Reinvestment, task complexity and decision making under pressure in basketball

Noel P. Kinrade[*], Robin C. Jackson, Kelly J. Ashford

Centre for Sports Medicine and Human Performance, Brunel University, London, UK

ABSTRACT

The aims of this study were to investigate choking susceptibility in a perceptual judgment task and to examine the predictive validity of the Decision Specific Reinvestment Scale (DSRS). A computer-based, choice response time basketball passing task was performed under low and high pressure conditions. Complexity was manipulated by depicting 3-on-3 and 5-on-5 scenarios. Repeated-measures ANOVAs revealed performance decrements under pressure with regard to response accuracy, moderated by task complexity, and a general speeding of performance over successive blocks. The DSRS was a significant predictor of poorer response accuracy under pressure in the high-complex task. Examination of the DSRS subscales revealed rumination as the only significant factor, predicting changes in response time and accuracy in the low- and high-complex versions of the task, respectively. Findings support the predictive validity of the DSRS, and highlight the importance of avoiding ruminative thoughts when making complex decisions under pressure.

Introduction

The competitive sporting environment is psychologically demanding and it is not uncommon to see athletes performing significantly below expectations in spite of high motivation and incentives for success; this is referred to as 'choking' (Jackson, Beilock, & Kinrade, 2013). Researchers examining the factors underlying this phenomenon have tended to focus on the attentional processes governing skill execution (Baumeister, 1984; Masters, Polman, & Hammond, 1993). The two main theoretical frameworks that have been used to explain choking, distraction and self-focus, draw evidence from differing backgrounds. Distraction theories suggest that increases in performance pressure provoke a shift in focus of attention to task-irrelevant cues, and draw support from working memory intensive cognitive tasks (Beilock, Kulp, Holt, & Carr, 2004). In contrast, self-focus theories suggest that performance pressure increases self-awareness about performing correctly causing individuals to try to consciously control normally automatic processes and behaviors (Masters, 1992).

Masters and colleagues' work on reinvestment addresses individual differences in the tendency to reinvest, defined as the "propensity for manipulation of conscious, explicit, rule-based knowledge, by working memory, to control the mechanics of one's movements during motor output" (Masters & Maxwell, 2004, p.208). The concept of reinvestment has received substantial support from a variety of motor tasks including golf putting (Hardy, Mullen, & Jones, 1996), a football 'wall volley' task (Chell, Graydon, Crowley, & Child, 2003) and field-hockey dribbling (Jackson, Ashford, & Norsworthy, 2006). With respect to individual differences Masters et al. (1993) developed the Reinvestment Scale (RS) and found that individuals classified as high reinvesters were more likely to suffer skill failure under pressure than low reinvesters (e.g., Kinrade, Jackson & Ashford, 2010; Masters et al., 1993). Following conceptual advancements in the definition of reinvestment, and to address limitations in the design of the original scale, Masters, Eves, and Maxwell (2005) developed the Movement-Specific Reinvestment Scale (MSRS). Factor analysis of the scale revealed two distinct factors: movement self-consciousness, which concerns the 'style' of movement and public perceptions, and conscious motor processing, which focuses on the contemplation of the process of movement. To date, there has been little research into the psychometric properties of the MSRS in sport; however, evidence from health settings indicates that an inward focus of attention on performance processes may be disruptive. For

* Corresponding author. Centre for Sports Medicine and Human Performance, Brunel University, Uxbridge, Middlesex UB8 3PH, UK. Tel.: +44 (0)1895 267383; fax: +44 (0)1895 269769.

E-mail address: noel.kinrade@brunel.ac.uk (N.P. Kinrade).

example, MSRS scores were positively correlated with the incidence of falls in the elderly (Wong, Masters, Maxwell, & Abernethy, 2008), the length of time individuals have been suffering from Parkinson's disease (Masters, Pall, MacMahon, & Eves, 2007), and functional impairment in stroke patients (Orrell, Masters, & Eves, 2009). Concerning the association between movement-specific reinvestment and performance under pressure, Malhotra, Poolton, Wilson, Ngo, and Masters (2012) found that surgeons who were low reinvesters performed significantly faster and more efficiently on a laparoscopic task than their high-reinvester counterparts when under temporal pressure. Differences in the neural co-activations of high and low reinvesters have also been observed; Zhu, Poolton, Wilson, Maxwell, and Masters (2011) found that high scorers on the MSRS showed significantly greater cortical co-activation between the verbal analytical and motor planning regions of the cortex compared to low scorers. The greater coherence between these regions reflects the increased role that verbal-analytical processes play during motor performance in high reinvesters.

Research examining the role of reinvestment in skill failure under pressure has typically focused on motor tasks while researchers have tended to appeal to distraction theory to explain skill failure in cognitive tasks (Beilock et al., 2004). While these offer the most plausible explanations for each task type, Beilock et al., also noted that the type of skill being executed and/or the ability of the performer may moderate the applicability of each theory. There is also some evidence that reinvestment might apply to skill failure in perceptual-motor tasks. Such tasks involve cognitions required to make a decision accompanied by a motor response (e.g. tennis serve return with cross court forehand). Whilst the performer uses working memory to make a conscious decision based on presented stimuli and experience, the motor response, which through practice becomes automated, is performed without online processing of working memory. Smeeton, Williams, Hodges, and Ward (2005) found that junior players who learned to judge the direction and depth of tennis strokes with the aid of explicit rules subsequently suffered performance decrements when performing under pressure. Indeed, explicit learners became both slower and less accurate under pressure and slowing of decision time was strongly correlated with the number of explicit rules reported. By contrast, this correlation was non-significant in the guided discovery and discovery learning groups. Similarly, Poolton, Masters, and Maxwell (2006) and Masters, Poolton, Maxwell, and Raab (2008) investigated the benefits of implicit learning to cognitive efficiency in a task involving both motor and decision-making components. Following training, in which participants learned to perform a table tennis shot either implicitly (through analogy learning) or explicitly, motor performance and movement kinematics were assessed as participants performed a concurrent low- and high-complexity decision-making task concerned with where to direct the shot. Findings from both studies revealed that only explicit learners exhibited performance decrements when performing a concurrent decision-making task and this was confined to the high-complex version of the task. They concluded that explicit processes place an increased load upon working memory, due to the conscious retrieval of declarative knowledge to control motor skill execution, which impairs processing efficiency and the ability to meet the demands of multiple concurrent tasks.

Kinrade, Jackson and Ashford (2010) examined the moderating effect of dispositional reinvestment upon choking in motor and cognitive tasks of varying complexity. They found that pressure had a deleterious effect on performance in a low complex motor task (peg board), led to faster but more error-prone performance in a high-complexity psychomotor task (card sorting), and led to more errors in a high-complexity working memory task (modular arithmetic). High RS scores were significantly correlated with performance decrements from low to high pressure conditions in both low and high complex (golf putting) motor tasks, and in both working memory tasks. However, higher RS scores were associated with a speeding of performance from the low to high pressure condition in the psychomotor tasks.

Evidence that the association between reinvestment and choking extends beyond the motor domain led Kinrade, Jackson, Ashford and Bishop (2010) to develop the Decision-Specific Reinvestment Scale (DSRS); their intention being to measure the propensity for reinvesting explicit knowledge in decision-making tasks. The scale comprises two factors, decision reinvestment and decision rumination, and was developed by adapting items from the original RS. Their initial investigation into the predictive validity of the scale used judgments of coaches, who were required to rate a player's tendency to choke on a 10-point Likert-type scale anchored by 1 ("never chokes under pressure") and 10 ("always chokes under pressure"). Analysis revealed a strong correlation between DSRS scores and peer ratings of decision failure under stress ($n = 59$, $r = .74$, $p < .01$). In a field-based study of passing accuracy in netball players Jackson, Kinrade, Hicks, and Wills (2013) found that the DSRS, but not MSRS, was a significant predictor of change in passing accuracy from low- to high-pressure games. Jackson et al. acknowledged that it was not possible to determine the extent to which poorer passing performance related to the decision making and skill execution components of the pass. However, in a study of referees' decision making, Poolton, Siu, and Masters (2011) found that soccer referees who scored highly on the rumination factor of the DSRS, exhibited greater bias towards the home team in the decisions they made.

Task complexity has been identified as a moderating factor in the examination of performance under pressure. Within the literature, choking has been observed in relatively complex motor tasks, such as golf putting, basketball free throw, baseball batting, and soccer and field-hockey dribbling (e.g., Hill, Hanton, Matthews, & Fleming, 2010; Jackson et al., 2006; Masters et al., 1993; Otten, 2009), training for which is typically associated with substantial technical instruction. However, performance on simple motor tasks has proved more robust under stress. For example, Magill and Clark (1997) and Masters et al. (1993) found no evidence of performance breakdown on a simple tracking task and rod-tracing task, respectively, while Baumeister, Hutton, and Cairns (1990) found that performance on a simple card-sorting task actually improved under pressure. Similarly, Beilock et al. (2004) found that pressure impaired performance on modular arithmetic problems that place high demands on working memory but not on less demanding problems. Further, Kinrade, Jackson and Ashford (2010) only observed choking in complex versions of cognitive based tasks (working memory and psychomotor).

The aims of the present study were, first, to investigate choking susceptibility in a complex perceptual judgment task. In so doing, the second aim was to examine the predictive validity of the DSRS in a task in which complexity was systematically manipulated. A choice response time basketball task was chosen that required participants to judge to whom to pass the ball, with complexity manipulated by depicting 3-on-3 and 5-on-5 versions of the task. Based on previous research (e.g., Kinrade, Jackson, Ashford & Bishop, 2010), we predicted that propensity for reinvestment would be associated with poorer decision making under high pressure relative to low pressure. The second aim of the study was to determine whether the DSRS or the original RS is a better tool for predicting performance decrements under pressure in a decision-making task. To this end, we compared the predictive validity of the two scales.

Method

Participants

Having gained institutional ethical approval 38 skilled male basketball players (*M Age* = 23.46 years, *SD* = 4.90) were recruited for the study. At the time of the study participants were competing for local clubs (*n* = 25), in county or regional level teams (*n* = 2), or at national league level (*n* = 11) and had a mean of 10.00 years (*SD* = 4.65) competitive experience.

Design and measures

A 2 (Task Complexity) × 3 (Pressure) factorial design was used, with the pressure factor incorporating an A-B-A design (low pressure, high pressure, low pressure). Response time and response accuracy served as dependent variables. Response time was calculated as the mean response time across all trials, within each block, at each level of complexity; whilst response accuracy was calculated as the percentage of correct trials across all trials, within each block, at each level of complexity.

The reinvestment scale (RS)

The RS (Masters et al., 1993) comprises 20 items and has good internal reliability (α = .86) and test-retest reliability over a four-month period (*r* = .74). In line with previous studies, (Jackson et al., 2006; Kinrade, Jackson, & Ashford, 2010), participants rated each item on a 5-point Likert-type scale from 0 (extremely uncharacteristic) to 4 (extremely characteristic).

Decision-specific reinvestment scale (DSRS)

The DSRS (Kinrade, Jackson, Ashford, & Bishop, 2010) comprises 13 items that assess an individual's propensity to engage in behaviors detrimental to performance under pressure. The first factor, decision reinvestment, assesses the conscious monitoring of processes involved in making a decision; for example, "I'm always trying to figure out how I make decisions". The second factor, decision rumination, assesses the tendency to focus on past inaccurate decisions they have made; for example, "I remember poor decisions I make for a long time afterwards". Participants rated each item on the same 5-point Likert-type scale used for the RS. Acceptable internal consistency estimates have been reported for both decision reinvestment (α = .89) and decision rumination (α = 91) (Kinrade, Jackson, Ashford, & Bishop, 2010). Internal consistency scores for the current sample were calculated and above acceptable for all scales (DSRS: decision reinvestment α = .80, decision rumination α = .85; RS: Reinvestment α = .83).

Assessment of explicit knowledge

To measure participants' awareness of information governing their decisions, participants were required to write down any information they considered important in making their decisions. Practice clips were shown to participants to aid recall and enhance the sensitivity of the test. Explicit rules were operationally defined as statements that referred to specific aspects of the offense, individual player characteristics, or information relating these features to a player's openness to receive a pass. Statements were assessed by two independent raters who counted the number of explicit rules reported for each participant. Participants were also required to rate the importance of this information and their awareness of using it in each block of trials.

Manipulation checks

State anxiety

To assess the effectiveness of the pressure manipulation, the cognitive and somatic anxiety subscales of the Revised Competitive State Anxiety Inventory-2 (CSAI-2R: Cox, Martens, & Russell, 2003) were administered prior to the low- and high-pressure trials. Participants rated anxiety intensity on a 4-point Likert-type scale anchored by 1 (not at all) and 4 (very much so). Cox et al. (2003) reported acceptable internal consistency estimates for both cognitive (α > .81) and somatic anxiety subscales (α > .82).

Perceived pressure

After each condition participants were asked to rate how much pressure they felt they were under on a 7-point Likert-type scale anchored by 1 ("no pressure") and 7 ("extreme pressure") (Kinrade, Jackson & Ashford, 2010).

Construction of test stimuli and experimental task

Two-choice and four-choice response time tasks were developed in which participants were required to judge to whom to pass the ball (see Fig. 1). The situation used in this experiment was based on a simple 'motion offence' that involved players 'screening' away from the ball to provide two passing options (low complex trials: pass to the cutting forward; pass to the sealing guard) or four passing options (high-complex trials: pass to the cutting forward; pass to the cutting guard; pass to the sealing forward; pass to the sealing guard). Scenarios were filmed using an HD tripod-mounted video camera (Canon HV30) to provide a pool of eight to 10 trials for every option. Players from a premier division University basketball team were used as models for clip construction. Video trials were edited using Pinnacle Studio (Version 11.0) to create the stimuli for the practice and test blocks. Trials had a mean duration of 4750 ms (*SD* = 780) and a gray screen of 1700 ms duration followed the occlusion of each clip. Participants were instructed that responses must be made before the end of the gray screen or the response would be recorded as incorrect. Video sequences of each scenario were selected based on independent evaluations of two expert national league coaches who rated each clip for quality, based on how much the clip represented a good example of the offensive arrangement, and clarity of the available passing option, using a five point Likert-based scale. The top four trials for each option were selected for use in the experiment and were randomly distributed across the four blocks. Inter-rater reliability for quality ratings of clips was assessed using intra-class correlations for high complex (ICC = .74) and low complex trials (ICC = .79). Finally, by viewing the video frame-by-frame, the coaches calculated a 'decision point' for each video sequence, operationally defined as the point at which the best passing option became evident. This was used as a reference to determine participant decision time for each trial. Inter-rater reliability between the two coaches for decision point was found to be very high (high complex trials: ICC = .99; low complex trials: ICC = .99).

To familiarize participants with the task, the time constraints for responding, and the offensive arrangement used in the test stimuli participants were presented with 36 trials. Familiarization trials consisted of three clips of each of the four passing option for the high-complexity (3 × 4 = 12 unique clips) and low-complexity (3 × 2 = 6 unique clips) sequences repeated for two cycles (total of 36 trials). The test blocks consisted of one cycle of unique clips used (total of 18 trials). The test phase consisted of 54 trials divided equally amongst the three experimental blocks (low pressure 1 (LP1), high pressure, low pressure 2 (LP2)). Each block consisted of novel clips and the passing options and complexity were randomized.

Fig. 1. Video stills depicting the design of the video stimuli used for the low-complex, two-choice response time (upper panel) and high-complex, four-choice response time (lower panel) tasks.

The task was designed and run on E-Prime (v. 2.0.1; Psychology Software Tools, Inc., Pittsburgh, Pennsylvania, US). Video sequences were presented on a computer screen viewed from a distance of approximately 0.5 m. Participants responded to each sequence by pressing one of two (low-complex trials) or four (high-complex trials) buttons positioned horizontally on a handheld response pad corresponding with players' on-court position (see Fig. 1).

Pressure manipulation

The pressure manipulation involved two steps; the first induced evaluation apprehension by requiring participants to perform the task in the presence of an associate of the experimenter who filmed the trials. A cover story was given in which participants were told their performance was to be filmed for the Basketball National Governing Body in order to assess their anticipation and decision making skills against other players of their level and ability. In addition, participants were told that if they could improve their performance score by 20% relative to the average for their age and ability, they would receive £10 and that the best performer in the study would win £100.

Procedure

Having gained informed consent, the initial questionnaire package comprising the DSRS, RS and demographic questionnaire was administered. Participants were informed about the nature of the task and that they should respond as quickly and accurately as possible as both decision time and judgment accuracy would be used to determine overall performance. This instruction was reinforced prior to each block of trials. Participants were then shown the familiarization trials. Immediately prior to each block of test trials, the CSAI-2R was administered, whilst ratings of perceived pressure were recorded immediately after each block. The 18 trials constituting LP1 were then presented. Following this test block, participants were introduced to the experimenter's associate and were given the cover story regarding filming and details of the performance needed in order to win the prize money. Following the high-pressure block of trials the associate departed and participants were informed that the final block of trials (LP2) would not be filmed and that their performance would not affect any prize they may have won. Following the completion of all test trials, participants completed the explicit knowledge test before being debriefed and thanked for their participation.

Data analysis

To analyze the effect of pressure on performance, response time and accuracy data were subjected to separate 2 × 3 (Task complexity × Pressure) repeated measures ANOVAs. Predictive

validity of the RS and DSRS was assessed by standard multiple regression analyses using global scores of each scale as predictors of performance change between high and low pressure blocks (mean low pressure block score minus high pressure block score) for response time and accuracy data. Further, to assess the individual contribution of each DSRS factor, separate multiple regression analyses were performed. Finally, Pearson's product moment correlation coefficients were calculated to assess the relationships between the DSRS, its related subscales, the RS, and the number of explicit rules reported. The number of explicit rules reported was also correlated with change in performance between high and low-pressure blocks. Alpha was set to .05 for all tests.

Results

Preliminary screening of all data, using univariate z scores ($>\pm3.29$) and Mahalanobis distance values, revealed no outliers. Descriptive statistics revealed participants' DSRS scores ranged from 11 to 48 ($M = 30.00$, $SD = 9.11$) and RS scores ranged from 19 to 64 ($M = 41.71$, $SD = 10.68$).

Response accuracy

A 2 × 3 (Task complexity × Pressure) repeated measures ANOVA revealed significant main effects for task complexity, $F(1,37) = 30.36$, $p < .001$, $\eta_p^2 = .45$, and pressure, $F(2,36) = 7.05$, $p = .003$, $\eta_p^2 = .28$. Further, a significant interaction was found between task complexity and pressure $F(2,36) = 7.05$, $p = .003$, $\eta_p^2 = .28$. To examine the interaction, separate one-way repeated measures ANOVAs were performed for each level of complexity. For the low-complex trials the analysis revealed a significant effect of pressure, $F(2,36) = 4.57$, $p = .017$, $\eta_p^2 = .20$ with pairwise comparisons showing a significant difference between LP1 ($M = .84$, $SE = .04$) and LP2 ($M = .93$, $SE = .03$, $p = .017$) indicating a slight improvement between the first and last low pressure blocks. For the high-complex trials, a significant effect of pressure, $F(2,36) = 4.07$, $p = .026$, $\eta_p^2 = .18$, was also observed. Pairwise comparisons revealed a significant difference between high pressure ($M = .68$, $SE = .03$) and both LP1 ($M = .76$, $SE = .02$, $p = .03$) and LP2 ($M = .77$, $SE = .02$, $p = .02$) reflecting poorer performance in the high pressure condition (see Fig. 2).

Response time

A 2 × 3 (Task complexity × Pressure) repeated measures ANOVA revealed significant main effects for task complexity, $F(1, 37) = 26.60$, $p < .001$, $\eta_p^2 = .42$, and pressure, $F(2, 36) = 53.79$, $p < .001$, $\eta_p^2 = .75$. Further, a significant interaction was observed between task complexity and pressure, $F(2, 36) = 13.23$, $p < .001$, $\eta_p^2 = .42$. To follow up the interaction, the effect of pressure was assessed at each level of complexity. The analysis revealed a significant effect of pressure in the low-complex trials, $F(2, 36) = 44.49$, $p < .001$, $\eta_p^2 = .71$, with performance in LP1 ($M = 76.22$, $SE = 28.81$) significantly slower than in high pressure ($M = -104.43$, $SE = 24.59$, $p < .001$) and LP2 ($M = -105.22$, $SE = 23.28$, $p < .001$). There was also a significant effect of pressure in the high-complex trials, $F(2, 36) = 28.66$, $p < .001$, $\eta_p^2 = .61$, with performance in LP2 ($M = -58.56$, $SE = 30.30$) significantly faster than in LP1 ($M = 127.26$, $SE = 32.88$, $p < .001$) and high pressure ($M = 71.37$, $SE = 31.63$, $p < .001$). Overall, these results reflect a slight quickening of response times across the test (see Fig. 2).
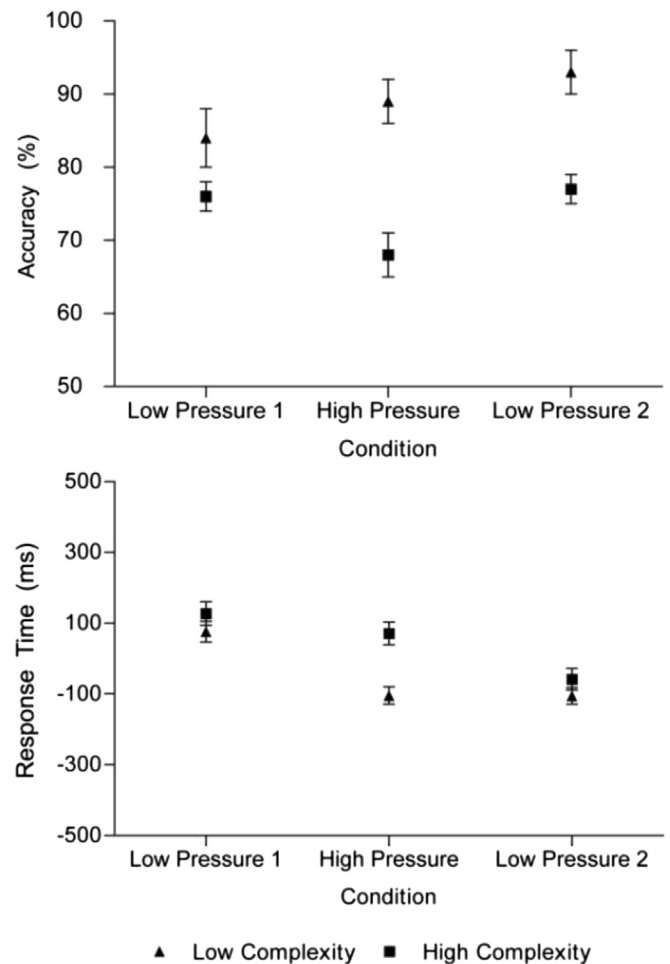

Fig. 2. Mean (±SE) response accuracy scores (upper panel) and response times (lower panel) on the low-complexity and high-complexity decision-making tasks under low- and high-pressure conditions.

Predictive validity of the reinvestment and decision-specific reinvestment scales

To compare the predictive validity of the DSRS to the original RS, separate standard multiple regressions were conducted for the low- and high-complex trials (see Table 1), using the difference in response accuracy and response time between low- and high-pressure conditions as the dependent variables. Pearson product moment correlation coefficients were also calculated to assess the relationship between predictors. Analysis of the low-complex trials revealed neither scale to be a significant predictor of response accuracy or response time change under pressure. In the high-complex trials, DSRS score was found to be a significant predictor of decrements in response accuracy under pressure but not decision time, whilst RS score was a non-significant predictor of both variables. Correlation analysis also revealed RS score to be unrelated to DSRS global and subscale scores (see Table 3).

To examine the predictive validity of the DSRS subscales, separate multiple regression analyses were conducted for decision reinvestment and decision rumination in the low- and high-complex trials. Results revealed that decision reinvestment was not a significant predictor of difference in decision accuracy or time, whilst decision rumination was predictive of pressure differences in response time and accuracy in the low and high complex versions of the task respectively (Table 2).

Table 1
Multiple Regression Analysis examining the influence of Decision-Specific Reinvestment Scale scores and original Reinvestment Scale scores on performance change under pressure in low- and high-complexity tasks.

	B	SE B	β
Low-Complex			
Response Accuracy			
Constant	−.038	.093	
Decision-Specific Reinvestment Scale	.002	.002	.127
Original Reinvestment Scale	.000	.002	−.030
Response Time			
Constant	43.855	87.425	
Decision-Specific Reinvestment Scale	3.753	2.125	.295
Original Reinvestment Scale	−1.595	1.814	−.147
High-Complex			
Response Accuracy			
Constant	−.160	.121	
Decision-Specific Reinvestment Scale	.009	.003	.466**
Original Reinvestment Scale	−.001	.003	−.036
Response Time			
Constant	16.392	86.080	
Decision-Specific Reinvestment Scale	2.435	2.092	.194
Original Reinvestment Scale	−3.032	1.786	−.283

Note: Low-Complex: Response Accuracy, $R^2 = .02$, $\Delta R^2 = -.04$, Response Time, $R^2 = .09$, $\Delta R^2 = .03$; High-Complex: Response Accuracy, $R^2 = .21$, $\Delta R^2 = .17$; Response Time, $R^2 = .09$, $\Delta R^2 = .04$. *$p < .05$, **$p < .01$.

Table 2
Multiple regression analysis examining the influence of Decision-Specific Reinvestment Scale subscales scores on performance change under pressure in low- and high-complexity tasks.

	B	SE B	β
Low-Complex			
Response Accuracy			
Constant	−.040	.070	
Decision Reinvestment	−.001	.005	−.035
Decision Rumination	.003	.004	.164
Response Time			
Constant	13.478	65.147	
Decision Reinvestment	−2.669	4.709	−.102
Decision Rumination	7.049	3.376	.375*
High-Complex			
Response Accuracy			
Constant	−.148	.087	
Decision Reinvestment	−.003	.006	−.065
Decision Rumination	−.016	.005	.563**
Response Time			
Constant	−69.435	67.176	
Decision Reinvestment	−2.091	4.856	−.081
Decision Rumination	3.816	3.481	.206

Note: Low-Complex: Response Accuracy, $R^2 = .02$, $\Delta R^2 = -.03$, Response Time, $R^2 = .12$, $\Delta R^2 = .07$; High-Complex: Response Accuracy, $R^2 = .29$, $\Delta R^2 = .25$; Response Time, $R^2 = .03$ $\Delta R^2 = -.02$. *$p < .05$, **$p < .01$.

The significant results from the regression analyses highlight that high scores on the global DSRS and the decision rumination subscale were associated with greater performance decrements under pressure in the high-complex trials only. In low-complex trials, high scores on the decision rumination sub-scale were associated with faster decision-making under pressure.

Explicit knowledge

Information reported as underpinning participants' choices, focused either on offensive awareness (e.g., readiness of receiver, size mis-matches, speed of cutter, strength/speed of screener), defensive awareness (e.g., location of defender, defensive strategy for dealing with screens, position of supporting defenders), and/or threats to outcome (e.g., ease of pass, type of pass, ease of shot from pass, distance of pass to basket). One-tailed Pearson product−moment correlation coefficients were calculated between the number of explicit rules reported and the change in performance between high- and mean low-pressure blocks. Analyses revealed no significant relationships for decision accuracy or decision time in either the low-complex (response accuracy, $r = -.04$, $p = .41$; response time, $r = -.23$, $p = .08$) or high-complex (response accuracy, $r = -.24$, $p = .07$; response time, $r = .17$, $p = .15$) conditions. The number of explicit rules reported was also unrelated to RS scores ($r = .10$, $p = .57$), DSRS global ($r = -.09$, $p = .58$) and subscale scores (Decision Reinvestment, $r = -.03$, $p = .84$, Decision Rumination, $r = -.11$, $p = .50$).

Pressure manipulation checks

To test whether the pressure manipulation was successful a one-way repeated measures MANOVA was performed on the cognitive and somatic CSAI-2R subscale scores and perceived pressure ratings. The multivariate analysis revealed a significant effect of pressure, Wilks' Lambda = .22, $F(6,32) = 18.46$, $p < .001$, $\eta_p^2 = .78$. After applying Greenhouse-Geisser corrections univariate analyses revealed significant effects of pressure for cognitive anxiety, $F(1.69,62.47) = 22.85$, $p < .001$, $\eta_p^2 = .38$, somatic anxiety, $F(1.49,55.25) = 13.09$, $p < .001$, $\eta_p^2 = .26$, and perceived pressure ratings, $F(1.53,56.57) = 64.07$, $p < .001$, $\eta_p^2 = .63$. Pairwise comparisons revealed significantly higher ($p < .01$) cognitive anxiety, somatic anxiety, and perceived pressure in the high-pressure block than in the low-pressure blocks (cognitive anxiety: LP1, $M = 16.47$, $SE = .75$; High Pressure, $M = 20.63$, $SE = 1.17$; LP2, $M = 14.53$, $SE = .80$; somatic anxiety: LP1, $M = 12.71$, $SE = .47$; High Pressure, $M = 15.60$, $SE = .87$; LP2, $M = 12.70$, $SE = .55$; perceived pressure: LP1, $M = 2.45$, $SE = .19$; High Pressure, $M = 4.50$, $SE = .24$; LP2, $M = 2.02$, $SE = .24$). Additionally, cognitive anxiety was significantly lower in LP2 than LP1 ($p = .03$).

Table 3
Pearsons product moment correlations between RS, DSRS global and subscale scores, and performance change performance change under pressure in low- and high-complexity tasks.

	DSRS reinvestment	DSRS rumination	DSRS global	RS	Low complex Accuracy difference	Low complex RT difference	High complex Accuracy difference	High complex RT difference
DSRS Rumination	.467**							
DSRS Global	.801**	.903**						
RS	.163	.264	.258					
Low Complex Accuracy Difference	.041	.147	.120	.003				
Low Complex RT Difference	.073	.328*	.257	−.071	.350*			
High Complex Accuracy Difference	.198	.533**	.457**	.084	.356*	.376*		
High Complex RT Difference	.015	.168	.121	−.233	.012	−.092	.360*	
Explicit_Rules	−.034	−.112	−.092	.096	−.036	−.230	−.241	.173

*$p < .05$, **$p < .01$.

Discussion

The purpose of the present study was to investigate the effect of pressure on performance on a low- and high-complex version of a time-constrained decision-making task, and to examine the predictive validity of the DSRS (Kinrade, Jackson, Ashford, & Bishop, 2010). In the study, participants were required to respond to video stimuli depicting a common offensive set in basketball, that required either a two-choice (low-complex) or four-choice (high-complex) response. Participants responded as quickly and accurately as possible by indicating which player was the best option to pass to. The cognitive and somatic anxiety sub-scales of the CSAI-2R and the ratings of perceived pressure were used to examine the success of the pressure manipulation. Overall, the analysis revealed performance decrements under pressure with regard to response accuracy, which was moderated by task complexity. Whilst the analysis of the response time data was less clear, a general speeding of performance over successive blocks was observed, with either blocks two and/or three being faster depending on complexity. There was also clear evidence that participants were more anxious and felt under greater pressure during the high pressure trials than in the low pressure trials. Examination of the predictive validity of DSRS and RS revealed that only the DSRS was a significant predictor of performance change under pressure with regard to response accuracy in the high-complexity condition. With regard to the subscales of the DSRS, analyses revealed that rumination was the only significant factor predicting changes in response time and accuracy in the low and high complex versions of the task respectively. Use of explicit knowledge was found to be unrelated to performance change under pressure and unrelated to ratings on either the DSRS or RS.

In line with previous work examining choking in the motor skill domain (see Masters & Maxwell, 2008), significant decrements in decision accuracy from low pressure to high pressure were only observed in the more complex task. Whilst a significant difference in response time was observed in the low-complexity task, the finding reflected a learning effect evidenced by observed differences between the two low-pressure blocks. The findings from the regression analysis revealed DSRS global scores to be associated with performance breakdown in response accuracy for the high-complexity task. This extends the findings from the initial validation of the DSRS, wherein global scale scores were highly correlated with peer ratings of choking tendency (Kinrade, Jackson, Ashford & Bishop, 2010). This was only observed in the high-complexity condition, mirroring the findings of Kinrade, Jackson and Ashford (2010) and Masters et al. (1993) who found performance decrements in only high-complex versions of their experimental tasks. The inference drawn from such studies is that simple tasks place relatively little burden on the processing capacity of participants, meaning they are still able to meet the processing demands of the task in spite of additional demands by they from concurrent application of conscious control or competing ruminative thoughts.

Whilst there is evidence of an association between explicit knowledge and propensity for reinvestment in the motor learning literature (Poolton et al., 2006), there was no difference in the amount of explicit knowledge reported by high and low reinvesters in the present study, nor was it correlated with performance change under pressure. There are several potential explanations for these findings including floor or ceiling effects, lack of sensitivity of the measure or that performance failure in decision-making tasks is not influenced by conscious control using explicit knowledge. Given the dynamic interactive nature of the scenarios, floor and ceiling effects seem unlikely. However, it is possible that the self-report method of response may lack sensitivity, either in terms of the number of rules reported or in reflecting the extent to which

the rules were used. These findings also leave open the possibility raised by Kinrade, Jackson and Ashford (2010) that the process of explicit monitoring and conscious control is more influential to performance breakdown than the number of explicit rules used, or indeed that a different process of skill breakdown is implicated. An alternative explanation may lie in the role of working memory. Distraction-based accounts view choking as a result of reduced working memory due to consumption from task-irrelevant cues and thoughts of worry (Beilock et al., 2004). Masters and Maxwell (2004) drew parity between reinvestment and distraction explanations highlighting that the explicit processes used when reinvesting ones actions rely on working memory to store and manipulate information and that a reduction in working memory capacity to perform the primary task can result in performance breakdown. Support for a working memory explanation was also found in the studies of Poolton et al. (2006) and Masters et al. (2008) on concurrent motor and decision making performance of implicit and explicit learners. The experimental task used in the current paper did not require a complex motor response. Given that support for distraction based accounts of choking has largely come from cognitive based tasks (e.g. Beilock et al., 2004), it could be argued that in such tasks, the role of distracting thoughts is more influential to performance breakdown than conscious control and may explain why the RS was unrelated to performance failure under pressure. Potential support for this explanation is evident when examining the regression analysis using the subscale factors of the DSRS.

Results of the multiple regression analyses indicated that in more complex decisions, the DSRS was a better predictor of less accurate decision making under pressure than the original RS. The DSRS was developed from the original RS; however, there are differences in the factor structures of each instrument. A single reinvestment factor constituted the original scale and it did not attempt to measure the process of reinvestment directly, but rather linked conceptually-related items that aimed to predict this process. The DSRS arguably has greater face validity, comprising two factors hypothesized to consume working memory: ruminative thoughts (decision rumination) and processing of explicit information during the decision-making process (decision reinvestment). Perhaps the DSRS's factor structure is more sensitive in examining of processes that inhibit working memory, and subsequently impair performance, than the original RS. Alternatively, the different factor structure of the DSRS may reflect differences in the constructs each scale measures. The non-significant correlations between the original RS and the DSRS global and sub-scale scores certainly support this.

It could be argued that the rumination factor may assess a predisposition to engage in distracting behaviors, potentially offering support to distraction based accounts of choking such as Attentional Control Theory (ACT; Eysenck, Derakshan, Santos, & Calvo, 2007). This theory suggests anxiety influences the balance of two attentional systems: a top-down goal-directed system and a bottom-up stimulus-driven system directs attention, by focusing attention to the source of the threat. Under pressure, the influence of the bottom-up system is increased, reducing the inhibition of task-irrelevant information. Compensatory effort can mitigate performance impairment, but will fail when resources are insufficient for the demands of the task. Thus offering further explanation as to why performance decrements were not observed in the low-complex versions of the tasks. ACT specifically highlights that the emotional significance of the threat is important, as it has a biasing effect on attentional control. It is possible the rumination factor highlights individuals who are more prone to worry about salient threats prior to and during performance of a decision-making task, which ultimately results in decrements to their performance.

Indeed, the results from the regression analyses revealed that the rumination factor significantly predicted poorer decision making accuracy under pressure in the high-complex trials and faster completion times under pressure in the low-complex trials. This observation that rumination, and not conscious control of decision processes, is the contributing factor in performance breakdown under pressure on a high-complex decision making task lends support to distraction based accounts such as ACT or Beilock et al.'s (2004) working memory based explanation of choking.

The results also indicate that ruminative thoughts aided performance in low-complex trials (evidenced by faster decisions without compromising accuracy) but were disruptive to performance in high-complex trials (evidenced by poorer accuracy with no change to response time). Although speculative at this stage, one possible explanation for this finding may lie in the concept of perceived control, defined as "the perception of one's capacity to be able to cope and attain goals under stress" (Cheng, Hardy, & Marklund, 2009, p. 273). Otten (2009) proposed perceived control to be a key determinant of skill failure under pressure. He hypothesized that if an athlete perceives control over a task, they will engage less in conscious control, and be more likely to succeed under pressure. It is conceivable that in low-complex decisions perceived control remains high so ruminative thoughts are perceived positively, for example serving to motivate the performer to rectify past mistakes. Conversely, during more complex decisions perceived control is likely to be lower so ruminative thoughts may be perceived negatively, reflected in individuals worrying about repeating past mistakes. An individual's inability to dispel negative cognitions and memories fueled by lack of perceived control, may lead to difficulties attending to and processing new information vital for performing a complex decision-making task (Joormann & Gotlib, 2008). The interaction between rumination, increased demands on working memory load and perceived control may be addressed in future research by employing think-aloud protocols and measures of perceived control to examine the nature and magnitude of ruminative thoughts in low- and high-complex tasks.

The general trend in the response time data seemed to be a speeding of decision time between blocks one and two and/or between blocks two and three that was moderated by task complexity. This suggests that a speed-accuracy trade-off, often observed in sporting domains, does not explain the performance decrements under pressure in decision accuracy. A potential explanation for the observed differences in decision accuracy under pressure in the absence of changes in decision time may come from decision field theory (Busemeyer & Townsend, 1993). The theory holds that, under time pressure, decision makers may be subject to a decision threshold (the point at which a decision must be made), leading them to reduce the amount of information used in making a decision (Johnson, 2006). Participants were all required to complete the task as quickly and as accurately as possible in order to achieve a best performance score. Faster decision times result in less time available to sample the relevant information upon which to base a decision. As a result less salient information is often missed. As reinvestment was not predictive of change in decision time under pressure it may be assumed that the slower processing efficiency of high reinvesters, as a result of conscious control strategies and ruminative thoughts, reduced the amount of information they were able to process before reaching the decision threshold, resulting in a poorer decision than that of low reinvesters who were able to draw from a more complete sample of processed information.

It is difficult to draw clear conclusions regarding the implications of the present findings for performers or practitioners. On the one hand, in the low-complex trials the extent of performance decrements under high-pressure was relatively small and to some degree masked by slight improvements in performance across the

test conditions. In the high-complex trials, where a clearer decrement in performance was observed, the DSRS was a significant predictor of change in performance; however, analysis of the subscales revealed only decision rumination to be significant. Accordingly, these data suggest that interventions directed towards minimizing decision reinvestment, that is, the conscious monitoring of decision processes, will be ineffective. Conversely, interventions that attempt to prevent or address ruminative thoughts of past poor decisions are likely to be more effective in maintaining decision making under pressure. Such interventions could focus on cognitive interventions such as thought stopping (Zinsser, Bunker, & Williams, 2001), positive self-talk (Hardy, Gammage, & Hall, 2001) and cognitive restructuring (Greenspan & Feltz, 1989).

There were several limitations that need to be acknowledged. The first is regarding the ecological validity of the task. In creating a video based task, with a keypad response, the task simplified in terms of cognitive demands of the stimuli and response compared to what would normally be experienced. In an actual game, the player may have to concurrently perform a complex motor task (dribbling) whilst cognitively adapting to an evolving situation, with additional stimuli and external threats (e.g. on ball defender), before responding with a complex motor skill (performing the required pass). Given the role that task complexity appears to play in skill failure under pressure, it is possible that our findings in the low complex task may not be representative of what happens in real game situations. Additionally, the study design did not account for discriminative validity between the DSRS and the original RS. The data suggests that the RS and DSRS may examine different constructs as there was no significant relationship between the two scales (and between RS and subscale scores) and, whilst non-significant, the RS correlated negatively with performance change, while DSRS correlates positively. The latter finding is particularly interesting given that Kinrade, Jackson and Ashford (2010), Kinrade, Jackson, Ashford and Bishop (2010) found RS scores to be associated with more errors on a working memory dependent task, however this may be a result of a lack of face validity as they used a generic assessment of working memory (modular arithmetic). Notwithstanding, these findings have identified a need to further examine the construct validity of the DSRS. The prevalence of a factor that seems to be concerned with distraction based accounts of choking such as ACT, and a factor concerned with conscious control indicates the inclusion of the two main theories of choking within this psychometric instrument. Additionally, future research should also look to include think aloud protocols in order to establish if there are any changes in the adoption of goal-directed and stimulus-driven attentional systems.

As a final point, it is important to note there has been some debate over the definition of 'choking'; specifically, Mesagno and Hill (2013) pointed to the dramatic instances of skill failure typically discussed in the media that involved more significant declines in performance than are generally observed in experimental research on choking. They argued that the term 'choking' should be reserved for these more significant declines in performance, proposing that a distinction be made between 'choking' and 'under-performance' which was supported by athletes suggesting a distinction in the perceived outcome and causes between the two cases (Hill & Shaw, 2013). In response, Jackson (2013) argued that the important question of whether there are common causes of 'moderate' and 'major' under-performance first requires that different levels of performance decrements are operationally defined. He noted Mesagno and Hill's reluctance to do this in their proposed re-definition of choking, arguing that this effectively rendered the hypothesis untestable. Further, Jackson noted that Mesagno and Hill, and Hill, Hanton, Fleming and Matthews (2009), conflated their definitions of the phenomenon with its putative causes. Notwithstanding these conceptual issues, the extent to

which the performance decrements observed in the present study are governed by the same processes underlying larger decrements in performance remains an important empirical question.

In conclusion, the results of the present study support the original hypothesis that decision accuracy would be maintained across all pressure conditions in the low complex task, whilst performance decrements would be observed in the high pressure trials during the high-complex task. The DSRS was found to be a significant predictor of choking, whilst the amount of explicit knowledge individuals reported was unrelated to choking. More specifically, it was the Rumination factor of the DSRS that was the key determinant of performance decrements under pressure. Thus potentially offering support for distraction based accounts of choking such as ACT. Further, these findings suggest the DSRS has sound predictive validity in identifying individuals who may be more prone to disrupted decision making under pressure, and thus may provide coaches and practitioners with a useful tool for identifying personal development needs. The potential of the scale to be useful in other high pressure decision making contexts and domains, such as medicine, aviation and the military, has yet to be established.

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