The Rowing Specific State Reinvestment Scale

Katherine V. Sparks[1], Maria Kavussanu[1], Rich S.W. Masters[2] & Christopher Ring[1],

University of Birmingham, Birmingham, UK[1]

University of Waikato, Hamilton, New Zealand[2]

Address correspondence to:

Katherine Sparks, School of Sport, Exercise & Rehabilitation Sciences, University of Birmingham, Birmingham, B15 2TT. KVS414@student.bham.ac.uk

Abstract

This research project aimed to develop and validate a rowing-specific measure of reinvestment. Two studies were conducted to develop and validate the Rowing-Specific Reinvestment Scale (RSRS). In Study 1, a 24-item questionnaire was developed and the content validity was assessed using experts (N = 7) and pilot-tested in rowers (N = 24). Next, rowers (N = 282) completed the questionnaire with the remaining items, and exploratory factor analysis was conducted. This further reduced the number of items and revealed two factors, rowing specific conscious motor processing (RS-CMP) and movement self-consciousness (RS-MSC). In Study 2, rowers (N = 270) completed the scale that was evaluated using confirmatory factor analysis (CFA). Moreover, the construct validity of the scale was investigated by asking them to complete measures of movement specific reinvestment, perceived performance, self-consciousness, and state anxiety. Actual performance was also determined based on their finishing position in the race. Study 1 EFA resulted in a 2-factor model with six items assessing RS-CMP and six items assessing RS-MSC. Study 2 supported the factor structure of scale; CFA indicated an acceptable model fit with good internal consistency. Content validity was also supported, with evidence of concurrent, convergent, discriminant, and predictive validity. In conclusion, these studies provided good initial evidence for the validity and reliability of the RSRS, a state measure of reinvestment during rowing.

Keywords

Reinvestment, rowing, pressure, choking, scale development

The Rowing Specific Reinvestment Scale

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., Mosley et al., 2017; Malhotra et al., 2015a). Accordingly, the extent to which conscious control and monitoring of movements affect performance has yet to be established (Mosley et al., 2017; Iwatsuki & Wright, 2016; 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 & Gutermann, 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; Mesagano et al., 2011). 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 & Gutermann, 2000). In this way, performance will depend on 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 used RS scores to classify participants in a golf putting study as relatively high or low reinvestors, and found that high reinvestors reported more declarative rules and performed worse under pressure and than low reinvestors. Taken together, these experiemental studies suggest that high reinvestors accumulate more rules about movement during learning and then reinvest this declarative knowledge and thereby perform poorer 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, Eves and Maxwell (2005), 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 (Mosely, 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; Zhu et al., 2011; Deeny et al., 2003; Kerick et al., 2004).

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., 2021), however, the 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-report 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 under perform in competition.

Other researchers have investigated movement reinvestment in relation to the yips, a phenomenon characterized 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 (Klampfl 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 (Guttierez, 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 behavior; 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. Private pressures, including monetary rewards and time limits, activated self-focus traits, such as private self-consciousness, whilst public pressures, consisting of crowds, video taping, comparison with others, activated self-presentational traits, such as fear of evaluation and public self-consciousness (Geukes et al., 2013). Furthermore, researchers have found that traits across time and situations, a phenomon known as intra-individual variability, and therefore an individual may not always express a certain trait (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), respondible 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, Hillman, Janelle & Hatfield, 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 pressurized 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-specfic 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 phenomon 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.

Continous 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 (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 signigicant drop from typical performance (Baumeister, 1984) and technical fault (a mistake), because it tends to occur in pressure situations due to overgripping 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 etiology, treatment and further validate our reinvestment measure as predictive of disrupted performance under pressure.

Present Research

In sum, 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 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.

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 Components Analysis (PCA) 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, 1995). The theoretical basis for the scale was dervived 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 evalutative apprehensions whilst rowing. Using both inductive and deductive approaches during the development is recommended 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 for coherency and difficulty 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.

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 A). 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.

EFA

Before proceeding with the exploratory factor analysis, 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 (Field, 2013; Clark & Watson, 2017). 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 singalled that we could proceed with the EFA (Kaiser, 1974; Tabachnick & Fidell, 2013).

Pricipal axis factoring (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 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 1.

Internal consistency of the subscales were assessed using Cronbach alpha analysis and Omega H on each subscale, with very good consistency scores for both, above .70 (Table 2).

Study 2: Confirmatory Factor Analysis 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 confirmatory factor analysis. Second, we investigated the construct validity of the scale by assessing the scale's convergent, discriminant, concurrent, 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 (Masters et al, 1993; Geukes, et al., 2012). 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).

Concurrent validity pertains to whether a scale is correlated with an established instrument that is measuring a similar construct or a measure that is taken at the same time and effectively estimates a similar outcome, this further established the validity of the new scale (Lin & Yao, 2014). In order to explore this, we examined the association between the RSRS and measures of perceived race performance of the competitive race they had just completed. In line with the reinvestment theory (Masters & Maxwell, 2008) and previous research (Zhu et al, 2011; Orn, 2017) we expected to find a negative relationship between the RSRS and perceived performance measures.

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 both actual race performance and rowing experience, and examining the difference between levels of rowing specific conscious processing between rowers that 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 (Zhu et al, 2011; Iwatsuki & Wright, 2016; Guttierez, 2018) we expected a negative relationship between the RSRS and actual 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), who ranged from senior and masters racing bracket, with 78% of the sample characterised as senior, 18 – 26 years old, and 26% as masters, 27-100 years old, (*M* = 43-49 age category, *SD* = 1.9 age categories) gave consent and participated. 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 500-2000 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 and following 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 plus), coxless or coxed boat, had atleast one years 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 B).

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).

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, endurance), psychological (i.e., focus, mental toughness, 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 you 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 C). 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).

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 today's 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).

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 i.e. 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).

Crabbing. Crabbing was measured by rowers declaring whether they crabbed during today's 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. amount 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 crewmember contributes equally to the speed of the boat (Cuijper et al, 2017). If one rower makes a fault or inefficient stroke then this impacts the overall speed.

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 adequency 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 minimize 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 Criterion 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 MFL-1. We computed the bivariate Pearson correlation coefficients between RSRS, MSRS, Self-consciousness scale and MFL-1. 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 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 sub-scale 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). 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).

Concurrent validity

Evidence of concurrent validity (Table 2) was revealed with 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 associaition with psychological perceived performance. In contrast RS-CMP was not associated with any of the perceived performance measures.

Predictive validity

Predictive validity was partially supported. 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, η_p^2 = .02. Similarly crabbers 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, η_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, η_p^2 = .01.

Predictive power analysis

The models demonstrated that only RS-CMP significantly predicted crabbing, β = .07, p <.01, over CMP, β = .02, p = .60. While in the RS-MSC and MSC regression model, neither significantly predicted crabbing over the other (Table 3). Furthermore, neither RS-CMP versus CMP or RS-MSC versus MSC predicted actual performance.

General Discussion

The present programme of research developed and validated a new scale for measuring sport-specific reinvestment. In the first 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 study also examined the construct validity of the scale, including the convergent, divergent, concurrent 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 sub-scales, 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.

Criterion Validity

The concurrent validity of the scale was examined in relation to a number of rowing specific and general perceived performance scales. Only RS-MSC was related to performance. Nevertheless, this is not uncommon, as previous research has also found that one of the dimensions has stronger relationship with performance than the other dimension (Malhotra et al, 2014; 2015b; Iwatsuki & Wright, 2016). 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 argues that the type of pressure or situational cue, whether it is public or private, can determine which traits are activated (Mesagno et al, 2012; Geukes 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 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; Malhotra, Poolton, Wilson, Uiga & Masters, 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).

Overall, partial concurrent validity was provided for the RSRS, especially with RS-CMP being unrelated to the majority of measures apart from self-consciousness. This suggests a number of possibilities. First, the RS-CMP items did not capture conscious motor processing. Second, rowing performance is not influenced by conscious motor processing. Third, the relationship between CMP and performance relies on trait-activation (Geukes et al., 2012), and the current context and associated situational demands did not (sufficiently) activate this conscious process. These possibilities must await further investigation.

The RSRS's predictive validity was examined by first analyzing its relation to actual performance and 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 (Mesagno et al, 2012; Geukes et al, 2012). However, RSRS or MSRS subscales did not predict performance over the other.

We also analysed whether the self-report 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 to 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 temporally stuck but they can recover it quickly, they may have felt that others (i.e. crew members, coaches, audience) would not notice and that it could be easily disguised within their other crew-members (Iwatsuki et al., 2016). This is similar to Iwatsuki et al (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 one 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 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; Kerick, et al., 2004; Zhu et al., 2011; Gallicchio et al., 2016). 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 everchanging 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 consciously processing during competition (see Birrer et al., 2012).

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 been influenced by self-desirability bias. Therefore, subsequent studies need to include more objective measures, such as psychophysiological measures (i.e. EEGs, electromyography, heart rate) or have external individuals (e.g., coach, expert) rating the rower on their performance. 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 validation with other scales that measure conscious processing, such as mindfulness. Third, 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. Subsequently the performance measure is not a unique 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 influded 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 (Masters & Maxwell, 2008; Guttierez, 2018). 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.

Acknowledgements

ESRC DTP 1+3 Studentship awarded to the first author.

Conflict of Interest Statement:

None

References

Afthanorhan, W. M. A. B. W. (2013). A comparison of partial least square structural equation modeling (PLS-SEM) and covariance based structural equation modeling (CB-SEM) for confirmatory factor analysis. *International Journal of Engineering Science and Innovative Technology*, *2*(5), 198-205.

Allport, G. W (1937). *Personality: A psychological interpretation.* Holt.

Al-Yaaribi, A., Kavussanu, M., & Ring, C. (2016). Consequences of prosocial and antisocial behavior for the recipient. *Psychology of Sport and Exercise, 26,* 102-112.

Baumeister, R. F. (1984). Choking under pressure: self-consciousness and paradoxical effects of incentives on skilful performance. *Journal Personality & Social Psychology, 46,* 610-620.

Beilock, S. L., Carr, T. H., MacMahon, C., & Starkes, J. L. (2002). When paying attention becomes counterproductive: impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied*, *8*(1), 6.

Bellomo, E., Cooke, A., & Hardy, J. (2018). Chunking, conscious processing, and EEG during sequence acquisition and performance pressure: A comprehensive test of reinvestment theory. *Journal of Sport and Exercise Psychology*, *40*(3), 135-145.

Bentler, P. M., & Wu, E. J. (2005). *EQS 6.1 for Windows*. Multivariate Software Inc.

Birrer, D., Röthlin, P., & Morgan, G. (2012). Mindfulness to enhance athletic performance: Theoretical considerations and possible impact mechanisms. *Mindfulness*, *3*(3), 235-246.

Bolarinwa, O. A. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. *Nigerian Postgraduate Medical Journal*, *22*(4), 195.

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The cognitive failures questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*, *21*(1), 1-16.

Capio, C. M., Uiga, L., Malhotra, N., Eguia, K. F., & Masters, R. S. (2018). Propensity for movement specific reinvestment by physiotherapists: implications for education. *Physiotherapy Theory and Practice*, *34*(12), 926-930.

Cicchetti, D. V., Shoinralter, D., & Tyrer, P. J. (1985). The effect of number of rating scale categories on levels of interrater reliability: A Monte Carlo investigation. *Applied Psychological Measurement*, *9*(1), 31-36.

Clark, L. A., & Watson, D. (2019). Constructing validity: New developments in creating objective measuring instruments. *Psychological Assessment.*

Clarke, P., Sheffield, D., & Akehurst, S. (2020). Personality predictors of yips and choking susceptibility. *Frontiers in Psychology, 10* (1), 2784.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112,* 155-159.

Cooke, A., Kavussanu, M., McIntyre, D., Boardley, I. D., & Ring, C. (2011). Effects of competitive pressure on expert performance: Underlying psychological, physiological, and kinematic mechanisms. *Psychophysiology, 48,* 1146-1156.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16,* 297-334.

Deeny, S. P., Hillman, C. H., Janelle, C. M., & Hatfield, B. D. (2003). Cortico-cortical communication and superior performance in skilled marksmen: An EEG coherence analysis. *Journal of Sport & Exercise Psychology*, *25*(2), 188-204.

DeVellis, R. F. (2016). *Scale development: Theory and applications* (Vol. 26). Sage.

Dolnicar, S., & Grün, B. (2013). Validly measuring destination image in survey studies. *Journal of Travel Research*, *52*(1), 3-14.

Fabrigar, L.R., Wegener, D.T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, *4*(3), 272.

Fenigstein, A., Scheier, M. F., & Buss, A. H. (1975). Public and private self-consciousness: Assessment and theory. *Journal of Consulting & Clinical Psychology*, *43*(4), 522.

Fenigstein, A., Scheier, M. F., & Buss, A. H. (1975). Public and private self-consciousness: Assessment and theory. *Journal of consulting and clinical psychology*, *43*(4), 522.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.

Fitts, P. M., & Posner, M. I. (1967). *Human performance*. Brooks/Cole.

Gallicchio, G., Cooke, A., & Ring, C. (2016). Lower left temporal-frontal connectivity characterizes expert and accurate performance: High-alpha T7-Fz connectivity as a marker of conscious processing during movement. *Sport, Exercise, and Performance Psychology, 5,* 14-24.

Gallicchio, G., Cooke, A., & Ring, C. (2017). Practice makes efficient: Cortical alpha oscillations are associated with improved golf putting performance. *Sport, Exercise, and Performance Psychology,* 6, 89.

Geukes, K., Harvey, J. T., Trezise, A., & Mesagno, C. (2017). Personality and performance in real-world competitions: Testing trait activation of fear of negative evaluation, dispositional reinvestment, and athletic identity in the field. *Psychology of Sport and Exercise, 30,* 101-109.

Geukes, K., Mesagno, C., Hanrahan, S. J., & Kellmann, M. (2012). Testing an interactionist perspective on the relationship between personality traits and performance under public pressure. *Psychology of Sport and Exercise*, *13*(3), 243-250.

Geukes, K., Mesagno, C., Hanrahan, S. J., & Kellmann, M. (2013). Activation of self-focus and self-presentation traits under private, mixed, and public pressure. *Journal of Sport and Exercise Psychology*, *35*(1), 50-59.

Ghiselli, E. E. (1939). All or none versus graded response questionnaires. *Journal of Applied Psychology*, *23*(3), 405.

Gignac, G. E., & Szodorai, E. T. (2016). Effect size guidelines for individual differences researchers. *Personality and Individual Differences*, *102*, 74-78.

Gray, R. (2004). Attending to the execution of a complex sensorimotor skill: expertise differences, choking, and slumps. *Journal of Experimental Psychology: Applied, 10*, 42-54.

Gutierrez, L. (2018). *Examining movement-specific reinvestment and the yips in professional baseball* (Doctoral dissertation, Grand Canyon University).

Haynes, S. N., Richard, D., & Kubany, E. S. (1995). Content validity in psychological assessment: A functional approach to concepts and methods. *Psychological Assessment*, *7*(3), 238.

Horn, T. S. (2008). *Advances in sport psychology* (3rd ed.). Human Kinetics.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1-55.

Iwatsuki, T., & Wright, P. (2016). Relationships among movement reinvestment, decision-making reinvestment, and perceived choking. *International Journal of Coaching Science, 10,* 25-35.

Iwatsuki, T., Van Raalte, J. L., Brewer, B. W., Petitpas, A., & Takahashi, M. (2018). Relations among reinvestment, self-regulation, and perception of choking under pressure. *Journal of Human Kinetics*, *65*, 281.

Jackson, R. C., Ashford, K. J., & Norsworthy, G. (2006). Attentional focus, dispositional reinvestment, and skilled motor performance under pressure. *Journal of Sport and Exercise Psychology*, *28*, 49-68.

Jackson, R. C., Kinrade, N. P., Hicks, T., & Wills, R. (2013). Individual propensity for reinvestment: Field-based evidence for the predictive validity of three scales. *International Journal of Sport Psychology, 44,* 331-350.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, *20*(1), 141-151.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31-36.

Kerick, S.E., Douglass, L.W., & Hatfield, B.D. (2004). Cerebral cortical adaptations assoiated with visuomotor practice. *Medicine & Science in Sports & Exercise*, *36*(1), 118-129.

Kinrade, N. P., Jackson, R. C., & Ashford, K. J. (2015). Reinvestment, task complexity and decision making under pressure in basketball. *Psychology of Sport & Exercise*, *20*, 11-19.

Kinrade, N. P., Jackson, R. C., Ashford, K. J., & Bishop, D. T. (2010). Development and validation of the decision-specific reinvestment scale. *Journal of Sports Sciences*, *28*(10), 1127-1135.

Klämpfl, M. K., Lobinger, B. H., & Raab, M. (2013). Reinvestment–the cause of the yips?. *PloS One*, *8*(12).

Kleshnev, V. (2016). *Biomechanics of rowing*. The Crowood Press.

Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford.

Koedijker, J. M., Oudejans, R. R., & Beek, P. J. (2008). Table tennis performance following explicit and analogy learning over 10,000 repetitions. *International Journal of Sport Psychology*, *39*(3), 237.

Krane, V. (1994). The mental readiness form as a measure of competitive state anxiety. *The Sport Psychologist*, *8*(2), 189-202.

Laborde, S., Musculus, L., Kalicinski, M., Klämpfl, M. K., Kinrade, N. P., & Lobinger, B. H. (2015). Reinvestment: Examining convergent, discriminant, and criterion validity using psychometric and behavioral measures. *Personality & Individual Differences*, *78*, 77-87.

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2014). *IBM SPSS for intermediate statistics: Use and interpretation*. Routledge.

Li, C. H. (2016). Confirmatory factor analysis with ordinal data: Comparing robust maximum likelihood and diagonally weighted least squares. *Behavior Research Methods*, *48*(3), 936-949.

Liao, C. M., & Masters, R. S. (2001). Analogy learning: A means to implicit motor learning. *Journal of sports sciences*, *19*(5), 307-319.

Malhotra, N., Poolton, J. M., Wilson, M. R., Fan, J. K., & Masters, R. S. W. (2014). Conscious motor processing and movement self-consciousness: Two dimensions of personality that influence laparoscopic training. *Journal of Surgical Education, 71,* 798-804.

Malhotra, N., Poolton, J. M., Wilson, M. R., Ngo, K., & Masters, R. S. (2012). Conscious monitoring and control (reinvestment) in surgical performance under pressure. *Surgical Endoscopy*, *26*(9), 2423-2429.

Malhotra, N., Poolton, J. M., Wilson, M. R., Omuro, S., & Masters, R. S. W. (2015a). Dimensions of movement specific reinvestment in practice of a golf putting task. *Psychology of Sport and Exercise, 18,* 1-8.

Malhotra, N., Poolton, J. M., Wilson, M. R., Uiga, L., & Masters, R. S. (2015b). Examining movement-specific reinvestment and performance in demanding contexts. *Journal of Sport and Exercise Psychology*, *37*(3), 327-338.

Martens, R., Burton, D., Vealey, R. S., Bump, L. A., & Smith, D. E. (1990). Development and validation of the competitive state anxiety inventory-2. *Competitive Anxiety in Sport*, 117-190.

Masters, R. S. (1992). Knowledge, knerves and know-how: The role of explicit versus implicit knowledge in the breakdown of a complex motor skill under pressure. *British Journal of Psychology*, *83*(3), 343-358.

Masters, R. S. W., Eves, F. F., & Maxwell, J. P. (2005). Development of a movement specific reinvestment scale. In *International Society of Sport Psychology (ISSP) World Congress*. International Society of Sport Psychology (ISSP).

Masters, R. S., Polman, R. C. J., & Hammond, N. V. (1993). 'Reinvestment': A dimension of personality implicated in skill breakdown under pressure. *Personality and Individual Differences*, *14*(5), 655-666.

Masters, R., & Maxwell, J. (2008). The theory of reinvestment. *International Review of Sport and Exercise Psychology*, *1*(2), 160-183.

Matsunaga, M. (2010). How to factor-analyze your data right: do's, don'ts, and how-to's. *International Journal of Psychological Research*, *3*(1), 97-110.

Maxwell, J. P., Masters, R. S. W., & Poolton, J. M. (2006). Performance breakdown in sport: the roles of reinvestment and verbal knowledge. *Research Quarterly for Exercise and Sport*, *77*(2), 271-276.

McDonald, R. P. (1999). *Test theory: A unified treatment.* Lawrence Erlbaum.

McIntosh, C. N. (2007). Rethinking fit assessment in structural equation modelling: A commentary and elaboration on Barrett (2007). *Personality Individual Differences*, *42*(5), 859-867.

Mesagno, C., & Beckmann, J. (2017). Choking under pressure: theoretical models and interventions. *Current Opinion in Psychology*, *16*, 170-175.

Mesagno, C., & Hill, D. M. (2013). Definition of choking in sport: re-conceptualization and debate. *International Journal of Sport Psychology*.

Mesagno, C., Harvey, J. T., & Janelle, C. M. (2012). Choking under pressure: The role of fear of negative evaluation. *Psychology of Sport and Exercise*, *13*(1), 60-68.

Morgado, F. F., Meireles, J. F., Neves, C. M., Amaral, A. C., & Ferreira, M. E. (2018). Scale development: ten main limitations and recommendations to improve future research practices. *Psicologia: Reflexão e Crítica*, *30*(1), 3.

Mosley, E., & Laborde, S. (2015). Performing with all my heart: heart rate variability and its relationship with Personality-Trait-Like-Individual-Differences (PTLIDs) in pressurized performance situations. *Heart rate variability (HRV): Prognostic significance, risk factors and clinical applications*, 291-314.

Mosley, E., & Laborde, S. (2016). Performing under pressure: Influence of personality-trait-like individual differences. In: *Performance Psychology* (pp. 291-314). Academic Press.

Mosley, E., Laborde, S., & Kavanagh, E. (2017). The contribution of coping related variables and cardiac vagal activity on the performance of a dart throwing task under pressure. *Physiology & Behavior*, *179*, 116-125.

Muthén, L. K., & Muthén, B. (2018). Mplus. *The comprehensive modelling program for applied researchers: user's guide*, *5*. Publisher

Orn, A. (2017). *Effects of pressure and free throw routine on basketball kinematics and sport performance* (Doctoral dissertation, Arizona State University).

Papaioannou, A. G., & Hackfort, D. (2014). *Routledge companion to sport and exercise psychology*. Routledge.

Poolton, J., Maxwell, J., & Masters, R. (2004). Rules for reinvestment. *Perceptual & Motor Skills*, *99*(3), 771-774.

Post, M. W. (2016). What to do with "moderate" reliability and validity coefficients?. *Archives of Physical Medicine and Rehabilitation*, *97*(7), 1051-1052.

Roger, D., & Nesshoever, W. (1987). The construction and preliminary validation of a scale for measuring emotional control. *Personality & Individual Differences*, *8*(4), 527-534.

Schinka, J.A., Velicer, W.F., & Weiner, I.R. (2012). *Handbook of psychology, vol. 2, research methods in psychology*. Wiley.

Sellbom, M., & Tellegen, A. (2019). Factor analysis in psychological assessment research: Common pitfalls and recommendations. *Psychological Assessment*, *31*(12), 1428–1441.

Sparks, K. V., Kavussanu, M., Masters R. S. W., & Ring. C. (2021) Conscious processing and rowing: a field study, International Journal of Sport and Exercise Psychology, DOI: 10.1080/1612197X.2021.1891122

Struwig, M., Struwig, F. W., & Stead, G. B. (2001). *Planning, reporting and designing research*. Pearson South Africa.

Swann, C., Crust, L., Jackman, P., Vella, S. A., Allen, M. S., & Keegan, R. (2017). Psychological states underlying excellent performance in sport: toward an integrated model of flow and clutch states. *Journal of Applied Sport Psychology*, *29*(4), 375-401.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics*, 6th Ed. *California State University*.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53.

Toner, J., & Moran, A. (2014). In praise of conscious awareness: a new framework for the investigation of "continuous improvement" in expert athletes. *Frontiers in Psychology*, *5*, 769.

van Ginneken, W. F., Poolton, J. M., Masters, R. S., Capio, C. M., Kal, E. C., & van der Kamp, J. (2017). Comparing the effects of conscious monitoring and conscious control on motor performance. *Psychology of Sport and Exercise*, *30*, 145-152.

Watson, J. C. (2017). Establishing evidence for internal structure using exploratory factor analysis. *Measurement & Evaluation in Counseling and Development*, *50*(4), 232-238.

Wolf, S., Brölz, E., Keune, P. M., Wesa, B., Hautzinger, M., Birbaumer, N., & Strehl, U. (2015). Motor skill failure or flow-experience? Functional brain asymmetry and brain connectivity in elite and amateur table tennis players. *Biological Psychology*, *105*, 95-105.

Zhu, F. F., Poolton, J. M., Wilson, M. R., Maxwell, J. P., & Masters, R. S. W. (2011). Neural co-activation as a yardstick of implicit motor learning and the propensity for conscious control of movement. *Biological Psychology, 87,* 66-73.

Table 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 synchronize 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 scrutinizing 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.

Descriptive statistics, alpha coefficients, and zero-order correlations between conscious processing, 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		.45 ***		
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***
Percieved Technical Performance	4.67	.82			.01	-.23***		
Percieved Strength	4.89	1.17			-.01	-.09	.03	-.17**
Percieved Tactical	5.09	1.24			.06	.02	-.01	-.08
Percieved 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 Rowing Specific 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. $^{*}p < .05$, $p < .01^{**}$ $p < .001^{***}$.

Table 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***.