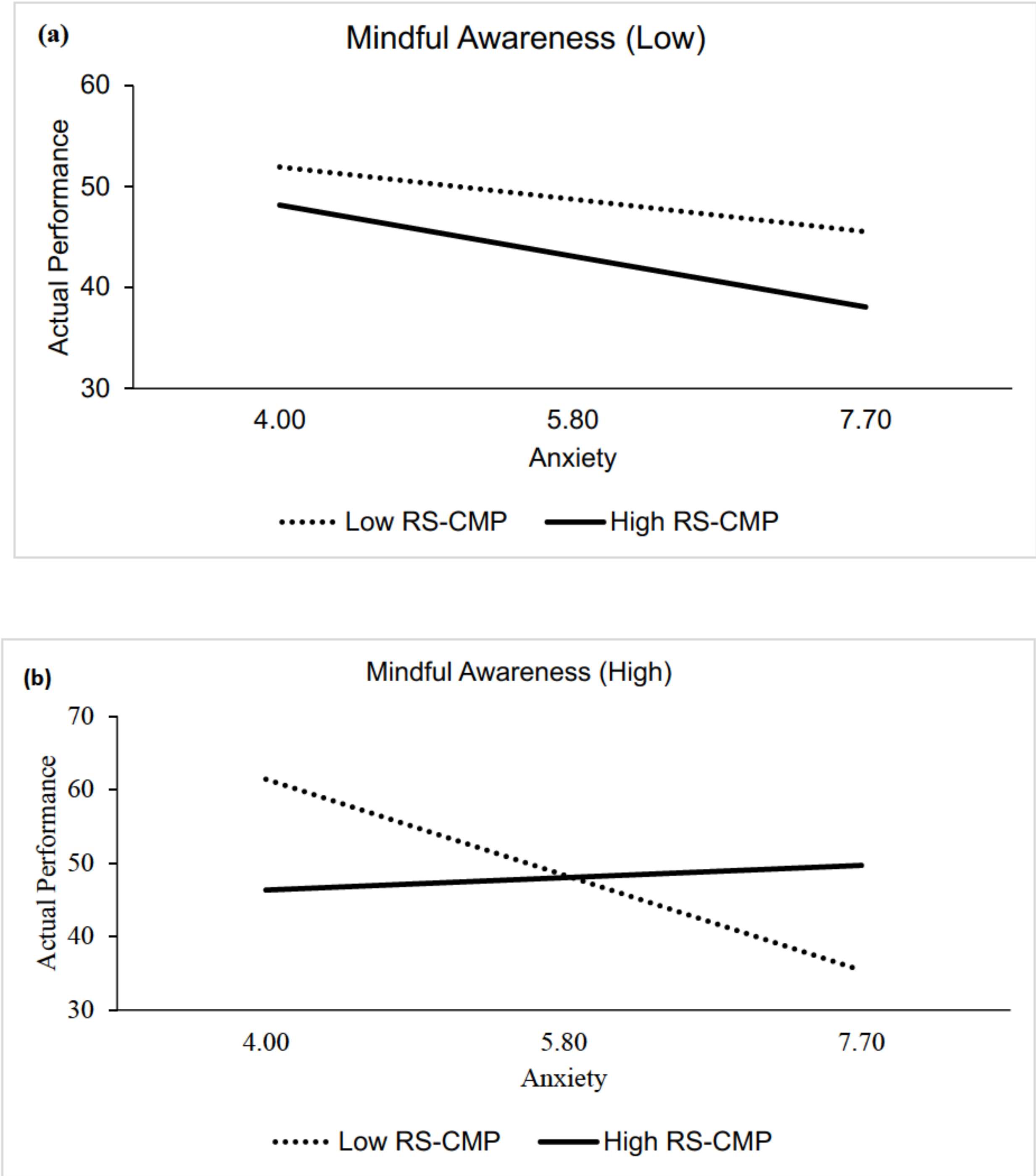


Figure 3.3a and 3.3b.

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



PROCESS also revealed a comparable three-way interaction for perceived performance (Figure 3.4). 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 (Figure 3.5a and 3.5b).

Figure 3.4.

*Unstandardised 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.*

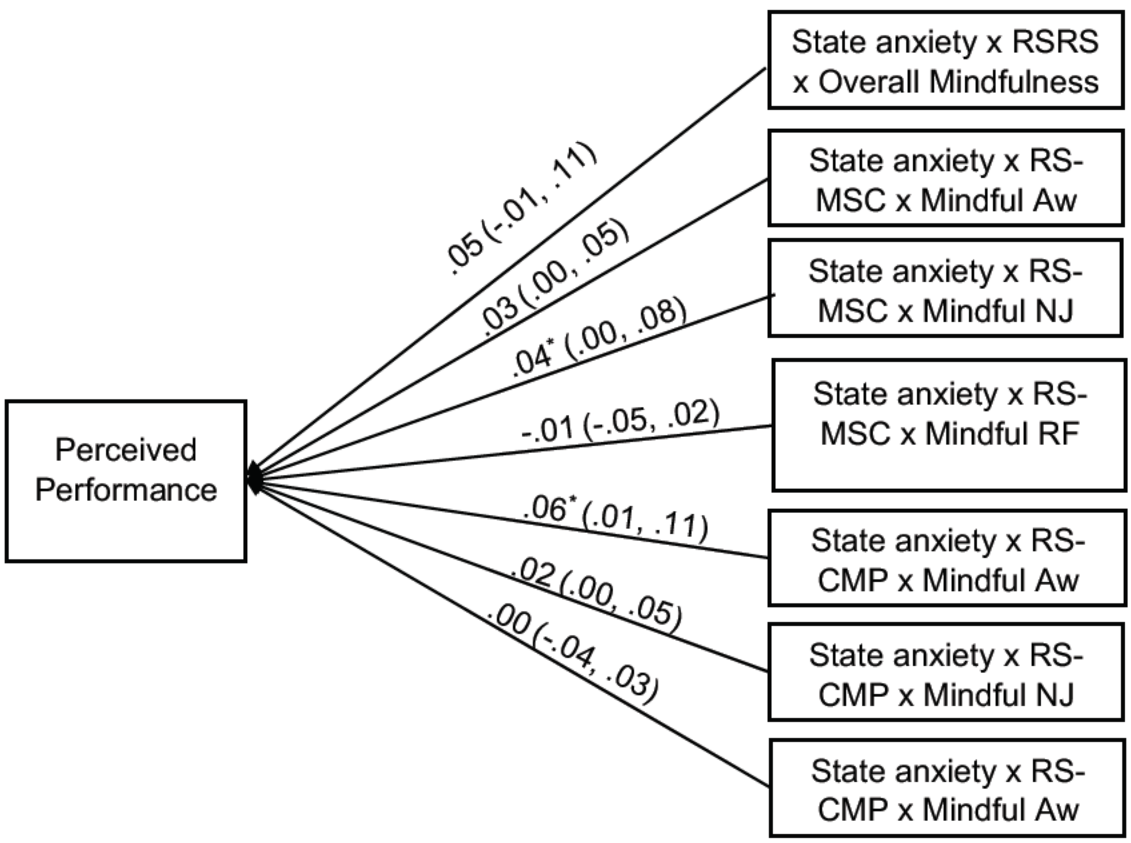
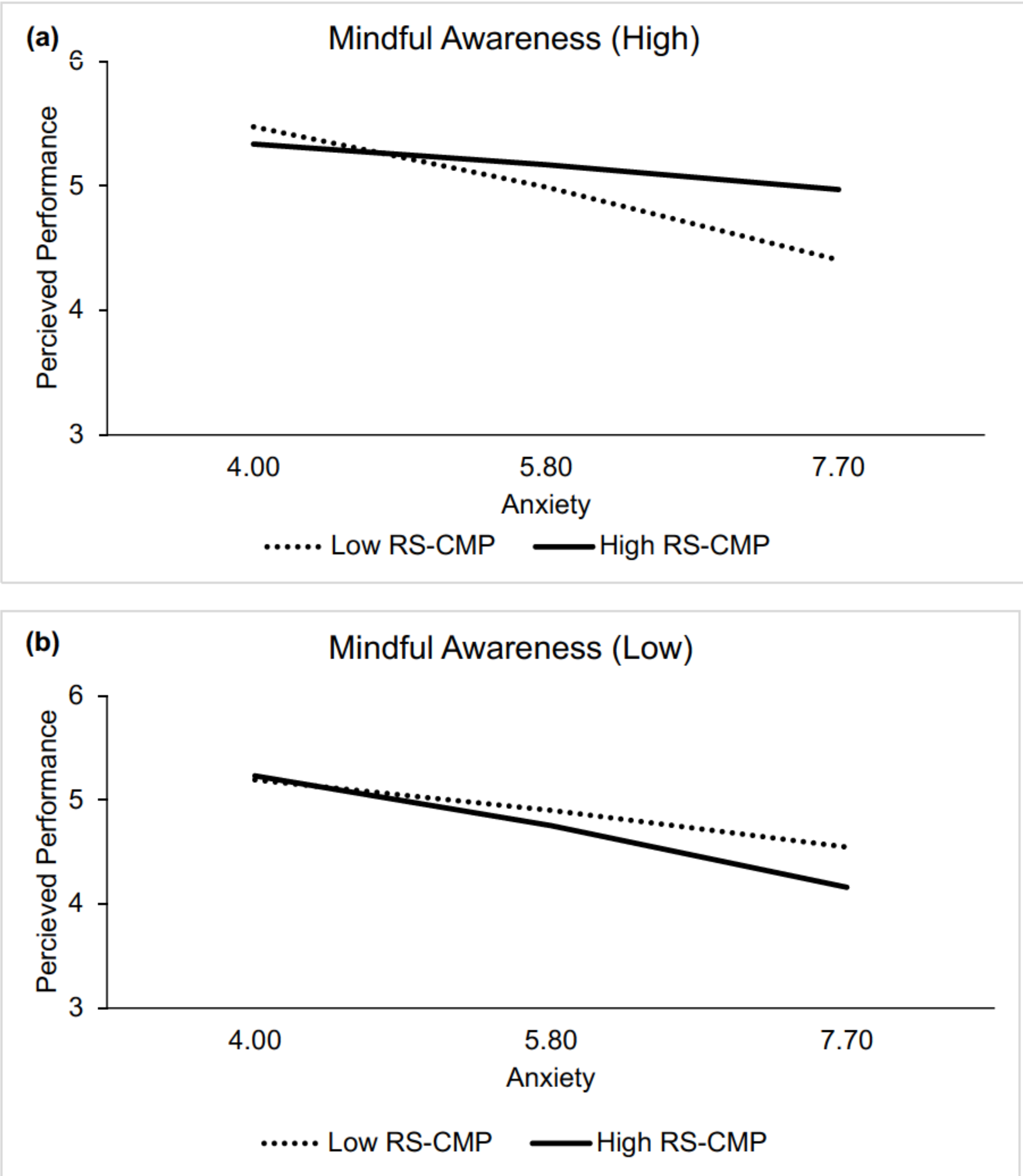


Figure 3.5a and 3.5b.

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

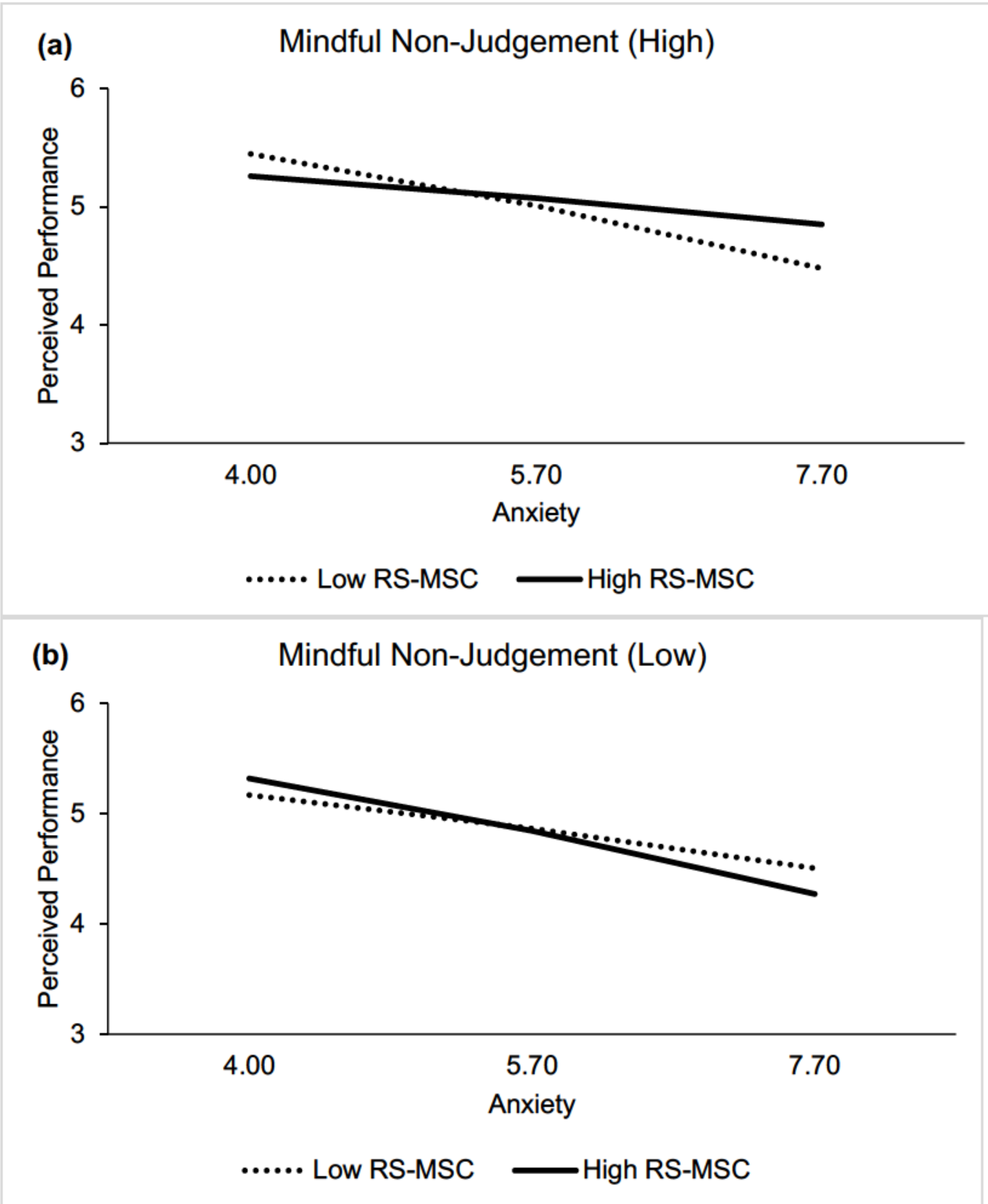


Anxiety, movement self-consciousness and mindfulness subscales

Last, we examined whether the mindfulness components (awareness, refocus, non-judgement) 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 (Figure 3.6a and 3.6b).

Figure 3.6a and 3.6b.

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).



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.

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).

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-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 themselves 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.

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 non-judgement 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).

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., 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.

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.

Chapter 4 – The Effect of a Brief Sport-Specific Mindfulness intervention on Mindfulness, Reinvestment and Dealing with Failure

Introduction

Coaches, athletes, and sport psychologists frequently seek ways to enhance performance. The most common is Psychological Skills Training (PST). Despite this being widely used, researchers have questioned the utility of this training due to athletes finding it difficult to employ PST methods to control their cognitive processes (Birrer et al., 2012). Therefore, an alternative approach has been proposed and has grown in popularity over the last 15 years, namely, mindfulness. Mindfulness-based interventions have been found to facilitate peak performance (Wu et al., 2021). However, most of the interventions tend to be between 8 and 12 weeks, with multiple sessions during the week (Bühlmayer et al., 2017). Athletes have demanding schedules and therefore can find it difficult to schedule in the required mindful practice, consequently, researchers have been interested in finding the smallest dose to induce it (Baltzell & Summers, 2018). Research has found that shorter interventions of 15-minutes have demonstrated some, albeit mixed, evidence in the ability to induce mindfulness, however, such mixed outcomes are a characteristic of the longer mindfulness interventions (Shaabani et al., 2020; Wolch et al., 2020). Hopper (2017) proposed sport-specific mindfulness practices may appeal more to athletes and therefore strengthen their effect. Mindfulness-based interventions, such as MPSE and MMTS, have incorporated sport-specific practices but these are 6-8 weeks long. Therefore, the present study explores the effect of 5-minute sport-specific mindfulness versus 5-minute history of rowing to evaluate the effectiveness of very brief interventions.

One of the most researched phenomena in sport psychology is paradoxical performance – where athletes that usually can perform the targeted movement are no longer able to perform it successfully (Lobinger et al., 2014). There are several different types of paradoxical performance, one of which is choking. Choking is defined as a significant drop in performance that is due to an anxiety-producing situation, when performance would normally be successful in a low-pressured situation (Mesagno & Hill, 2013). Choking can cause poor performance outcomes and also lead to athletes losing their athletic career and harming their mental well-being as they partake in destructive, harmful behaviours because of choking, such as binge drinking (Hill et al., 2019). Although there has been a plethora of research investigating the mechanism behind choking, there is no universal agreement, but one of the prominent theories is Reinvestment (Masters et al., 1992). This theory suggests that under pressure performers consciously control their movements resulting in a disruption of the automated skill (Masters & Maxwell, 2008). Automated skills are those that are well learnt and can be executed will little or no conscious awareness, they tend to be consistent, accurate and fluid-like but when disrupted by conscious control they are inconsistent and inaccurate (Fitts & Posner, 1967; Masters & Maxwell, 2008).

Furthermore, it has been suggested that reinvestment can also be described as a dispositional factor (Masters et al., 1993). There has been extensive support for reinvestment theory as both a dispositional factor (Chell et al., 2003; Jackson et al., 2013; Orn, 2017) and a process of choking under pressure (Iwatsuki & Wright, 2016; Masters et al., 1993; Masters & Maxwell, 2008). Research has found that high reinvestors are more likely to perform worse under pressure compared to low reinvestors in various motor skills, such as golf-putting (Poolton et al., 2004), hockey dribbling (Jackson et al., 2006), and basketball shooting (Orn, 2017). Furthermore, it has been associated with ratings of choking in several sports such as golf, squash, and athletics (Iwatsuki & Wright, 2016; Masters et al., 1993). Overall, reinvestment has proven to be detrimental for performance.

Following a movement failure, such as a choke, the athlete must decide how they should proceed, whether to take immediate action and move on, leaving the choke or under performance in the past, or whether to focus and ruminate over it (Beckman & Kossock, 2018). According to Beckman and Kossock (2018) these two types of performers are called action-orientated and state-orientated individuals. Action-orientated performers deal with failures better through being more efficient and draw the attention to challenges ahead, whilst state-orientated individuals focus on their emotions, thoughts, and goals rather than immediate actions (Krohler & Berti, 2019). Action-orientated individuals tend to perform better than state-orientated individuals in ego-depleted states (Grospel et al., 2014). Ego-depletion tends to occur when there is a depletion of resources, such as during moments of extensive self-focus (Grospel et al., 2014), which may be elicited by anxiety in competition. Moreover, athletes who are state-orientated may be more likely to reinvest due to having a decreased sense of experiential acceptance, as they have been found more likely to ruminate (Korhler & Berti, 2019), therefore they may try to excessively consciously control their movements to prevent further faults. Nevertheless, no one has explored the relationship between reinvestment and action-state orientation, and therefore this warrants investigation. Nonetheless both processes can impact performance, therefore, the need for an effective intervention to prevent these is needed.

One of the proposed interventions is mindfulness. Mindfulness is described as “paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn 1994, p.4), it is both a state and trait. Mindfulness-based interventions were first established for therapeutic practice and have been found to contribute to positive outcomes related to mental well-being (Lyzwinski et al., 2018). This was later introduced to sport as an alternative to the traditional psychological skills training, especially for those athletes that find it difficult to control their thoughts and feelings (Birrer et al., 2012). Mindfulness has been linked to numerous performance relevant benefits, such as increasing mental toughness (Bita et al., 2021), achieving flow-state, self-confidence, and reductions in competitive anxiety (Bühlmayer et al., 2017; Thompson et al., 2011). Furthermore, Rothlin et al. (2020) found that following four weeks of mindfulness, athletes exhibited a significantly higher level of action over state-orientation in comparison to the control group. In addition, mindfulness has been found to attenuate reinvestment as a moderator of the anxiety-performance relationship in competitive rowing (Sparks et al., 2021b, Chapter 2). Therefore, mindfulness may be acting on reinvestment and an athlete's orientation by inducing present moment-awareness and experiential acceptance, so that athletes do not ruminate over failures or unexpected faults and subsequently try to consciously control their movements (Birrer et al., 2012; Josffeson et al., 2017; Sparks et al., 2021b, Chapter 2). Although mindfulness is an effective tool in preventing these processes, most studies have used interventions that have lasted on average 8-12 weeks (Bühlmayar et al., 2017). However, athletes have limited time, therefore long interventions may not be practicable as athletes claim they cannot complete the practices needed to induce mindfulness (Baltzell et al., 2014). Consequently, there are demands to find ways to induce mindfulness over a brief amount of time.

Brief mindfulness-based interventions, ranging between 6-30 minutes, have been developed to cultivate mindfulness (Perry et al., 2017; Shaabani et al., 2020; Wolch et al., 2020). There has been mixed success in inducing mindfulness, especially with the 15-minute interventions (Shaabani et al., 2020; Wolch et al., 2020), however, as little as 6-minutes has been found to induce it successfully (Li et al., 2018). One of the potential problems is that these mindfulness interventions are not sport-specific and therefore athletes do not understand the relevance or the application of the practices (Hopper, 2017; Scott-Hamilton et al., 2016). Longer mindfulness interventions in sport have included sport-specific practices, as seen in Mindful Specific Performance Enhancement and Mindfulness Meditation Training in Sport programmes. Accordingly, using a sport-specific practice for brief mindfulness would be the next logical step.

The present study investigated the difference between control audio and sport-specific mindfulness audio on reinvestment, mindfulness, and dealing with failures. In accordance with previous research by Rothlin et al. (2020) and Sparks et al. (2021b, Chapter 2), it was hypothesised that the mindfulness group would have higher levels of action-orientation versus state orientation and lower levels of sport-specific reinvestment compared to the control group following the pressured scenario. Second, in-line with state-orientated athletes exhibiting increased self-focus behaviours following a failure compared to action-orientated athletes (Körhler & Berti, 2019), we hypothesised that state-orientation would be positively associated with RS-CMP and RS-MSC. In contrast, action-orientated athletes tend to exhibit less self-focus and more experiential acceptance (Kröhler & Berti, 2019), therefore we hypothesised action-orientation would be negatively associated with RS-CMP and RS-MSC.

Method

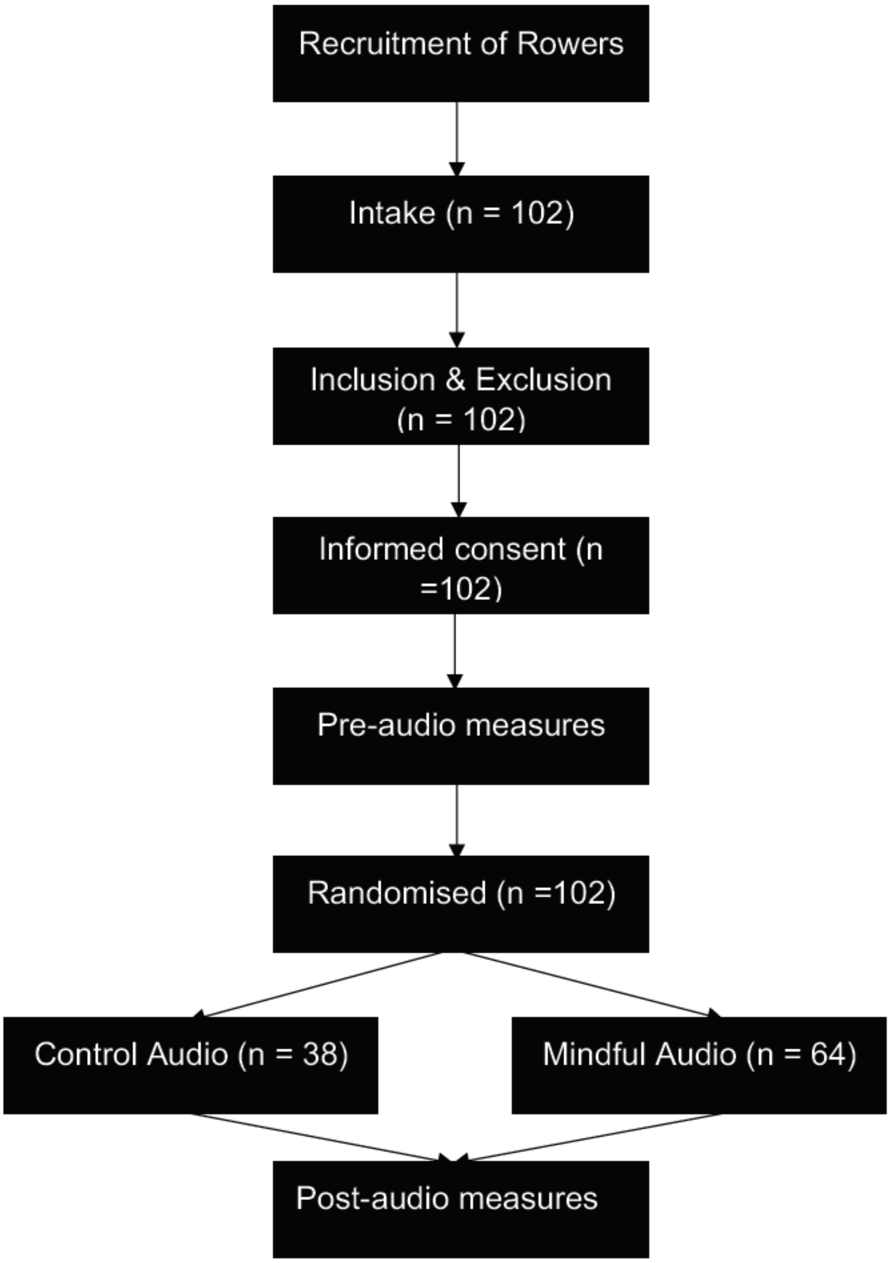
Participants

The study involved 101 rowers (53 males and 48 females, mean age = 41.99 ± 19.64 who had competed at local, regional, national, and international events. Rowers were recruited online through social media platforms that included Twitter and Facebook, as well as through emailing all UK club secretaries and international clubs that spoke

English (including USA, Canada, Australia, and New Zealand). Participants were only included if they had competed in the last two years, had at least one year's rowing experience and were aged 16 and over. A CONSORT flow chart of the study is shown in Figure 4.1. The study was approved by the University of Birmingham Ethics Committee and informed consent was obtained (Appendix 1B).

Fig 4.1.

Recruitment and Flow of the study



Measurements

Dealing with Failures

To measure the rowers' responses to failure we used the scale Action Orientation After Failure and State Orientation After Failure (ASOAF6) (Rothlin et al., 2020), which was adapted from the longer version created by Beckmann (2003). The ASOAF6 is a 6-item scale, consisting of two 3-item sub-scales measuring action orientation (e.g., If I get little playtime to prove myself, and something goes wrong, I try to do better in the next action) and state orientation (e.g., If I fail in an important situation in a (championship) game, then it goes through my mind repeatedly in the further course of the game). The items were altered specifically for rowing, therefore "If I get little playtime to prove myself, and something goes wrong, I try to do better in the next action", was changed to, "If I do something wrong with my movement, I try to do better in the next action". Rowers rated each statement on a 7-point Likert scale from strongly disagree to strongly agree. This scale has previously demonstrated good validity and reliability (Rothlin et al., 2020). Additionally, the scale presented fair reliability with omega scores above .65.

Rowing-specific reinvestment scale

This scale measured the rowers' conscious processes of their movements, developed by Sparks et al. (2021b, Chapter 2), adapted from the Movement Specific Reinvestment Scale (MSRS) (Masters et al., 2005). The scale consisted of 12-items, 6-items comprised of the RS-CMP subscale (e.g., "I paid attention to how I carried out my rowing movements"), and 6-items of the RS-MSC subscale (e.g., "I believed that everyone was just looking at me and scrutinising my rowing"). Athletes rated their level of agreement of each item 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. The scale has demonstrated good validity (Sparks et al., 2021, Chapter 2) and Omega coefficient scores above .70 (Table 1).

Mindfulness in Sport scale

Using the Mindfulness Inventory for Sport (MIS) scale (Thienot et al., 2014), we assessed an individual's ability to mindful in the sporting context. The MIS 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 indicated how much each statement was generally reflective of what they experience when they row, on a scale of 1 (not at all) to 7 (very much). The non-judgemental subscale items were reverse scored. The mean of all items was calculated to measure overall Sport-specific trait mindfulness. The scale has demonstrated good validity and reliability with Omega coefficients above .70 for each subscale (Table 4.1) (Thienot et al., 2014).

State-Anxiety

Mental Readiness Form-Likert (MRF-L) was used to measure the athlete's level of competitive state anxiety in response to the pressured race imagined scenario. The scale consists of 3-items measuring cognitive anxiety (my thoughts would have been calm-worried) somatic anxiety (my body would have felt relaxed-tense), and self-efficacy (I would have felt confident-scared). Participants rated their levels of each item on an 11-point Likert scale, the low end of the scale reflected desirable ratings of the item (calm, relaxed, confident), whilst the higher end depicted undesirable ratings of the item (worried, tense, and scared). The MRF-L has previously demonstrated good convergent validity with CSAI-2 subscales, 0.68 for self-confidence, 0.69 for somatic anxiety, and 0.76 for cognitive anxiety (Krane, 1994). The scale has also demonstrated good reliability with Omega coefficients above .70 for each subscale (Table 4.1).

Manipulation check

To determine whether the audios induced mindfulness, participants completed the Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003). MAAS measures an individual's level of short-term or current expression of state mindfulness (i.e., "I was finding it difficult to stay focused on what was happening"). Participants indicted how much each item reflected their experience during the audio, from 1 (not at all) to 7 (very much). This scale has previously demonstrated good validity (MacKillop & Anderson, 2007) and presented good reliability with Omega coefficient above .70.

Scenario

To induce the feeling of being under pressure in a competition, participants were given a pressured scenario that could happen in a race and asked to imagine it: "You're on the start line of a the most important regatta of the season, a final and one that you need to win. You're competing against equally matched opponents, with one of the boats beating you last year. Everyone is watching you from the bank, family, friends, coach and boat club members. You hear the 'Attention! Go!', you take the first few strokes building up the boat speed and the power, suddenly you take an air stroke, miss the water and crab. The opposition is edging forward, and their bow ball is in front. You quickly try to get back rowing again. Your cox and coach riding along the bank, videoing you and your crew, has seen this happen." To ensure the athletes had thought about the scenario, after listening to it they were asked, "Can you now briefly discuss what your thoughts and feelings would have been/were in response to the imagined situation during the race and how it may have affected the rest of your performance?".

Protocol

After consenting, rowers completed pre-audio measures of ASOAF6, RSRS and MIS. Rowers then listened to either a control or sport specific audio. The control audio consisted of facts about rowing, whilst the sport-specific audio was an adaptation of Gardner and Moores (2007) Brief Centering Exercise to be more rowing-specific. The same female voice was used for each audio to prevent any ambiguity. Participants were then asked to complete the manipulation check. Following this the rowers then received the pressured race scenario and completed post-audio measures of ASOAF6, RSRS and state-anxiety in response to the scenario.

The control audio was as follows: "Rowing. It is one of the oldest and most traditional competitive sports, but rowing was first simply a mode of transport, especially used in ancient Egypt, Greece and Rome. It first became a sport in 1829 with the first Oxford and Cambridge boat race, at this point rowers, were called professional watermen. This race took place on the Thames, yes, the same race that I'm sure a lot of you still go and watch today! Ten years later the first Henley Royal regatta was held, but it was not until 1843 that the first American college rowing club would be formed at Yale University. Rowing has also featured in all the editions of the Olympic games apart from one in 1896 in Athens, it was on the programme but was unable to run due to the stormy sea and high winds. Although a male dominated sport at the beginning, women are still seen in photographs competitively rowing in the early 1800s. However, the first all-women's rowing club was not created until 1892, by four women, today it is known as the oldest running all-women's rowing club, the ZLAC in San Diego, California. It was then not until 1974 where women rowers then rowed competitively at the world rowing championship and not until 1976 when they finally competed in the Olympics.

The sport has progressed over the years, including the rowing equipment. This looked a lot different then, compared to how it does today, for instance the seats were first fixed, the riggers were in-rigged, the boat was made of wood before epoxy and carbon fibre was used, the oars were wooden and had small narrow spoons whilst now the majority have carbon fibre shafts and the spoons are cleaver shaped. The boats back then would have been extremely heavy but these days an eight can weigh as little as 200 lbs, as they can be made from fibre glass.

Our fashion sense has also taken an upgrade, in the early 1900s rowers wore shorts and white cotton singlets with their club colours horizontally striped across their chest, whilst now it is all about the lycra all in ones. I'm sure you all have a blazer or know of someone with a club blazer, well the rowers used to row in their blazers, imagine the heat of rowing in one of them on a hot sunny Henley final... they were worn so the audience could distinguish who was who during a race. These days we don't have to row in them, they are used as more of a status symbol. I'm sure many of you own one and wear it with pride.

The race lengths have also changed over the years. The Cambridge and Oxford boat race was first 3630m then 9254m, before in 1845 being finally changed to the distance they still race today, 6800m... The famous 2K distance, that we all enjoy or dread, that defines our performance as a rower sometimes, has been around since 1894. The World Rowing Federation, FISA, decided to standardise the wide variety of racing distances that were being used across countries, they settled on 2K. This was due to the geographical constraints that they had at the 1894 championship being that the river was only just over 2K in Macon, so this is what the length then was agreed to be. We would all probably argue that the worst type of 2K is on an erg, those ergs were first developed by can simply notice them and acknowledge their presence [pause 10 seconds]. Don't try to make them go away or change them in any way [pause 10 seconds]. Now allow yourself to focus on what you want from your rowing. What is most important to you? What do you want to do with rowing career? [pause 10 seconds]. Remain comfortable for a few more moments and slowly let yourself focus once again on any sounds and movements occurring around you [pause 10 seconds]. Once again notice your own breathing [pause 10 seconds]. When you are ready, open your eyes and notice that you feel focused and attentive."

Data Analysis

Internal consistency of the scales was computed using Hayes and Rockwood (2019) Omega SPSS macro to compute McDonald's omega coefficient (Dunn et al., 2014; McDonald, 1999). Analysis of Covariance (ANCOVA) compared the mindful manipulation scores between the control and experimental groups, while controlling for trait mindfulness. To examine whether sport-specific mindfulness versus control audios had a greater influence of RSRS and action-state orientation, separate ANOVAs were performed on each dependent variable. While, for anxiety we conducted an independent sample t test to compare the difference in scores between the control and mindful audio group. Pearson correlations were computed between post RS-CMP, RS-MSC, state and action orientation.

Results

Descriptive statistics and reliabilities

Descriptive statistics and scale reliabilities are presented in Table 4.1. RSRS, state anxiety, trait and state mindfulness scales showed good internal consistency, with omega coefficients above 0.70 but Action-State orientation demonstrated moderate internal consistency (Dunn et al., 2014a; 2014b; Kline, 2005). RS-CMP, RS-MSC and action orientation increased for both the control and mindfulness audio group from baseline to post scenario. State-orientation decreased for both groups from baseline to post scenario.

Table 4.1.

Mean and Standard deviations of Pre and Post intervention scores and independent t-test of pre-intervention scores between Mindfulness and Control audio group

		Pre-Intervention				Post-Intervention				Comparison of pre-intervention	
		Mindfulness		Control		Mindfulness		Control			
Variables	*W*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*t*	*p*
RS-CMP	.86	4.97	1.19	4.97	1.33	5.51	1.16	5.51	1.10	0.2	.99
RS-MSC	.90	3.90	1.58	3.74	1.55	4.43	1.76	3.81	1.58	-.50	.62
Trait Mindfulness	.70	4.88	0.68	4.83	0.64					-.35	.73
State Mindfulness	.80					2.41	1.31	2.77	1.34	1.34	.18
Action-Orientation	.65	5.64	0.94	5.58	1.10	5.97	0.96	5.65	1.16	-.30	.77

State-Orientation	.67	3.61	1.32	3.70	1.29	3.73	1.51	3.47	1.45	.33	.75
State-Anxiety	.83					6.09	2.54	5.86	2.06	-.47	.64

Mean and Standard deviations of Pre and Post intervention scores and independent t-test of pre-intervention scores between Mindfulness and Control audio group

Note. RS-CMP = Rowing-Specific Conscious motor Processing, RS-MSC = Rowing-Specific Movement Self-conscious; p = <.001***, p = <.01**, p = <.05*. The possible range scores for Reinvestment, Trait Mindfulness, State Mindfulness, Action-Orientation, State-Orientation were 1-7. State Anxiety was 1-11.

Manipulation check

The ANCOVA revealed there was no significant difference in state mindfulness when trait mindfulness was controlled for between the mindfulness (*M* = 2.77, *SD* = 1.34) and control (*M* = 2.41, *SD* = 1.31) groups, *F*(1, 100) = 1.76, *p* = .19 np^2 = .02.

Rowing Specific Reinvestment Scale

The 2 (time) x 2 (audio group) ANOVA revealed there was a group by time interaction effect for RS-MSC, *F*(1, 100) = 4.01, *p* = <.05, np^2 = .04, but not for RS-CMP, *F*(1, 100) = .001, *p* = .97, np^2 = .00. Furthermore, there was a main effect of time for RS-CMP, *F*(1, 100) = 21.77, *p* = <.001, np^2 = .18, and RS-MSC, *F*(1,100) = 7.08, *p* = <.01, np^2 = .07. Finally, there were no main effect of audio type on RS-CMP, *F*(1, 100) = .00, *p* = 1.000, np^2 = .00, and RS-MSC, *F*(1, 100) = 1.52, *p* = .22, np^2 = .15.

State-Action orientation

The 2 (time) x 2 (audio group) ANOVA revealed there was also no group by time interaction effect for action-orientation *F*(1, 100) = 2.71 *p* = .10, np^2 = .03 or state-orientation *F*(1, 100) = 2.43, *p* = .12, np^2 = .02. However, there was a main effect for time for Action-orientation *F*(1, 100) = 6.46, *p* = <.05, np^2 = .06 but not state-orientation *F*(1, 100) = .27, *p* = .61, np^2 = .003. Finally, there was no main effect for audio on Action-orientation *F*(1, 100) = .96, *p* = .33, np^2 = .01 or State-orientation *F*(1, 100) = .10 *p* = .75, np^2 = .001.

Anxiety

The independent t test confirmed no difference in anxiety between the control (M = 5.86, SD = 2.06) and mindful audio (M = 6.09, SD = 2.54) groups, $t(100) = -.47$, $p = .64$, $d = 2.32$.

Pearson Correlations

Our hypothesis was partially supported, with Pearson correlations (Table 4.2) revealing that RS-MSC was positively associated with a medium-large effect size to state-orientation. Furthermore, RS-MSC was negatively associated with action-orientation with a small-medium effect size but RS-CMP was positively associated with action-orientation with a small-medium effect size. However, in contrast to our hypothesis, RS-CMP was not associated with state-orientation.

Table 4.2

Pearson Correlations for Post scenario RS-CMP, RS-MSC, Action and State-Orientation

Variables	Post RS-CMP	Post RS-MSC	Post Action-orientation	Post State-orientation
Post RS-CMP	1.00			
Post RS-MSC	$.21^{*}$	1.00		
Post Action-orientation	.29**	-.32***	1.00	
Post State-orientation	-.10	$.63^{***}$	$-.59^{***}$	1.00

Note. $p = <.001^{***}$, $p = <.01^{**}$, $p = <.05^{*}$.

Discussion

This study was the first to explore the use of brief sport-specific mindfulness on reinvestment, state-action orientation, and mindfulness. The main research hypothesis that brief sport-specific mindfulness practice, in comparison to control, would produce lower rowing-specific reinvestment, state orientation but higher action orientation following a pressured scenario was not supported. There was no group by time interaction effects for RS-CMP, action, or state-orientation. Only rowing specific MSC increased more in the mindfulness group following the pressured scenario in comparison to the control group, suggesting, contrary to expectation, that the intervention increased the likelihood of a rower reinvesting.

We utilised and adapted Gardner and Moore's (2007) brief centering mindfulness exercise to be more relevant to a rower. Such experiential exercises have proven to be the most effective means to induce mindfulness (Levin et al., 2021). Despite this evidence, there was no effect on state mindfulness in the current study. Nevertheless, this is consistent with previous brief mindfulness interventions that have also found no changes in mindfulness (Noetel et al., 2017; Wolch et al., 2020), this may be due to the practice (dose-response) not being long enough. Other interventions that last 30 minutes have reported a change in state mindfulness compared to the control group (Liu et al., 2021; Perry et al., 2020). However, longer interventions across 6-8 weeks have also found mixed results in terms of inducing mindfulness (Bühlmayer et al., 2017). The mixed results across the longer intervention may be due to the lack of time, as athletes have many commitments during the day (such as training, competitions and video analysis) therefore there is already a large demand on their time. Consequently, they will sacrifice going to mindfulness practice over anything else. Therefore, an online intervention may be more beneficial as athletes do not need to travel, and could have accessibility 24/7. On the other hand, mindfulness may only work for certain individuals, as with any psychological intervention it will not benefit all (Lilienfield, 2007).

The results revealed that state anxiety was higher following the pressure scenario, but did not differ between the two groups. Anxiety was relatively high compared to other anxiety-induction studies (Moore et al., 2013; Wilson et al., 2009), suggesting that the scenario was successful in evoking an anxious response in athletes. This follows as RS-CMP and RS-MSC levels significantly increased from baseline to post pressure scenario for both groups. This is consistent with previous research that has found anxiety to activate reinvestment (Laborde & Allen, 2015). Furthermore, although the trait mindfulness levels for both groups were moderate, the intervention did not induce mindfulness, consequently, mindfulness was not able to attenuate their reinvestment levels (Sparks et al., 2021c, Chapter 3). Nevertheless, their action-orientation significantly changed from baseline to post pressured scenario, suggesting that athletes tended to draw their attention to challenges ahead and not ruminate over the failure but think fast to rectify it and move on (Krohler & Berti, 2019).

Contrary to the hypothesis there was no group by time interaction for RS-CMP, state, or action orientation, suggesting that the mindfulness intervention had no more influence than the control condition. The lack of results could be due to the mindfulness intervention not inducing mindfulness enough to have a response. Nevertheless, there was an interaction effect for RS-MSC, which was higher following the pressure scenario for the mindfulness group in comparison to the control group. These results suggest that the mindfulness intervention may have increased the athlete’s level of self-consciousness to their rowing movements in response to the pressured scenario. This contrasts with previous research that has demonstrated high levels of mindfulness to attenuate levels of RS-MSC (Sparks et al., 2021c, Chapter 3). Mindfulness enables the performer to stay in the present moment and not ruminate over a mistake or failure (Birrer et al., 2012; Rothlin et al., 2016), furthermore it prevents judgemental thinking and therefore self-consciousness and self-critical thoughts (Evans et al., 2009). Nevertheless, due to low level of mindfulness that was induced from the brief mindfulness practice this may have still brought a level of awareness to themselves but not enough to attenuate the RS-MSC (Sparks et al., 2021c, Chapter 3). Centering mindfulness exercises increase an individuals' awareness to their surroundings, breath, and body (Gardner & Moores, 2007), therefore this may have primed the rowers' focus to their body movements during the pressured scenario, which in turn increased their self-consciousness. Furthermore, Mindfulness is a difficult skill to cultivate over a short amount of time and without the support from a practitioner that you tend to get with face-to-face or over longer practices, the participants may be struggling to grasp it and how to use it beneficially (Baltzell et al., 2014).

In partial support of the hypothesis, the correlations revealed that RS-MSC was positively associated with state-orientation, suggesting that high levels of state-orientation were related to high levels of rowing-specific reinvestment. This is consistent with research that has found that athletes with high state orientation tend to exhibit a decreased sense of experiential acceptance (Korhler & Berti, 2019). Therefore, if an athlete makes an error during their performance and they have high levels of state-orientation, they may try to excessively consciously control their movements to prevent future errors in front of their crewmates or audience, which causes more errors due to lack of automaticity during execution (Masters & Maxwell, 2008). In addition, RS-MSC was negatively associated with action-orientation. This was to be expected as RS-MSC is a self-focus behaviour, similar to state-orientation, whilst action-orientation evokes experience acceptance responses. Nevertheless RS-CMP was positively related to action-orientation but not related to state-orientation. In contrast to previous research that highlights excessive conscious control as a detrimental process for performance (Masters & Maxwell, 2008), our finding would suggest an increased level of conscious control is associated with perceiving failure as a challenge and acting fast to rectify what has occurred and move on (Kuhl & Kazén, 2003). These results may be in line with the work from Toner and Moran (2014) that suggests that having some conscious control and awareness of your movement is vital in being able to alter or change your movement when something goes wrong to maintain performance proficiency.

Limitations and future considerations

The study had several limitations. First, the low and unequal group sizes can result in unequal variances between groups or a lack of power therefore leading to unreliable results or non-significance. Second, due to the study being online, we could not assess the fidelity of the intervention effectively, for instance we could not observe participant engagement or responsiveness to the audios, therefore the audio may have never been listened to in some circumstances. Ensuring adherence to a protocol is vital in whether an intervention is successful or not (Carroll et al., 2007). However, having the study online enabled participants world-wide to be included, therefore improving heterogeneously of the sample. Moreover, future research should consider a tool to stop participants from skipping the audio, such as following the audio with a question that only an individual who had listened to the audio could answer. Third, there was no performance measure, therefore we could not explore whether the changes to psychometric variables impacted performance. Future research should include objective performance measures to corroborate the benefits of mindfulness on psychological variables. In addition, another limitation is the heavy reliance of self-report measures, although the scales are valid and reliable, the measures could be subject to bias such as social desirability. Future research could consider including electrophysiological measures, such as EEG, to measure changes in reinvestment (Zhu et al., 2011).

Conclusion

This is the first study to examine the effects of brief sport-specific mindfulness training on rowing-specific reinvestment and state-action orientation. Researchers have found that mindfulness attenuates reinvestment (Sparks et al., 2021c, Chapter 3) and increases level of action-orientation, while decreasing state orientation to failures (Rothlin et al., 2020). However, the present results do not align with these previous findings, rowing-specific conscious motor processing and action-state orientation were not significantly different between the control and mindfulness group. Furthermore rowing-specific movement self-consciousness increased following the brief mindfulness training compared to the control. Nevertheless, this may be due to the type of practice, as centering exercises tend to increase an individual's awareness of body but also the intervention did not cultivate high levels of state-mindfulness. Despite the minimal findings for brief sport-specific mindfulness, the study suffered from a number of limitations, including small and unequal sample sizes, and therefore warrants further investigation.

Chapter 5: A Rowing-Specific Mindfulness Intervention: Effects on Mindfulness, Flow, Reinvestment and Performance

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Introduction

Coaches and sport psychologists are continuously seeking new methods to help athletes fulfil their potential in training and competition. One such method is mindfulness, a practice which emphasises open non-judgmental awareness and moment-to-moment attention (Vidic & Cherup, 2021). Mindfulness has been found to facilitate peak performance and to attenuate processes linked to choking, such as reinvestment (Sparks et al., 2021c, Chapter 3). Building on this cross-sectional research, the current study employed an experimental design to compare the effects of a sport-specific mindfulness intervention on competitive rowers' thoughts and actions.

Mindfulness is a non-judgmental moment-to-moment awareness of current experiences, thoughts, and emotions (Kabat-Zinn, 1990). It has been described as both a trait and state. Trait mindfulness is the tendency to exhibit non-judgemental present moment awareness, whilst state mindfulness is being mindful in the present moment. Mindfulness-based interventions have been developed to cultivate mindfulness, and they tend to include practices such as guided meditations, body scans, gentle stretching, and group discussions (Creswell et al., 2019). These interventions were first employed in the therapeutic setting and demonstrated great efficacy (Baer, 2003). Later, mindfulness-based interventions were introduced to sport. Mindfulness was proposed to enhance performance, through processes that contrast with traditional psychological skills training: the latter teaches athletes to control or suppress thoughts, whilst the former promotes acceptance and non-judgement. Mindful athletes are more accepting of their current experiences, thoughts, and emotions, and therefore do not attempt to control or suppress their internal processes which can increase rumination or frequency of unwanted thoughts (Gardner & Moore, 2004; Vidic & Cherup, 2021). Furthermore, mindfulness also increases present moment self-awareness, therefore, athletes are no longer plagued by cognitive activity related to previous or future events but can instead focus on present performance relevant cues (Gardner & Moore, 2004).

A number of popular mindfulness interventions for sport have been developed, including Mindfulness Acceptance-Commitment (Garder & Moore, 2004), Mindfulness Sport Performance Enhancement (Kaufman et al., 2009), and Mindfulness Meditation Training for Sport (Batzell & Summers, 2018). All of these interventions have had mixed success in enhancing performance or impacting performance-relevant outcomes (Buhlmayer et al., 2017). Importantly, the mechanism underlying the beneficial effects of mindfulness on performance has yet to be established, with several candidate mechanisms proposed.

Mindfulness training facilitates flow (Cathcart et al., 2014; Hill et al., 2020; Kaufman et al., 2009; Thompson et al., 2011). Flow is an intrinsically rewarding, harmonious psychological state involving intense focus and absorption in a specific activity where someone perceives balance between their ability and the task demands (Csikszentmihalyi & Csikszentmihalyi, 1990). Flow comprises nine dimensions: challenge-skill balance, action-awareness emerging, sense of control, clear goals, concentration on the task, unambiguous feedback, transformation of time, autotelic experience, and loss of self-consciousness (Csikszentmihalyi & Csikszentmihalyi, 1990). Flow is not something that can be taught, and, therefore, being able to facilitate the likelihood of it occurring is considered to be beneficial for athletes (Baltzell & Summers, 2017). The flow experience shares similarities with mindfulness, in that they both are a purposeful, present-moment awareness. When in a flow-state, the athlete is fully focused on the present, no external or internal distractions occupy the mental space, which is like being mindful (Jackson, 2016).

Therefore, researchers have proposed that teaching athletes to be more mindful will also increase their likelihood to be in flow-state and thereby help them to reach their peak performance (Landhäußer & Keller, 2012).

Another possible mechanism is that mindfulness helps athletes to control their attentional focus. Research has found that mindfulness improves selective attention (van den Hurk et al., 2010) and attention flexibility (Hodgins & Adair, 2010). Consequently, it has been proposed that mindfulness may regulate athletes' self-focus and thereby attenuate or mitigate reinvestment (Birrer et a., 2012; Josefsson et al., 2017; Shaabani et al., 2020). Reinvestment describes the situation where individuals consciously control and monitor their motor processes leading to a breakdown in the automaticity of skill execution (Masters & Maxwell, 2008). A plethora of reinvestment research has demonstrated that reinvestment is associated with poor performance in laboratory-based skills, such as golf putting (Zhu et al., 2011), hockey dribbling (Jackson et al., 2006), football volleying (Chell et al., 2003) and basketball free-throw (Orn, 2017). In addition, in the field context, high levels of reinvestment have been associated with poor rowing race performance and crabbing, which describes a rowing-specific choke (Sparks et al., 2021a; 2021b, Chapter 2; 2021c, Chapter 3).

Reinvestment can have a detrimental impact on performance and, therefore, it is important for athletes to find ways to prevent it from occurring. Recent research has demonstrated that mindfulness attenuated the moderating effect of rowing-specific reinvestment on the anxiety-performance relationship (Sparks et al., 2021c, Chapter 3). This effect may be due to mindfulness facilitating increased present moment awareness and experiential acceptance. Therefore, mindful performers accept an unexpectedly poor performance and do not ruminate over it or try to consciously control their movements (Birrer et al., 2012). Additionally, present moment awareness prevents rumination of experiences, thoughts, or emotions, and thereby aids athletes to perform autonomously (Birrer et al., 2012; Josefsson et al., 2017; Rothlin, et al., 2016). Nevertheless, the study by Sparks et al (2021c, Chapter 3) employed a cross-sectional design and therefore a causal effect cannot be concluded. Clearly, this mechanism warrants further investigation.

Despite evidence that mindfulness-based interventions have a positive impact on performance, they typically last 6-12 weeks, with an average of 14 sessions (Buhlmayar et al., 2017). However, due to the demanding schedules of athletes they tend to claim that they do not have time for the practice needed to cultivate mindfulness and its benefits (Baltzell & Summers, 2018). Consequently, exploring shorter interventions is required. Additionally, there is scepticism surrounding mindfulness in sport among both athletes and coaches, making it difficult for them to employ mindfulness as they do not believe in it or its benefits (Joseffon et al., 2019; Vidic et al., 2018). Therefore, developing a mindfulness-based intervention that is sport-specific should improve an athlete's understanding of mindfulness and make it easier for them to apply mindfulness to their sport (Hopper, 2017).

Scott-Hamilton et al. (2016) conducted an 8-week mindfulness intervention for competitive cyclists and incorporated mindful spinning into the activities. The intervention increased both mindfulness and flow compared to a control group. These beneficial effects were attributed to the inclusion of sport-specific practice; with the cyclists able to apply the mindfulness processes to their sport. However, it is worth noting that two popular interventions – Mindful Sport Performance Enhancement (MSPE) and Mindfulness Meditation Training in Sport (MMTS) – included sport-specific scripts for only one of eight sessions (Baltzell & Summers, 2018). Therefore, a mindfulness-based intervention that includes sport-specific practices in multiple sessions of the intervention may be expected to be more effective at cultivating mindfulness. Moreover, it is also possible that a sport-specific intervention may require fewer sessions than a generic intervention.

The present study developed and evaluated a multi-session rowing-specific mindfulness intervention and investigated its effects on mindfulness, flow, reinvestment, and rowing performance. In line with the abovementioned previous research, it was hypothesised that the intervention would increase mindfulness and flow (Cathcart et al., 2014; Scott-Hamilton et al., 2016), decrease reinvestment (Sparks et al., 2021c, Chapter 3), and improve performance (Jones et al., 2020) compared to the control group.

Methods

Participants

Forty-five rowers (33 females, 12 males) aged 16 and above (*M* = 44.76, *SD* = 19.62 years) agreed to participate in the study. Rowers were of varying skill level, with 24% club, 16% regional, 42% national and 18% international level. Rowers were recruited through Twitter and Facebook using a recruitment poster. Additionally, recruitment emails to club secretaries in the United Kingdom were also sent out, this included the recruitment poster and details of the study in terms of eligibility, time commitment and study involvement (Appendix 1C, 1E). Participants were only included if they had competed and had at least one year's rowing experience and were aged 16 and over. A study flow diagram is shown in Figure 5.1. All participants provided informed consent prior to partaking in the study (Appendix 1D). The study was approved by the University Ethics Committee.

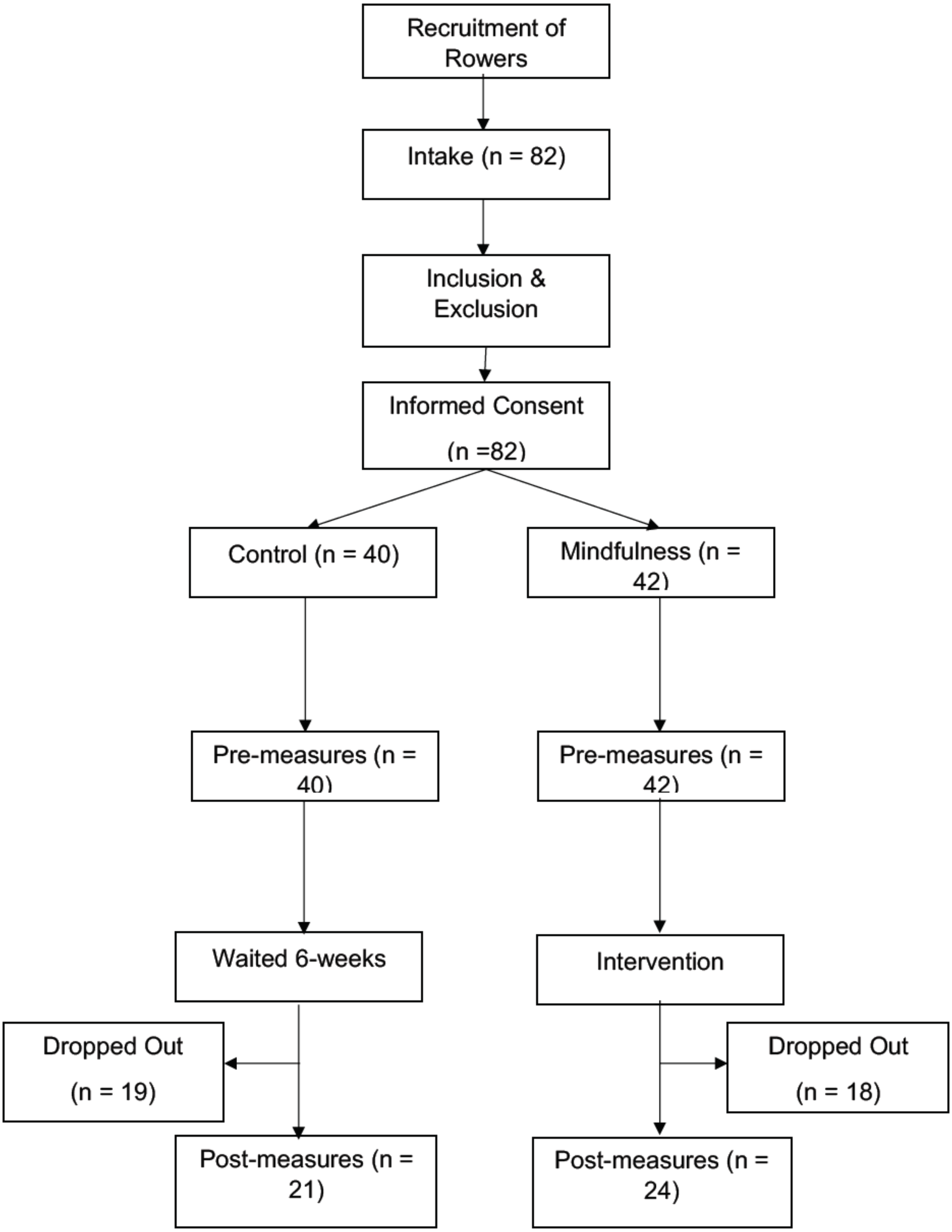

Figure 5.1. *Participant recruitment and study flow*

Background Questionnaire

The background questionnaire included questions regarding age, boat club they currently hold membership for, the type of boat they typically compete in (single, double/pair, quad/four, eight), highest level they have competed at, and how much mindfulness-related practice they have already experienced.

Rowing Performance

We asked athletes one question about their training performance using a single item (“During the last two weeks I rate my training performance as ...”) on a 10-point Likert scale, ranging from “1 = very poor” to “10 = very good” (Hasker 2010; Josefsson et al., 2019).

Sport Rating Form (SRF)

We also measured self-reported satisfaction with athletic performance (Hasker, 2010). Athletes were asked to rate their satisfaction on overall performance and 10 different dimensions that assessed physical (strength, endurance, quickness, fitness, mechanics), mental (concentration, motivation, aggression), and team cohesion. Each item was rated on a Likert scale of 1 (Very poor) to 5 (Very good). The scale has demonstrated good validity and reliability with alpha coefficients above .70 in previous research (Hasker, 2010) and the current study (Table 5.1).

Rowing Specific Reinvestment Scale (RSRS)

A sport-specific 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., 2021b, Chapter 2). The scale comprises the 6-item RS-CMP subscale (e.g., “I paid attention to how I carried out my rowing movements”), and the 6-item RS-MSC subscale (e.g., “I believed that everyone was just looking at me and scrutinising my rowing”). Athletes rated their level of agreement 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. The scale has demonstrated good validity (Sparks et al., 2021b, Chapter 2) and alpha coefficient scores above .70 (Table 4.1).

Sport-Specific Mindfulness

The Mindfulness Inventory for Sport (MIS) scale (Thienot et al., 2014) was used to assess the ability to be mindful in the context of sport. The MIS consists of three 5-item subscales, 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 experience when they row, on a scale of 1 (not at all) to 7 (very much). The non-judgemental subscale items were reverse scored. The mean of the items for each subscale were calculated to measure Mindful Awareness, Mindful Non-judgement, and Mindful Refocus. The scale has demonstrated good validity and reliability with alpha coefficients above .70 for each subscale (Table 5.1) (Thienot et al., 2014).

Dispositional Flow

The short dispositional Core flow 10-item scale was developed following qualitative interviews with athletes (Jackson, 1996). The scale measures the subjective optimal experience of flow (Martin & Jackson, 2008), rather than the nine dimensions that lead to flow (Jackson & Eklund, 2002). The items include “I am totally involved”, “I am in the groove”, and “I feel in control”. Athletes rated the frequency that they experienced flow when they rowed on a Likert Scale, with anchors of 1 (Never) to 5 (Always). The scale presents good validity (Martin & Jackson, 2008) and good reliability with an alpha coefficient above .70 (Table 5.1).

Self-reported Mindfulness completed

Participants who completed the mindfulness intervention also reported how many minutes they completed each week on total.

Programme Evaluation

Participants who completed the mindfulness intervention answered the Programme Evaluation Questionnaire (PEQ) (Minkler et al., 2020). We only included part of the PEQ regarding the five statements that assessed an athletes’ perception of program success. Athletes were asked, on a scale of 1 (Not at all helpful) to 7 (Extremely helpful), how helpful they found the mindfulness session in their “ability to be in the zone”, “ability to reduce anxiety”, “ability to focus”, “ability to let things go”, and “ability to be aware of and cope with feelings”. This scale has demonstrated good reliability with an alpha coefficient score above .70 (Table 4.1). We also included the question related to how confident the athlete felt incorporating mindfulness when rowing, which was rated between 1 (Not confident at all) and 7 (Extremely confident).

Rowing-Specific Mindfulness Intervention (See Appendix 4A)

The rowing-specific mindfulness intervention was adapted from the MMTS 2.0 and MSPE (Baltzell & Summers, 2018). It consisted of six sessions, 1 hour per week for 6 weeks, with participants told to practice 10 minutes every day (Aherne et al., 2011). The sessions were as follows:

Week 1: *Introduction to mindfulness.* This covered general and sport-specific mindfulness, it included a mindfulness definition, theoretical understanding of mindfulness and rationale for it to be used in sport. Practice activities following this were the ‘chocolate’ mindful exercise, a 3-minute breathing exercise, and a 5-minute brief rowing-specific centering exercise (Gardner & Moores, 2007) that was to be used before an erg(ometer) or water session.

Week 2: *Importance of acceptance.* This included further discussion around the core performance facilitators for mindfulness, which were taken from the MSPE. Participants were then taught about awareness, acceptance, clarity, decentering and labelling of thoughts, feelings, and emotions in relation to rowing and how this could possibly impact sport performance. This session was based on the MMTS 2.0 session 2a and 2b.

Week 3: *Understanding body awareness.* We introduced body awareness as a means of entering the present moment and being able to make a choice in face of a pressured/stressed moment. The body scan was first introduced in the session, this practice involved paying attention to different parts of the body, one part at a time, in a sequential order. However, in the home practice a sport-specific body scan was introduced to be practiced on the erg or in the rowing boat, whereby rowers focused on different elements of their body in the rowing position. Participants were also taught ‘soles of our feet’ walking meditation, included was a rowing-specific alternative to ‘soles of our feet’ for the rowing boat and erg.

Week 4: *Self-compassion and dealing with negative mind-states*. First, athletes were taught about the importance of self-compassion, followed by a practice where they directed their attention to wishing themselves and then their teammates well (see Module 4 MMTS, Baltzel & Summers, 2018). Following this, participants discussed the use of self-compassion and created their own self-compassion mantra. Participants then practised the acceptance of negative mind states specific to a personalised rowing scenario, were asked to label their state of mind, emotion or thought, and then practiced accepting it non-judgementally using a self-compassion phrase.

Week 5: *Value-driven performance* (see Module 5A MMTS, Baltzel & Summers, 2018). First, there was a discussion around self-regulation and the problem with outcome-orientated goals when under stress. Following this, participants were taught about inspirational sport values and how they could develop their own. Athletes then listened to a values script to help them to recognise and establish their own values for performance. Participants then practiced implementing their inspirational sport values, self-compassion and labelling in a rowing-specific race imagery to prevent rumination and negative thinking and to promote staying in the present. Furthermore, they were also introduced to the Bulls-eye value-driven circle, this way they could clarify their values in three different areas of performance ‘competition, training, and preparation & recovery (Henriksen et al., 2019).

Week 6: *Importance of open awareness for refocus.* The importance of an underlying broad awareness was first discussed before participants completed an open awareness script for sport. Participants were then taught about the need for a novelty state of mind when it comes to performance so they can be aware of the ever-changing environment (See Module 6, MMTS, Baltzel & Summers, 2018). Following this all athletes completed a brief pre-race mindfulness rowing practice for preparing to engage in their sport and were also introduced to the Focus Circle (Henriksen et al., 2019).

The mindfulness intervention was conducted by a facilitator who was a mindfulness teacher. The facilitator was a doctoral student in sport psychology. The facilitator possessed a mindfulness teacher qualification and practiced mindfulness for six months before the start of the intervention. This ensured that the facilitator had both knowledge and regular self-practice of mindfulness (Crane et al., 2012). The mindfulness sessions took place via videoconference (Zoom) due to COVID-19. Each session started with a 3–5-minute mindful breathing meditation to bring everyone together and to create a mindful mindset for the session. This was followed by a debrief of the week's home practice, any problems or issues with the practice, and advice for overcoming any barriers that were preventing completion of home practice were aired. Aims for the session were then introduced before the core session began. Throughout the sessions the participants could ask questions, but discussion was also prompted each time after a practice and how it could be implemented into their rowing training or competition. All athletes received recordings of the practices that had been performed in the session and any erg or water-specific alternatives as these could not be performed during the online sessions.

Procedure

Once rowers had agreed to take part in the intervention, they completed the informed consent and then they were randomly allocated to the intervention group or control group. Rowers then completed the background questionnaire and all pre-test measures (see above). The mindfulness teacher then discussed with the captain/coach of the intervention group a suitable time for mindfulness training each week to ensure every rower could participate. The control group carried on with their daily routine for 6 weeks. Following the 6 weeks rowers completed post-test measures of performance. To maintain anonymity each rower was given an identification number for their pre-test and post-test questionnaire. Finally, the fidelity of the intervention was measured using a self-reported measure of the number of minutes spent completing the home practice.

Data Analysis

Internal consistency of the scales was computed using SPSS to compute Cronbach's alpha coefficient (Cronbach, 1951) and Hayes and Rockwood (2019) Omega SPSS macro to compute McDonald's omega coefficient (Dunn et al., 2014; McDonald, 1999). To perform the data analysis, we used SPSS Version 26. First, to investigate whether the mindfulness versus control intervention had a beneficial influence on RSRS, Mindfulness and Flow, we conducted 2 group (mindfulness, control) by 2-time (pre-test, post-test) analyses of variance (ANOVAs) on each dependent variable. Eta-squared as measure of effect size for each of the ANOVAs. We also followed up any significant group by time interactions using within- and between-group t tests. Cohen's *d* as measure of effect size was calculated for each of the independent t tests (Cohen, 1992). Second, we explored the self-reported PEQ scores to help us understand the success of the intervention and the minutes spent practicing between the official sessions each week.

Results

Descriptive Statistics

Descriptive statistics are shown in Table 5.1. The scale reliabilities confirmed good internal consistency for every measure, with all alpha and omega coefficients above .70 (Dunn et al., 2014; Kline et al., 2005).

Table 5.1. ***Descriptive Statistics and two-way ANOVA effects for dependent variables.***

			Pre-Intervention				Post-Intervention									
			Mindful		Control		Mindful		Control							
											Time		Group		Interaction	
	ω	a	M	SD	M	SD	M	SD	M	SD	F (1,42)	Np^2	F (1,42)	Np^2	F (1,42)	Np^2
RS-CMP	.72	.71	4.36	1.00	5.01	0.89	3.97	0.61	4.82	0.70	5.02*	.11	12.18**	.23	0.54	.01
RS-MSC	.73	.82	4.90	0.91	5.52	0.88	5.15	0.91	5.46	0.84	0.36	.01	4.08*	.09	1.15	.03

Flow	.91	.90	3.44	0.52	3.51	0.73	3.85	0.58	3.42	0.52	2.76	.06	1.34	.03	6.81*	.14
Mindful Awareness	.74	.74	3.70	0.48	4.02	0.54	3.95	0.50	3.92	0.71	0.52	.01	1.13	.03	3.41	.08
Mindful NJ	.87	.86	3.15	0.75	3.19	0.93	3.76	0.70	3.44	0.58	9.70**	.19	0.62	.02	1.68	.04
Mindful Refocus	.78	.78	3.42	0.55	3.57	0.70	4.07	0.73	3.83	0.59	14.17***	.25	0.07	.00	2.67	.06
Overall Training			3.13	0.46	5.86	2.43	4.35	0.71	3.81	0.82	2.11	.05	15.29***	.27	32.58***	.44

Overall Perceived Perf	.75	.75	3.00	0.85	3.57	0.98	3.70	0.56	3.33	0.97	1.83	.04	0.30	.01	7.63**	.15
Perceived Physical	.75	.75	3.43	0.40	3.57	0.65	3.44	0.52	3.59	0.67	0.01	.00	1.34	.03	0.00	.00
Perceived Psychological	.75	.75	3.29	0.67	3.44	0.71	3.78	0.52	3.46	0.63	4.69*	.10	0.30	.01	4.13*	.09
Team Cohesion	.75	.75	3.61	0.89	2.76	0.79	4.09	0.79	5.10	0.58	64.61***	.61	.114	.00	28.13***	.40

Note. RS-CMP = Rowing-Specific Conscious motor Processing, RS-MSC = Rowing-Specific Movement Self-conscious; p = <.001***, p = <.01**, p = <.05*. The possible range scores for Reinvestment, Mindfulness and Performance were 1-7. Flow was 1-5.

RSRS

The 2 group (mindfulness, control) by 2 time (pre-intervention, post-intervention) ANOVAs revealed main effects for group on RS-CMP and RS-MSC. Furthermore, there was a main effect for time for RS-CMP but no group x time interactions (Table 5.1). The control group had higher levels of RS-CMP and RS-MSC compared to the mindfulness group. RS-CMP decreased for both groups from pre to post intervention.

Flow

The 2 group by 2 time ANOVA revealed a group by time interaction for flow but no main effects for group or time (Table 5.1). Follow-up t tests confirmed that the groups differed at post intervention, $t(42) = 2.53$, $p < .05$, $d = .76$, but not at pre intervention, $t(42) = 0.39$, $p = .70$, $d = .12$. Moreover, the mindfulness group increased flow from pre intervention to post intervention, $t(44) = 2.91$, $p < .01$, $d = .61$), whereas the control group did not change, $t(40) = 0.72$, $p = .48$, $d = .16$.

Mindfulness

The group by time ANOVAs revealed no group main effects or group x time interactions, however there were time main effects for mindful refocus and mindful non-judgmental thinking (Table 5.1). Mindful non-judgmental thinking and mindful refocus increased from baseline to post intervention.

Performance

The group by time ANOVA revealed a group main effect and a group x time interaction for perceived training performance but no time main effect (Table 5.1). Follow-up t tests revealed that the control group exhibited higher scores at pre intervention compared to the mindfulness group, $t(42) = 5.28$, $p < .001$, $d = 1.59$, whereas the mindfulness group exhibited higher scores at post intervention compared to the control group, $t(42) = 2.34$, $p < .05$, d = .71. Furthermore, training scores increased in the mindfulness group, $t(44) = 7.93$, $p < .001$, $d = 1.65$, but decreased in the control group, $t(44) = 3.56$, $p < .001$, $d = .78$, from pre to post intervention.

The group by time ANOVA on overall perceived competitive performance revealed a group x time interaction effect but no group or time main effects (Table 5.1). T tests confirmed that the control group reported higher scores than the mindfulness group at pre-intervention, $t(42) = 2.07$, $p < .05$, $d = .63$, but the mindfulness group at higher scores post intervention, compared to the control group $t(42) = 1.54$, $p = .13$, $d = .47$. In addition, perceived performance increased from pre to post intervention in the mindfulness group, $t(44) = 3.14$, $p = <.001$, $d = .78$, but did not change in the control group, $t(40) = 0.93$, $p = .18$, $d = .20$.

The group by time ANOVA yielded a time main effect and a group x time interaction effect for perceived psychological performance but no group main effect (Table 5.1). T-tests indicated that although the groups did not differ at both pre intervention, $t(42) = 0.74$, $p = .46$, $d = .22$, and post intervention., $t(42) = 1.83$, $p = .07$, $d = .55$, the perceived psychological performance increased in the mindfulness group, $t(44) = 3.02$, $p < .01$, $d = .63$, but not the control group, $t(44) = 0.10$, $p = .92$, $d = -.02$ from pre to post intervention.

However, there was no main group, time, or group x time interaction effects for perceived physical performance (Table 5.1).

In the case of perceived team cohesion, the group by time ANOVA showed time and group x time effects (Table 5.1). T tests indicated that team cohesion was rated higher at pre intervention in the mindfulness group versus the control group, $t(42) = 2.83$, $p < .01$, $d = .85$, however, cohesion was higher at post intervention in the control compared to the mindfulness group, $t(42) = 3.44$, $p < .01$, $d = 1.04$. Moreover, team cohesion increased from pre to post intervention in both the mindfulness, $t(44) = 1.92$, $p < .05$, $d = .57$, and control, $t(42) = 6.79$, $p < .001$, $d = 2.10$, groups. The group by time ANOVA found no group, time, or group x time effects for perceived physical performance (Table 5.1).

Mindfulness Programme Evaluation

The mindfulness group reported that the intervention helped increase their ability to be in the zone ($M = 5.79$, $SD = 0.98$), reduce anxiety ($M = 5.57$, $SD = 1.29$), be focused ($M = 5.79$, $SD = 1.06$), let things go ($M = 5.54$, $SD = 1.21$), and to be aware of and cope with feelings ($M = 5.67$, $SD = 1.24$). Furthermore, they were very confident in their ability to incorporate mindfulness when rowing.

Weekly Mindfulness

The mindfulness group reported that they practiced on average 10.8 minutes (SD = 8.33), this ranged from 0 – 30 minutes.

Discussion

Numerous methods have been proposed to aid performance under pressure. Mindfulness is one such method. Several putative mechanisms have been proposed to explain how mindfulness enhances performance, including increased flow (Cathcart et al., 2014; Hill et al., 2020; Kaufman et al., 2009; Thompson et al., 2011), and decreased attention on one's movements and reinvestment (Sparks et al., 2021c, Chapter 3). To investigate this issue further, the present study explored the effect of a sport-specific mindfulness intervention, adapted from the MMTS, on rowing-specific reinvestment, flow, mindfulness, and performance.

Overall, the participants reported positive experiences with the intervention. The PEQ confirmed that the intervention helped athletes to be 'in the zone', reduce anxiety, augment present moment focus, let go of distractions and be more aware of and better cope with their feelings. Furthermore, after completing the intervention, they were confident that they would continue to incorporate mindfulness when rowing, both during training and competition. Overall, the feedback demonstrated that the program equipped the rowers with some of the skills needed to be successful under pressure, especially in terms of reducing anxiety and exhibiting a present moment focus, which is an important feature of flow-state (Bishop et al., 2004).

In line with the hypothesis, mindfulness training increased flow compared to control. This finding agrees with those of previous studies describing mindfulness interventions (Aherne et al., 2011; Scott-Hamilton et al., 2016). Nevertheless, ours is one of the shortest interventions to change dispositional flow, with the majority prescribing more than 11 hours of official training (Bühlmayer et al., 2017; Noetel et al., 2017). The current finding is beneficial because athletes have demanding schedules and therefore being able to complete a mindfulness intervention in less time is preferable. Mindfulness and flow share similar characteristics, such as present moment attention and awareness (Jackson, 2016), and, therefore, it is logical that following the mindfulness training, rowers reported experiencing more flow. This is consistent with the feedback from the intervention, as athletes felt the mindfulness practice had increase their ability to stay in the present moment. The flow state has been linked with peak performance (Laudhauber & Keller, 2012) and automaticity in movement execution (Sparks et al., 2021b, Chapter 2).

Consistent with this evidence, we found that perceived training and overall athletic performance ratings between pre and post intervention increased more for the mindfulness group compared to the control group. Similarly, perceived rating of psychological performance and team cohesion followed the same trend, which supports previous research showing that mindfulness is associated with improved team-cohesion (Balzell et al., 2014; Piaseki, 2018), motivation (Birrer & Morgan, 2010), and concentration (Chen & Meggs, 2020). This finding highlights the versatility of mindfulness interventions over the traditional psychological skills training, that may only equip athletes with tools to self-control their internal states momentarily (Birrer et al., 2012). Nevertheless, perceived psychological performance improved in both groups from pre to post intervention, which may be explained by extraneous variables. For instance, some of the rowers transitioned from training alone in isolation to training with a coach in a crew-setting. It is to be expected that receiving real-time feedback from coaches and training with a crew on the water will have improved a rower's concentration, motivation, aggression, and team cohesion. Nevertheless, perceived physical performance did not change for either group, which may reflect the short timescale, as limited physiological changes can be expected to have occurred in 6-weeks in these experienced rowers.

In contrary to our hypothesis, mindfulness scores did not differ between mindfulness and control groups following the 6 weeks intervention. Several factors may account for this null finding. First, the intervention may not have been long enough to induce changes in sport-specific mindfulness (Bühlmayer et al., 2017). Second, the success of an intervention in cultivating mindfulness depends on the participant's engagement and tenacity to the practice (Zhang et al., 2016). We recommended participants complete at least 5 minutes practice on 5 days a week or more. However, only one participant reported completing over 25 minutes practice each week. Consequently, the amount of self-directed practice may have been insufficient.

Moreover, in contrast to our hypothesis that mindfulness training would reduce rowing-specific reinvestment, the intervention did not decrease conscious motor processing or movement self-consciousness compared to control. Given previous research showing that high mindfulness is associated with low RS-CMP and RS-MSC (Sparks et al., 2021c, Chapter 3), the current null finding may be because the intervention did not increase dispositional mindfulness. We found that RS-CMP decreased and RS-MSC increased from pre to post intervention in both groups. The increase in RS-MSC observed may be due to rowing training transferring during the study from initially being remote and completed in private on an erg to subsequently being back on the water in crews and with coaches observing. In accordance with trait-activation theory, whereby situational cues from specific situations activate certain traits (Geukes et al., 2013), these latter public conditions may have activated self-conscious traits in rowers, such as RS-MSC. A similar phenomenon has been observed when medical students performed a laparoscopic task – when completed in front of surgical experts, the students reported high levels of MSC, presumably because they wanted to impress their observers (Malhotra et al., 2014).

Limitations and Future Considerations

There are several study limitations that need to be considered when interpreting the present findings. First, the sample size was relatively small, and therefore the sample may have not been large enough to detect significant changes in some variables with small effect sizes, such as performance and mindfulness. Second, there was no actual performance measure, only self-report ratings, meaning they may be subject to social desirability bias. Nevertheless, objective performance measures could not be conducted due to COVID-19 as there were no races or erg tests during the season. Accordingly, future research could include kinematic measures of technical performance using telemetry. Furthermore, psychophysiology measures could also be included to support measures of reinvestment, flow, and mindfulness, as consciousness or cognitions can change over time and situations (Peifer et al., 2014). In addition, scales tend to measure the experience across the whole task rather than a particular moment that it happened, resulting in inaccurate recall due to our memory remembering the most recent experience. Moreover, scales tend to be developed for general and clinical populations, and most previous mindfulness interventions studies have used generic mindfulness scales over sport-specific scales (Solé et al., 2020), therefore results may be unreliable. However, the current study utilised a sport-specific mindfulness scale, but the scale warrants further validation. Furthermore, there are discussions around whether individuals can be both in a mindful and flow state, whether they occur at different times or if you can have one without the other (Sheldon et al., 2014; Jackson, 2016), which scales cannot determine.

Consequently, using psychophysiological measures, such as electroencephalography (EEG) to measure flow-states (Katahira et al., 2018), mindfulness (Bostanov et al., 2018) and reinvestment (Zhu et al., 2011), would improve our understanding of the different states and when these states occur (Jackson, 2016). Lastly, this study demonstrated the possible successes of a sport-specific mindful intervention, therefore it would be worth developing more sport-specific mindful interventions for different sports and investigating the impact of these.

Conclusions

The present study provides evidence to support the case that a 6 weeks sport-specific mindfulness intervention is long enough and effective at increasing dispositional flow. Furthermore, the intervention also increased perceived overall and psychological performance, further supporting the benefits of mindfulness. Nevertheless, 6 weeks of sport-specific mindfulness did not increase levels of mindfulness or reduce levels of reinvestment. The lack of change in these latter processes may be due to small sample size, therefore the promising findings yielded by the mindfulness intervention warrant replication.

Chapter 6: General Discussion

The aim of this thesis was to extend the existing literature on reinvestment, mindfulness and performance in sport. It aimed to develop a way of assessing reinvestment in the context of the sport of rowing, investigate the influence of reinvestment on competitive performance, and examine the influence of mindfulness on reinvestment and various psychological processes. This was done by developing a rowing-specific measure of reinvestment, analysing competitive rowing performance, and creating a rowing-specific mindfulness intervention. The next section will begin with a summary of the empirical and common themes that emerged across the chapters before discussing the strengths, weaknesses, theoretical implications, applied implications, and suggestions for future studies.

Summary of Results

Chapter 2

The aim of Chapter 2 was to develop and validate a rowing-specific reinvestment scale (RSRS) that addressed a gap in the literature because there were no pre-existing sport-specific measures of reinvestment. The RSRS was designed to measure two types of conscious processing, adapted from the Movement-Specific Reinvestment Scale (MSRS) (Masters et al., 2005), namely, rowing-specific conscious motor processing (RS-CMP) and rowing-specific movement self-consciousness (RS-MSC). Chapter 2's first sub-study reported scale construction, content validity and exploratory factor analysis, whereas its second sub-study reported confirmatory factor analysis and construct validity. The initial pool of 25 items was generated by modifying three MSRS items whereas the rest were inductively developed following discussions with coaches and rowers about their conscious thoughts, feelings and evaluative apprehensions whilst rowing. After establishing content validity by obtaining feedback from seven sport psychology academics and pilot testing, the number of items were reduced from 25 to 15, and then the wording of these items were modified. The items then went through principal axis factor analysis with oblimin rotation to reveal a two-factor solution which captured two constructs, namely, rowing-specific conscious motor processing and movement self-consciousness.

In sub-study 2 rowers of varying skill level completed the RSRS following their regatta race; a CFA confirmed the two-factor solution identified in sub-study 1. The rowers also completed scales measuring self-consciousness, state anxiety, and perceived performance. In terms of construct validity, the RSRS subscales revealed good convergent validity with their respective MSRS subscales and self-consciousness scale. Discriminant validity was only partly supported, whereby RS-CMP was weakly, but RS-MSC was strongly associated with state-anxiety. Lastly, predictive validity was demonstrated by evidence that the RS-MSC was negatively related to rowing experience, actual and perceived performance. Additionally, the RSRS scale identified crabbers who exhibited higher levels of RSRS, and RS-CMP compared to non-crabbers. Overall, the findings of chapter 2 provided preliminary support for the validity of the RSRS scale.

Chapter 3

Chapter 3 aimed to explore the relationship between trait sport-specific mindfulness and rowing performance in competition. In accordance with previous, albeit limited, research that has found trait mindfulness to play a positive role in perceived performance and performance in precision sports (Bühlmayer et al., 2017), I hypothesised that trait-sport mindfulness would be associated with better rowing performance in competition.

Secondly, in light of Chapter 2 showing that rowing-specific reinvestment can harm performance, I investigated whether trait sport-specific mindfulness moderated the moderating effect of reinvestment on the relationship between anxiety and performance. In line with previous proposals that mindfulness regulates attentional processes (Rothlin et al., 2020), I hypothesised that higher trait mindfulness would attenuate the amplifying effect of rowing-specific state reinvestment on the anxiety-performance relationship. Furthermore, the RSRS validity and reliability was also re-examined.

Results revealed that trait mindful refocus was positively associated with perceived and actual performance, whilst non-judgmental thinking was only positively associated with perceived performance. Moreover, similar to Chapter 2, rowing-specific reinvestment was negatively related to actual performance. Furthermore, the moderation of the anxiety-performance relationship by RS-CMP was attenuated at high levels of mindful awareness for perceived and actual performance. However, the moderation of the anxiety-performance relationship by RS-MSC was attenuated at high levels of non-judgemental thinking but only for perceived performance. Furthermore, the study further supported the reliability and validity (convergent and predictive) of the scale. Findings from this study demonstrated the benefits of mindfulness on performance and reinvestment processes linked to poor performance.

Chapter 4

Building on the initial findings of Chapter 2 and Chapter 3, I aimed to further explore the influence of mindfulness on reinvestment and performance. In light of the moderating moderation effect concerning the effect of mindfulness on the effect of reinvestment on the anxiety-performance relationship, I further explored this effect using a brief sport-specific mindfulness intervention. Limited research has investigated the use of brief mindfulness manipulations on performance and performance-related characteristics (Perry et al., 2017; Shaabani et al., 2020; Wolch et al., 2019;). Although there has been limited research on brief mindfulness manipulations in sport, there has been a growing case for this type of intervention because athletes report having little time due to their busy schedules and training demands. Consequently, brief interventions make a desirable alternative compared to standard 6–12 weeks mindful interventions. Brief mindfulness interventions have previously comprised a generic mindful practice, such as a body scan or sitting meditation, which may have contributed to the mixed results (Shaabani et al., 2020; Wolch et al., 2020), and, therefore, this study explored the effect of a sport-specific brief mindfulness manipulation.

I compared the effect of brief sport-specific mindfulness versus neutral audiotaped activities on cultivating mindfulness, rowing-specific reinvestment, and dealing with failure after imagining a typical pressured race scenario. Athletes tend to be either action- or state-orientated following a failure, and previous research has demonstrated that mindfulness increased an athlete's likelihood to exhibit action-orientation compared to a state-orientation in response to a failure (Rothlin et al., 2020). In accordance with previous research and Chapter 3's results, I hypothesised that the brief sport-specific mindfulness group would exhibit higher levels of mindfulness, higher ratings of action-orientation than state-orientation, and lower levels of rowing-specific reinvestment compared to the neutral audio control group. Furthermore, to understand reinvestment's role in failure under pressure, I also analysed whether reinvestment was linked to state-action orientation. State-orientation evokes high levels of self-focus behaviours following a failure, while action-orientation involves experiential acceptance and moving on from the failure (Körhler

& Berti, 2019). I therefore hypothesised that state-orientation would be positively associated and action-orientation negatively associated with rowing-specific reinvestment.

The results were not consistent with previous research: state-mindfulness, RS-CMP, and action/state orientations did not differ between the two groups. Moreover, RS-MSC increased following the brief sport-specific mindfulness intervention compared to the control group. These results are in contrast to Chapter 3, where RS-CMP was attenuated by mindful awareness and RS-MSC was attenuated by mindful non-judgement, and, therefore, it is possible that the audio did not cultivate these elements of mindfulness and thereby decrease these conscious processes. Furthermore, the scale used, measured a single dimension of mindfulness, therefore I cannot conclude whether these mindful processes were induced or not. Moreover, the lack of difference between the groups is possibly due to the low levels of state mindfulness that was induced following the sport-specific mindfulness audio material. Nevertheless, the increase in RS-MSC is inconsistent and could be due to the small sample size. However, it is more likely to be due to type of mindful practice used, which was a brief centering exercise that increases an individual’s level of awareness to their body and movement (Gardner & Moores, 2007). Furthermore, RS-MSC was positively associated with state-orientation and negatively related to action-orientation, whilst RS-CMP was positively related to action-orientation, suggesting that these reinvestment process may play distinct roles in influencing how athletes deal with failure, whether that be beneficial or detrimental. Overall, this study yielded mixed findings and added to the growing body of evidence that brief mindfulness may not be effective in cultivating mindfulness and influencing performance.

Chapter 5

Extending from Chapter 4's results, I developed a longer sport-specific mindfulness intervention that lasted 6 weeks. In this study I aimed to further examine mindfulness's role in preventing rowing-specific reinvestment and aiding performance. A well-established individual characteristic linked to peak performance is flow (Kee & Wang, 2008). Flow is an intrinsically rewarding, harmonious psychological state involving intense focus and absorption in a specific activity where someone perceives balance between their ability and the task demands (Csikszentmihalyi & Csikszentmihalyi, 1990). Flow cannot be taught but it can be facilitated through mindfulness training (Cathcart et al., 2014). Previous mindfulness interventions in sport have been fairly generic, therefore I developed a multi-session rowing-specific mindfulness intervention. I evaluated the mindfulness intervention and investigated its effects on mindfulness, flow, rowing-specific reinvestment and rowing performance compared to a control group. In line with previous research, I hypothesised that the mindfulness group would increase their levels of mindfulness and flow, decrease their rowing-specific reinvestment, and improve their performance from pre- to post-intervention. I also hypothesised these changes from pre to post intervention would be greater in the mindfulness compared to the control group.

The results demonstrated that mindful refocus and non-judgemental thinking tended to increase from pre- to post-intervention in the mindfulness group, however, there was no statistically significant difference between the two groups. Furthermore, the control group exhibited higher levels of RS-CMP and RS-MSC post intervention compared to the mindfulness group; but they also had higher levels at baseline. Importantly, flow increased from baseline to post intervention for the mindfulness group but not the control group. Additionally, perceived training, competitive, psychological and team cohesion increased from baseline to post intervention for the mindfulness compared to the control group. These results are in line with Chapter 3's findings that high levels of mindfulness were associated with better performance. The positive impact of mindfulness on performance could due to the increase in flow-state as presented in this Chapter or as Chapter 3 demonstrated with RS-CMP and RS-MSC being attenuated by trait mindfulness. Although, the intervention study found the mindfulness intervention to make no significant difference on reinvestment compared to the control group, the groups had significantly different reinvestment scores from baseline so it would be unfair to make comparisons. Therefore, it is still unclear which mechanism, if not both, mindfulness is acting on. Furthermore, these are perceived performance measures, therefore the higher ratings in the mindful group could be in due to mindfulness practice resulting in the athletes having less negative self-evaluation of performance (Amemiya & Sakairi, 2021). Overall, the results of Chapter's 3 and 5 further support the use of mindfulness as a beneficial tool for performance and performance related characteristics. Moreover, the findings also provide further evidence highlighting a need for sport-specific mindfulness interventions (Baltzell et al., 2014; Scott-Hamilton et al., 2016).

Limitations

Despite the present thesis revealing some novel findings, there are several limitations to consider when interpreting them. First, Chapter 2 and 3 used cross-sectional designs and therefore cause and effect cannot be established. For instance, high levels of rowing-specific reinvestment may have not been the resulting factor of poor performance but just an antecedent. Nevertheless, the majority of reinvestment studies have been laboratory-based, thus they have lacked ecological validity. Consequently, the two field-based studies within this thesis have added to the limited research in this area. In addition, two of the studies were online intervention studies, this is an increasingly popular modality for psychological interventions, especially due to the advantages of reaching large audiences, being cost-effective, and being accessible in most environments. However, this mode led to difficulties, such as the inability to manage adequately the comparison group, lack of completion of post-test questionnaires and attrition. These problems are typical of online programs (Mitchell et al., 2018; Spijkerman et al., 2016).

A second limitation is the lack of objective measures of performance and psychological processes. Although the first two studies measured crew race performance, there was no measure of individual actual performance throughout all the studies. Self-report measures are prone to inaccuracy in recall, response bias and social desirability bias. For instance, the outcome of the race might have altered the rowers' perception of their own performance, even if they themselves did or did not perform well. Nevertheless, the perceived performance measure had previously proven to have high levels of validity and reliability (Al-Yaaribi et al., 2016). Moreover, in the final two studies, rowers had to recall their last training sessions and competitive rowing event, and it should be noted that people tend to have a recall bias and therefore the performance measure for these may be inaccurate.

Third, the majority of the rowers who participated were novice to intermediate standard. This limits the validity of the scales whereby the findings may not generalise to higher competitive levels. Furthermore, it would be interesting to include whether or not the boats were coxless or not, as this may have influenced how conscious the rowers were of their movements. Coxes tend to use technical and racing calls, therefore having a cox may increase consciousness of their movements. It would be interesting to next time include elite level rowers and compare whether or not they had a cox or not.

Future Directions

The cross-sectional and quasi-experimental approaches used here have provided promising findings to validate the scale and reveal the influence of mindfulness on performance-relevant outcomes. Nonetheless, future studies could consider using longitudinal or experimental designs. A longitudinal design could yield results in relation to the predictive validity of the RSRS and how state reinvestment may change across different environments, such as training versus competition (see Malhotra et al., 2015a). Moreover, performance could be measured at more than one time point, so that chokes could be captured and the role of reinvestment in choking be assessed (Masters & Maxwell, 2008).

In addition, large randomised control trials could be used to evaluate the sport-specific mindfulness-based intervention. This would provide further data regarding the influence of the intervention on mindfulness and performance relevant variables, such as reinvestment. Furthermore, it would also be recommended to use actual performance measures, such as kinematics and telemetry, alongside the perceived performance measure. This would identify individual performance drops but also the moment during the race when this occurs. Using these objective performance measures would also further validate the rowing-specific reinvestment scale. Comparatively, researchers should also next use psychophysiological measures of conscious processing, such as EEG-based cortico-cortical connectivity, to corroborate whether the scale is measuring reinvestment (Zhu et al., 2011). Altogether this would further our understanding of this phenomenon and its impact on performance.

In order to overcome the aforementioned limitations related to attrition and drop out in the intervention study, future research needs to implement strategies to try and prevent these from happening, such as having a reward-based system for those who complete the mindfulness practice in and outside of the official practice time. Thus, should help keep athletes motivated to complete the full 6 weeks and the 5 days of 5-10 minutes of training per week (Roger-Hogan et al., 2021). Additionally, dropout rates could be reduced for the control group if they received an intervention (such as completing relaxation training through breathing exercise (Rooks et al., 2017). Moreover, an app-based version could be developed as this would allow athletes to access the training and materials anytime that suited them and therefore, they may be more engaged, especially for athletes with a busy and sometimes inconsistent schedule (Roger-Hogan et al., 2021). Additionally, the athletes could access the materials more readily during training or before competition when the mindfulness may really help. This development would also complement the already growing interest and popularity in app-based psychological interventions (Lin et al., 2019; Roger-Hogan et al., 2021).

Theoretical Implications

This thesis makes an important contribution to research with the development of a sport-specific state reinvestment scale. There are no pre-existing sport-specific state measures of reinvestment, as previous measures of reinvestment have been generic (Kinrade et al., 2010; Masters et al., 1992; 2005) and therefore may have led to the mixed results. Consequently, this rowing-specific reinvestment scale has the potential to expand the understanding of reinvestment at a sport-specific level and may then inform the development of more sport-specific reinvestment measures which capture conscious processes with greater accuracy for athletes.

My research broadly supports reinvestment theory's premise that athletes who exhibit high levels of reinvestment during performance perform poorer under pressure (Masters & Maxwell, 2008). Chapters 2, 3 and 5 found similar results; rowers who exhibited high levels of rowing-specific reinvestment exhibited poor performance in competition and in some cases crabbed. Furthermore, the results in Chapters 2, 3 and 5 also indirectly supported trait-activation theory in relation to reinvestment. Trait activation theory proposes that traits are not always activated, and it is only when the relevant situation presents itself along with specific context-dependent factors that a trait is activated (Geukes et al., 2013). Although the rowing-specific reinvestment scale is a state measure, the results from these Chapters demonstrated that under the self-presentational environments of a regatta whereby crowds, coaches and club members are present, whether in real time (Chapters 2 and 3) or as an imagined scenario (Chapter 5), RS-MSC evoked more of a response with higher ratings, than RS-CMP.

This thesis also expands the theoretical understanding of mindfulness as a means of enhancing athletic performance. Numerous studies have provided support showing that mindfulness promotes a flow state due to the two phenomena sharing similarities, namely, present moment focus (Aherne et al., 2011; Kaufman et al., 2009; Scott-Hamilton et al., 2016). The results of Chapter 5 supported this notion, with increases in dispositional flow observed in the mindfulness group compared to the control group. Nevertheless, another potential mechanism was also found, mindfulness attenuated the debilitating self-focus behaviour of reinvestment which previously had not been investigated, regardless of the many proposals by academics (Birrer et al., 2012; Josefsson et al., 2017; Shaabani et al., 2020). Chapter 3 also revealed that only certain mindful components (mindful awareness, non-judgemental thinking and refocus) attenuated either rowing-specific conscious motor processing or movement self-consciousness. This evidence reveals that mindfulness does not function as a single construct (Thienot et al., 2014) and that future research should explore each mindful component separately. Mindful non-judgemental thinking and mindful awareness attenuated high levels of rowing-specific conscious motor processing or movement self-consciousness; therefore, mindful athletes performed better under pressure compared to those with lower levels of mindfulness. This furthers the theoretical knowledge behind the mechanism underpinning mindfulness as a means of enhancing performance and supports Birrer et al.'s (2012) speculation that mindfulness acts on many different processes to aid performance.

Applied Implications

A number of practical implications emerged from this thesis that may have relevance to athletes, coaches and sport psychology practitioners. The thesis provides a brief tool to help understand an individual's level of state rowing-specific reinvestment. Overall high levels of rowing-specific reinvestment are detrimental for competitive performance and may also explain the process behind crabbing. Therefore, coaches and practitioners can use the measure to better understand why an athlete's performance may have dropped, which can then be used to help identify an intervention or strategy to help prevent it from happening again.

This thesis also demonstrated that mindfulness could reduce high levels of reinvestment during performance. In addition, my results supported previous research that mindfulness can increase levels of flow-state (Cathcart et al., 2014; Hill et al., 2020; Kaufman et al., 2009; Thompson et al., 2011). Flow is not a psychological state that can be taught but mindfulness can increase the likelihood of it occurring. This is an important state involved in reaching optimal performance. Moreover, sport-specific mindfulness may evoke greater increases in levels of flow compared to generic mindfulness (Scott-Hamilton et al., 2016). The feedback from the rowing-specific reinvestment intervention revealed that athletes felt more confident in using the strategies learnt in the sessions within their sport and therefore suggesting that the athletes may be constantly cultivating and practising it during training and competition compared to a generic practice, which may be increasing the level of flow-state. Consequently, coaches or sport psychologists may opt to use sport-specific mindful practices over generic mindful practices or traditional psychological skills training. Furthermore, the findings of this thesis also demonstrate that mindfulness practice for athletes could be conducted online compared to the common in-person format, thereby reaching more athletes and being more cost and time effective.

Conclusion

My thesis sought to better understand the impact of reinvestment and mindfulness on performance. These studies examined this overarching purpose in training and competition through field-based and interventional studies. The overall findings have contributed to the extensive reinvestment research that has demonstrated that it is process that can harm performance (Chell et al., 2003; Jackson et al., 2013; Orn, 2017). Additionally, it has established and validated a reliable measure of sport-specific reinvestment. Furthermore, my research has also extended our understanding of mindfulness and the role that it may play in aiding performance. The findings indicated that mindfulness plays a moderating moderation role to aid performance by attenuating rowing-specific reinvestment. My research has also developed an online sport-specific mindfulness intervention that has proven to facilitate the flow-state in rowers. Consequently, athletes, coaches and practitioners may consider adapting mindfulness practices specific to their sport to aid the understanding and cultivation of mindfulness. Overall, this thesis provides exciting new evidence concerning the influence of mindfulness on performance, prevention of reinvestment, and induction of flow.

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Appendices Contents

Appendix 1 Information sheet and Informed Consent

Appendix 1A – Information sheet and Informed consent for Study 1, 2 and 3

Dear Rower,

We are inviting you to participate in a research study that we are conducting in the School of Sport, Exercise and Rehabilitation Sciences at the University of Birmingham. This study aims to explore factors that influence rowing performance. You have been invited as you are aged 16 years or over, are a rower, and take part in competitions.

Participation in this study involves completing an online questionnaire. The questionnaire asks a range of questions relating to your thoughts, feelings and actions in rowing. This study will take about 10-15 minutes to complete. The results of this study may be used in future reports such as academic journals and conference presentations. However, your responses will be part of a larger data set and your identity will be protected at all times. In other words, your data will be kept confidential and no information will be passed on to others. Participation in the study is entirely voluntary. You are free to withdraw or discontinue participation at any time and may do so without providing any reason. The deadline for your withdrawal is October 2020.

The information gained from this study may go some way to helping us understand how rowers' thoughts and mindsets may influence how they perform under the pressure of competition. For this research to be useful, it is important that you respond honestly to all questions. Many thanks for your cooperation. If you have any queries regarding this research please feel free to ask us.

Thank you for your time and consideration to participate in the study. If you understand the purpose of the study and would like to participate, please now complete the survey to indicate your consent to participate in our study. Please make sure that you provide an answer to every item.

Yours Sincerely,

Christopher Ring, Professor

Katie Sparks, ESRC DTP Doctoral Student

School of Sport, Exercise and Rehabilitation Sciences

University of Birmingham

Appendix 1B – Information sheet and informed consent for Study 4

Dear Rower,

We are inviting you to participate in a research study that we are conducting in the School of Sport, Exercise and Rehabilitation Sciences at the University of Birmingham. This study aims to explore factors that influence rowing performance. You have been invited as you are aged 16 years or over, are a rower, and take part in competitions.

Participation in this study involves completing an online questionnaire and a listening to an audio. The questionnaire asks a range of questions relating to your thoughts, feelings and actions in rowing. This study will take about 10-15 minutes to complete. The results of this study may be used in future reports such as academic journals and conference presentations. However, your responses will be part of a larger data set and your identity will be protected at all times. In other words, your data will be kept confidential and no information will be passed on to others. Participation in the study is entirely voluntary. You are free to withdraw or discontinue participation at any time and may do so without providing any reason. The deadline for your withdrawal is October 2021.

The information gained from this study may go some way to helping us understand how rowers' thoughts and mindsets may influence how they perform under the pressure of competition. For this research to be useful, it is important that you respond honestly to all questions. Many thanks for your cooperation. If you have any queries regarding this research, please feel free to ask us.

Thank you for your time and consideration to participate in the study. If you understand the purpose of the study and would like to participate, please now complete the survey to indicate your consent to participate in our study. Please make sure that you provide an answer to every item.

Yours Sincerely,

Christopher Ring, Professor

Katie Sparks, ESRC DTP Doctoral Student

School of Sport, Exercise and Rehabilitation Sciences

University of Birmingham

Appendix 1C – Information Sheet for Study 5

Information sheet for participants

The psychology of rowing

Dear Participant

I would like to invite you to take part in our research study, but first I will explain why the research is being conducted and what would be your involvement. Any questions you may have after reading this information sheet, do not hesitate to ask me.

The purpose is to investigate the use of mindfulness on rower's psychology and performance under pressure. The information gained from this study may go some way to helping us understand the mechanism behind mindfulness and how rower's performance can benefit from it under the pressure of competition. For this research to be useful, it is important that you respond honestly to all questions. Many thanks for your cooperation.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide that you would like to take part and you understand your involvement then please go ahead and complete the pre-questionnaire, completing this will act as your consent to complete the study. You are free to withdraw or to stop at any time, without providing any reason. The deadline for your withdrawal is September 2021.

Who can take part?

I am looking for competitive rowers aged 16 years old and above.

What will happen to me if I take part?

Firstly, you will complete a short questionnaire. The questionnaire asks a range of questions relating to their thoughts, feelings, and actions in rowing and general movement. The questionnaires will take about 10 minutes each to complete.

The questionnaire is in an online format.

Once the questionnaire has been completed, you will partake in 6 weeks of mindfulness, meeting me once a week and completing homework tasks (5-10 minutes, 5 days a week). You will then complete a post mindfulness questionnaire at the end of the 6 weeks.

Will all my information be kept confidential?

Your responses will be part of a larger data set and your identity will be protected at all times. The data will be kept safe and secure at all times and destroyed once I have finished using the data in my research.

What will happen to the results of the research study?

I hope to publish the results of this study in a scientific journal, and I may present the results at national scientific conferences, meetings, and seminars within the University. I would be happy to discuss the results of the study with yourself and to send you a copy of any published results. It will not be possible to identify any individual in the report or publication.

Is the research funded or organised by anyone?

This research is organised by Professor Christopher Ring (primary supervisor) and Katherine Sparks (postgraduate PhD Student) who are both part of the School of Sport, Exercise and Rehabilitation Sciences at the University of Birmingham. Katherine Sparks is funded by the Economic and Social Research Council for DTP Doctoral Students.

Have ethical guidelines been met?

Yes, the University of Birmingham Research Ethics Committee who protects your safety, rights, wellbeing, and dignity, have reviewed this research and have given it ethical clearance.

If there is a problem, please do not hesitate to contact my supervisor and I. My contact details are: Katherine Sparks, either by email: [redacted] or mobile number: [redacted]. Alternatively, my supervisor: Professor Christopher Ring, email: [redacted] or contact number: [redacted]

Appendix 1D – Informed consent for Study 5

INFORMED CONSENT FORM

PSYCHOLOGY OF ROWING

My research project is investigating the psychology of rowing. By initialling the below statements and signing below, you are agreeing that:

You have read and understood the Participant Information Sheet.	
I have satisfactory answered all questions you may have.	
You understand that taking part in this research voluntarily	
You understand that you have the right to withdraw at any time until Sept 2021	
You understand that you can refuse to participate and this will be respected	

____

Participant's Name (Printed)*

________________________________ ________________________

Participants signature* Date

Katherine Sparks

________________________________ ________________________________

Name of person obtaining consent (Printed) Signature of Katherine Sparks

1E – Recruitment poster for Intervention for Study 5

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

UNIVERSITY OF BIRMINGHAM

Breathe. Row. Meditate. Succeed.

MINDFUL MENTAL TRAINING

Some say performance under pressure is 20% Physical and 80% Mental, what have you done recently to train this?

Our mind is like a muscle.. it can adapt and change for performance success!

I introduce you to **rowing-specific mindfulness** - improve your focus, resilience, awareness, enhance your adaptability, less negative reactivity and increase your flow-state.

6 weeks of rowing and performance specific mindfulness training (1 hour a week, group sessions and free recordings). Fancy signing up your crew or group of rowers?

Completely **FREE,** all you need to do is complete a pre and post questionnaire about rowing performance and your performance thoughts/feelings

Please contact me on: [redacted]

Appendix 2: Chapter 2 Rowing-specific Scale items and Perceived Technical Performance

Appendix 2A: Initial Rowing-Specific Reinvestment Scale 15-items

1. I was conscious about how my rowing technique looked to others
2. I thought about whether I was implementing the correct body movement sequence
3. I was concerned about what people (e.g., coach and crew) thought about my rowing
4. I focused on how I controlled my hands and/or arms during the drive phase of the stroke
5. I was aware of how I controlled my body while I rowed
6. When I made a bad stroke, I immediately tried to figure out why my technique failed so I could correct my mistake
7. I was mindful that my rowing needed to make a good impression on my coach and squad
8. I used conscious effort to adjust my movements to synchronise with my crew
9. I was concerned about how my style of rowing looked to others
10. If it had seen a video of me and my crew rowing in today's race(s), I would have focused mainly on how my own rowing looked
11. I was concerned my crew (e.g., cox and seat behind) thought I had poor technique when something went wrong (e.g., I fell out of synch)

12. I thought about whether my movements were technically correct

13. I was conscious of how I coordinated all of my rowing movements

14. I focused on how I controlled my hands and/or arms during the recovery phase of the stroke

15. I believed that everyone was just looking at me and scrutinising my rowing

Appendix 2B: Rowing Specific State Reinvestment Scale (RSRS)

The statements below describe situations that happen to rowers during competitive racing. Please read the statements below carefully and indicate the extent to which you agree with each based on how you felt during your previous race. What is your level of agreement with the following statements?

Rowing Specific Conscious Motor Processing:

1. I was conscious of how I coordinated all of my rowing movements
2. I thought about whether I was implementing the correct body movement sequence
3. I thought about whether my movements were technically correct
4. I was aware of how I controlled my body while I rowed
5. When I made a bad stroke, I immediately tried to figure out why my technique failed, so I could correct my mistake
6. I used conscious effort to adjust my movement to synchronise with my crew

Rowing Specific Movement Self-Consciousness:

1. I was concerned about what people (e.g., coach and crew) thought about my rowing
2. I was concerned about how my style of rowing looked to others
3. I was conscious about how my rowing technique looked to others

4. I was mindful that my rowing needed to make a good impression on my coach and squad
5. I believed that everyone was just looking at me and scrutinising my rowing
6. I was concerned my crew (e.g., cox and seat behind) thought I had poor technique when something went wrong (e.g., I fell out of synch)

Appendix 2C:

Principal axis analysis with oblimin rotation for 9 items of the PTP

Items	Factor Loadings
Stroke overall (drive and recovery)	.69
Catch placement	.61
Body position at the catch	.59
Body sequencing	.56
Synchronicity with the crew	.55
Body position at the finish	.54
Extraction of the blade(s) at the finish (washout)	.56
Squaring of your blade(s) (timing with crew, over or under square)	.54
Body swing throughout	.67

Note: N = 282

Appendix 3: Chapter 3 Supplementary tables of Moderated Moderation

Appendix 3A:

Table S1.

Moderated moderation results for RSRS and Mindfulness with unstandardised regression coefficients

	Actual Performance			Perceived performance		
	B	*t*	CI	B	*t*	CI
			Model 1: Anxiety x RSRS x Mindfulness			
Main effects						
Anxiety	-.71	-.69	-2.75, 1.32	-.14	-6.03	-.19, -.10
RSRS	-1.31	-.63	-5.40, 2.78	.10	2.03*	.03, 3.27
Mindfulness	4.41	1.42	-1.72, 10.53	.37	5.18***	-.20, 3.81
Two-way interaction						
Anxiety x RSRS	.76	.77	-1.18, 2.69	.02	.92	-.49, .05
Anxiety x Mindfulness	2.58	1.73	-.36, 5.53	.03	.75	-.54, .11
RSRS x Mindfulness	-2.38	-.82	-8.09, 3.32	-.09	-1.39*	-.72, -.02

Three-way interaction						
Anxiety x RSRS x Mindfulness	1.80	1.32	-.89, 4.49	.06	1.75	-.01, .11

Note: *p <0.05, **p < 0.01

Abbreviations: RSRS, Rowing Specific Reinvestment Scale.

Appendix 3B:

Table S2.

Moderated moderation results for RS-CMP and each mindfulness component with unstandardised regression coefficients

	Actual Performance			Perceived performance		
	B	t	CI	B	t	CI
			Model 2: Anxiety x RS-CMP x Mindful Aw			
Anxiety	-2.67	-2.62**	12.17, 117.12	-.20	-7.93***	-.25, -.15
RS-CMP	-1.75	-.90	12.52, 117.37	.05	1.09	-.04, .15
Mindful Aw	1.15	.55	25.94, 136.19	.07	1.28	-.04, .17
Two-way Interaction						
Anxiety x RSRS	1.83	1.89	-22.78, -2.72	.03	1.11	-.02, .07

Anxiety x Mindful Aw	-.70	-.70	-24.85, -4.18	.01	.43	-.04, .06
RS-CMP x Mindful Aw	1.64	-.76	-24.71, -4.51	.03	.59	-.07, .13
Three-way Interaction						
Anxiety x RS-CMP x Mindful Aw	2.96	2.93**	.82, 4.70	.06	2.47*	.01, .11
			Model 3: Anxiety x RS-CMP x Mindful NJ			
Main effects						
Anxiety	-1.15	-1.13	-3.14, .84	-.15	-6.18***	-.20, -.10
RS-CMP	-.87	-.43	-4.85, 3.10	.12	2.53*	.03, .21
Mindful NJ	1.19	.83	-1.64, 4.03	.15	4.41***	.08, .22
Two-way Interaction						
Anxiety x RS-CMP	1.40	1.49	-.46, 3.26	.01	.61	-.03, .06
Anxiety x Mindful NJ	.52	.77	-.80, 1.84	-.02	-.95	-.05, .02
RS-CMP x Mindful NJ	.51	.41	-1.96, 2.98	-.03	-1.02	-.09, .03
Three-way Interaction						
Anxiety x RS-CMP x Mindful NJ	.74	1.24	-.43, 1.92	.02	1.80	.00, .05

	Model 4: Anxiety x RS-CMP x Mindful RF					
Main effects						
Anxiety	-.57	-.54	-2.66, 1.52	-.13	-5.02***	-.18, -.08
RS-CMP	-2.94	-1.37	-7.14, 1.27	-.00	-.09	-.11, .10
Mindful RF	4.36	2.09*	.26, 8.46	.22	4.33***	.12, .32
Two-way Interaction						
Anxiety x RS-CMP	-0.31	-.03	-2.03, 1.96	-.00	.11	-.05, .05
Anxiety x Mindful RF	2.80	3.00**	.96, 4.63	.04	1.93	-.00, .09
RS-CMP x Mindful RF	-2.26	-1.32	-5.62, 1.10	-.02	-.39	-.10, .07
Three-way Interaction						
Anxiety x RS-CMP x Mindful RF	.42	.55	-1.09, 1.94	-.00	-.15	-.04, .03

Note: *p <0.05, **p < 0.01

Abbreviations: RS-CMP, Rowing Specific Conscious motor processing; Mindful Aw, Mindful Awareness; Mindful NJ, Mindful Non-judgemental thinking; Mindful RF, Mindful refocus.

Appendix 3C:

Table S3.

Moderated moderation results for RS-MSC and each mindfulness component with unstandardized regression coefficients

	Actual Performance			Perceived performance		
	B	t	CI	B	t	CI
	Model 5: Anxiety x RS-MSC x Mindful Aw					
Main effects						
Anxiety	-1.79	-1.67	-3.89, .31	-.19	-7.42	-.25, -.14
RS-MSC	-2.22	-1.36	-5.43, 1.00	.00	0.00	-.08, .08
Mindful Aw	.14	.06	-4.37, 4.65	.04	.74	-.07, .15
Two-way Interaction						
Anxiety x RS-MSC	.21	.25	-1.40, 1.81	.01	.72	-.02, .05
Anxiety x Mindful Aw	.40	.37	-1.71, 2.51	.01	.55	-.04, .07
RS-MSC x Mindful Aw	-.96	-.61	-4.09, 2.17	.01	.35	-.06, .09

Three-way Interaction						
Anxiety x RS-MSC x Mindful Aw	1.32	1.73	-.18, 2.83	.04	2.17*	.00, .08
Model 6: Anxiety x RS-MSC x Mindful NJ						
Main effects						
Anxiety	-.83	-.75	-3.01, 1.35	-.15	-5.67***	-.20, -.10
RS-MSC	-2.11	-1.18	-5.64, 1.42	.08	1.97*	.00, .17
Mindful NJ	.65	.40	-2.52, 3.81	.14	3.78***	.07, .22
Two-way Interaction						
Anxiety x RS-MSC	.26	.30	-1.45, 1.97	.01	.50	-.03, .05
Anxiety x Mindful NJ	.01	.02	-1.52, 1.54	-.01	-.53	-.05, .03
RS-MSC x Mindful NJ	1.71	1.57	-.43, 3.85	-.03	-1.18	-.08, .02
Three-way Interaction						
Anxiety x RS-MSC x Mindful NJ	.15	.30	-.85, 1.15	.03	2.44*	.01, .05
Model 7: Anxiety x RS-MSC x Mindful RF						
Main effects						

Anxiety	-.18	-.17	-2.33, 1.96	-.14	-5.16	-.19, -.08
RS-MSC	-2.59	-1.50	-5.99, .81	-.01	-.11	-.19, .08
Mindful RF	3.62	1.77	-.41, 7.65	.22	4.50***	.12, .32
Two-way Interaction						
Anxiety x RS-MSC	-.09	-.10**	-1.76, 1.59	.02	.90	-.02, .06
Anxiety x Mindful RF	2.98	3.18	1.13, 4.82	.04	1.71	-.01, .08
RS-MSC x Mindful RF	-1.02	-.65	-4.12, 2.07	.04	1.01	-.04, .11
Three-way Interaction						
Anxiety x RS-MSC x Mindful RF	-.05	-.06	-1.47, 1.37	-.01	-.70	-.05, .02

Note: *p <0.05, **p < 0.01

Abbreviations: RS-MSC, Rowing Specific movement self-consciousness; Mindful Aw, Mindful Awareness; Mindful NJ, Mindful Non-judgemental thinking; Mindful RF, Mindful refocus.

Appendix 4: Chapter 5 – Materials for Intervention

Appendix 4A: Intervention Slides, audios, and scripts

https://drive.google.com/drive/folders/1nefE8MNqzr7scIoTlEfIgA9WeSmEa0Vu?usp=shari

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