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Appraisal, coping, emotion and performance during elite fencing matches: A random coefficient regression model approach

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Abstract

Understanding more about the stress process is important for the performance of athletes during stressful situations. Grounded in Lazarus's (1991, 1999, 2000) CMRT of emotion, this study tracked longitudinally the relationships between cognitive appraisal, coping, emotions and performance in nine elite fencers across 14 international matches (representing 619 momentary assessments) using a naturalistic, video-assisted methodology. A series of hierarchical linear modelling analyses were conducted to: (a) explore the relationships between cognitive appraisals (challenge and threat), coping strategies (task- and disengagement oriented coping), emotions (positive and negative) and objective performance; (b) ascertain whether the relationship between appraisal and emotion was mediated by coping; and (c) examine whether the relationship between appraisal and objective performance was mediated by emotion and coping. The results of the random coefficient regression models showed: (a) positive relationships between challenge appraisal, task-oriented coping, positive emotions, and performance, as well as between threat appraisal, disengagement-oriented coping and negative emotions; (b) that disengagement-oriented coping partially mediated the relationship between threat and negative emotions, whereas task-oriented coping partially mediated the relationship between challenge and positive emotions; and (c) that disengagement-oriented coping mediated the relationship between threat and performance, whereas task-oriented coping and positive emotions partially mediated the relationship between challenge and performance. As a whole, this study furthered knowledge during sport performance situations of Lazarus's (1999) claim that these psychological constructs exist within a

conceptual unit. Specifically, our findings indicated that the ways these constructs are inter-related influence objective performance within competitive settings.

Keywords: cognitive-motivational-relational theory of emotion, process-oriented method, elite fencers, competition

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Participating in high-stakes competition can be a very stressful experience that may have damaging effects on performance (Lazarus, 2000). Coping is a mechanism that athletes can apply to manage the stressful demands of competition and maximise performance (Calmeiro, Tenenbaum, & Eccles, 2010, 2014; Doron & Gaudreau, 2014; Doron & Martinent, 2015; Gaudreau, Nicholls, & Levy, 2010). Based on Lazarus's (1991, 1999, 2000) cognitive-motivational-relational theory (CMRT) of emotion, cognitive appraisal, coping, and emotion are intertwined in a dynamic relationship that allows individuals to continuously adjust to constantly changing contextual demands. However, at the present time, little is known about the ongoing process-like nature of the relation between the key constructs of the CMRT of emotion and performance within sport performance situations. As such, the purpose of the study was to improve understanding of the overall experience of athletes during competitive events. Specifically, this study aimed to shed light on the relationship between the constructs central to the CMRT of emotion, as experienced by athletes in matches, and performance.

The CMRT of emotion (Lazarus, 1991, 1999, 2000) suggests that two forms of cognitive appraisal are associated with the coping process: primary appraisal and secondary appraisal. Primary appraisal refers to evaluation of the significance of an event in relation to the person, whereas secondary appraisal represents an evaluation of the coping strategies that individuals have at their disposal. When a transaction is perceived as a condition of stress, one of four primary appraisals (i.e., harm/loss, threat, challenge, or gain/benefit) is made. This study focused specifically on threat appraisals (i.e., the

possibility of future harms or losses) and challenge appraisals (i.e., evaluations of future gains or personal mastery). Emotions are generated by the evaluation a person makes about his or her environment in relation to personal goals, beliefs, or values (Lazarus, 1991, 1999, 2000). Emotions, according to Lazarus, are defined as "an organized psychophysiological reaction to ongoing relationships with the environment, most often, but not always, interpersonal or social" (Lazarus, 2000, p. 230). Empirical findings from the sport psychology literature indicated that pleasant emotions were positively associated with challenge, whereas unpleasant emotions were positively associated with threat (e.g., Nicholls, Hemmings, & Clough, 2010; Nicholls, Levy, Jones, Rengamani, & Polman, 2011; Nicholls, Polman, & Levy, 2012). Nevertheless, Lazarus (1999) stated that coping is integral to the process of emotional arousal because "judging the significance of what is happening always entails evaluating what might be done about it, which determines whether we react, say, with anxiety or anger" (p. 37). Therefore, emotions are generated throughout appraisal, coping, and upon the outcome of a situation (Folkman, 1997). As such, coping strategies influence the emotions a person experiences and could mediate the relationship between appraisal and the subsequent level of emotional states (Lazarus, 1999, 2000).

Coping represents the "constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person" (Lazarus & Folkman, 1984, p. 141). Although labelled differently across conceptual models, two dimensions have been proposed quite systematically: task-oriented and disengagement-oriented coping (Skinner, Edge, Altman, & Sherwood, 2003). These dimensions are based on the difference between engagement

and disengagement coping (e.g., Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). More specifically, the present study referred to Gaudreau and Blondin's (2002) hierarchical model of coping specific to the domain of sport. *Task-oriented coping* represents strategies aimed at dealing directly with the stressful situation and the resulting thoughts and emotions. This dimension of coping includes strategies such as effort expenditure, time management, planning, mental imagery, logical analysis, deep breathing, and cognitive reappraisal. *Disengagement-oriented coping* represents the strategies through which a person withdraws from the process of actively striving toward the realization of desirable outcomes, including strategies such as behavioural disengagement, denial, and venting of unpleasant emotions. The ability to effectively cope with stress in a specific situation is expected to influence the quality of the outcome in the person-environment transaction (Lazarus & Folkman, 1984). Some researchers have previously highlighted the associations between coping and sport performance with objective and/or subjective indicators (e.g., Calmeiro et al., 2010, 2014; Doron & Gaudreau, 2014; Doron & Martinent, 2015; Gaudreau et al., 2010; Haney & Long, 1995; Nicholls, Polman, & Levy, 2010; Nicholls et al., 2012; Smith & Christensen, 1995). Task-oriented coping has been shown to correlate positively, whereas disengagement-oriented coping has been found to correlate negatively with performance.

While there is an inherent relationship between the key constructs of the CMRT of emotion (Lazarus, 1999), researchers have essentially focused on one or two constructs (e.g., Nicholls et al., 2011). Very few studies have explored the overall sequence of the constructs central to the CMRT of emotion (e.g., Doron & Gaudreau, 2014; Doron & Martinent, 2015; Nicholls et al., 2012; Nicholls, Perry, & Calmeiro, 2014). Using

structural equation modelling, Nicholls et al. (2014) have examined a model that contained appraisals, emotions, and coping and provided support for Lazarus's (1999) claim that these constructs exist within a conceptual unit. However, this study adopted a cross-sectional design and did not explore the relationships between the key constructs of the CMRT of emotion and performance indicators. A central assumption of the CMRT of emotion is that individuals' cognitive appraisals, coping actions and emotional reactions are defined as highly contextual responses that change across situations and points in time during a stressful situation (Gaudreau, Blondin, & Lapierre, 2002). However, little attention has been devoted to the ongoing process-like nature of the relation between these constructs during real high-level competition and their link with objective indicators of performance.

Lazarus (1999) suggested examining the key constructs of the CMRT of emotion over a prolonged period to tap into the micro-analytical aspects of the stress process. Few studies have already monitored changes in these constructs during competition and adopted process-oriented methods, such as the think-aloud protocol (Calmeiro et al., 2010, 2014; Nicholls & Polman, 2008), or the diary study (Gaudreau et al., 2010; Nicholls, Holt, Polman, & James, 2005). Doron and Gaudreau (2014) used a process-oriented method and measured each construct (i.e., perceived control, negative emotions, and task-oriented coping) as experienced between points in simulated competitive matches performed by elite fencers during training sessions. However, multiple assessments during a match potentially affect the ongoing psychological processes and performance of athletes. As such, it would seem ethically and methodologically challenging to assess these processes immediately after each point during a real high-

level competition. When real-time momentary assessment is not feasible, video recall appears a viable method to improve retrospective recall validity, because it increases accessibility to earlier emotional experiences (Evans, Hoar, Gebotys, & Marchesin, 2014; Lorber, 2007; Martinent, Campo, & Ferrand, 2012). In line with this, Doron and Martinent (2015) used the video recall method to explore the trajectories and within-person synergies of perceived control, threat and challenge appraisals, problem- and emotion-focused coping, and positive and negative emotions during the final stages of fencing matches. While this study provided insights into transactional processes as they occur in match endings and highlights the dynamic nature of these constructs associated with winning and losing matches, disengagement-oriented coping and objective performance indicators were omitted in the measurement scheme. Despite the promising results, further information is needed to provide deeper understanding of the inherent relationship between the constructs central to the CMRT of emotion, as they are experienced by athletes in matches, and their link with performance during high-level competitions.

Grounded in Lazarus's (1991, 1999, 2000) CMRT of emotion, this study used the video recall method to track longitudinally the relationships among cognitive appraisals, coping strategies, emotions and performance over the course of an international fencing match. The aims of this study were: (a) to determine the relationships between cognitive appraisal (challenge and threat), coping strategies (task- and disengagement-oriented coping), emotions (positive and negative) and objective performance; (b) to ascertain whether the relationship between appraisal and emotion was mediated by coping; and (c)

to ascertain whether the relationship between appraisal and objective performance was mediated by emotion and coping.

Based on previous studies that have explored the key constructs of the CMRT of emotion as a conceptual unit (Doron & Gaudreau, 2014; Doron & Martinent, 2015; Nicholls et al., 2012, 2014), we hypothesized that perceived challenge (threat) would be positively (negatively) associated with task-oriented coping, positive emotions, and performance, as well as negatively (positively) associated with disengagement-oriented coping and negative emotions. We also hypothesized that task-oriented coping would be positively associated with positive emotions and performance, whereas disengagement-oriented coping would be positively associated with negative emotions and negatively associated with performance (Doron & Gaudreau, 2014; Doron & Martinent, 2015; Gaudreau et al., 2002; Nicholls et al., 2012, 2014). Finally, based on the assertions of Lazarus (1999, 2000), we hypothesized that disengagement-oriented coping would mediate the relationship between threat and negative emotions, whereas task-oriented coping would mediate the relationship between challenge and positive emotions. We, also, hypothesized that disengagement-oriented coping and negative emotions would mediate the relationship between threat appraisal and performance, whereas task-oriented coping and positive emotions would mediate the relationship between challenge appraisal and performance.

Method

Participants

Nine elite foil fencers (8 male, 1 female) aged between 21 and 33 (M = 26.44 ± 3.94 years) participated in this study. The sample represented national fencing (foil)

teams from France (n = 6), Egypt (n = 1) and Tunisia (n = 2) that were competing in the qualification phase of the Rio Olympic Games. At the time of the study (i.e., 2015), all the athletes trained in France and were French-speaking. All the athletes had competed at international level (M = 11.78 ± .52 years) and taken part in several major international championships including the World Cup, World Championships and the Olympic Games. All the fencers signed a consent form prior to participating in this study. The protocol was also approved by the National Fencing Federation's ethical committee.

Procedure and Measures

Based on Doron and Martinent's (2015) study, a video methodology was adopted in order to retrospectively ask participants to recall their psychological states after each point during a fencing match in high-level competition. The videos were recorded during the Fencing World Cup 2014-2015 season and at the beginning of the qualification phase of the 2016 Olympic Games in Rio. Given the potential stress associated with the first match of the direct elimination round, only matches from the round of 64[1] were recorded and retained for video analysis[2]. The fencers who qualified in direct elimination table of 64 fencers took part in the video-analysis within 48 hours of each tournament. In total, 14 matches were analysed (6 won, 8 lost; 1 or 2 matches for each athlete). In all, 619 momentary assessments[3] were obtained (M = 44.21 ± 8.83 per participant).

[1] World Cup competitions are governed by the FIE rules for competitions. World Cups are organised according to a mixed system consisting of one round of pools and a preliminary direct elimination table, followed by a main direct elimination table of 64 fencers.

[2] The stress thermometer (Kowalski & Crocker, 2001) was used to assess how much stress athletes had experienced during their match. It consists of a one-item scale ranging from 0 "not at all stressful" to 10 "extremely stressful". Results provided evidence about stress perceptions associated with the matches (M = 7.29 ± 1.68).

[3] The number of momentary assessments varies according to the score of the match. You win a match by being first to score 15 touches.

Firstly, the research assistant issued instructions verbally and handed each athlete a document summing up the purpose of the study, the procedure-related instructions, and the measures. Participants read the measures and could ask the research assistant questions to clarify the meaning of words and expressions used to define/measure the psychological processes. A single-item definitional approach (Ptacek, Smith, Espe, & Raffety, 1994; Raffety, Smith, & Ptacek, 1997) was used to measure the psychological processes. In the definitional approach, which has been used in other studies on coping (e.g., Doron & Gaudreau, 2014; Doron & Martinent, 2015; Ptacek et al., 1994; Raffety et al., 1997; Smith & Christensen, 1995), the key conceptual features of a construct are summarized into a brief paragraph on which participants are asked to provide a single rating. Previous research has demonstrated the convergent validity of definitional measures of coping and shown the usefulness of this approach for collecting data in longitudinal intensive designs (Ptacek et al., 1994). In this study, each definitional item was created using definitions used in previous studies (e.g., Doron & Gaudreau, 2014; Doron & Martinent, 2015; see Table 1).

Secondly, athletes learned how to apply the scales measuring the psychological processes using the Dartfish© tagging panel. Thirdly, they watched their match. Between each of the points, they had to assess and assign a score individually to threat and challenge appraisals, task-oriented and disengagement-oriented coping, and positive and negative emotions. They input their score[4] immediately after each point using the Dartfish© tagging panel. Thus, data were obtained using multiple assessments of

[4]Score range was: losing point (1), losing off-target (2), simultaneous (3), winning off-target (4), winning point (5)

psychological processes, rated on a six-point Likert scale, ranging from 0 (*not at all*) to 5 (*very much*), immediately after each point and over the entire match.

Data analysis

To investigate the relationships between the study variables – cognitive appraisal (threat and challenge), coping (disengagement- and task-oriented), emotions (positive and negative) and performance – a Hierarchical Linear Modelling approach (HLM; Bryk & Raudenbush, 1992) was used in the present study. All analyses were conducted using the R package labelled lme4 (Bates, Maechler, Bolker, & Walker, 2014). Since time-series data violate the assumption that residual effects are independent, level-1 models were developed that accounted for the residual autocorrelation in the data (Fullagar, Knight, & Sovern, 2013). Group mean centering was used for all (level 1) predictors based on the rationale that grand-mean centering or no centering may produce biased point estimates of the mediation effect (Zhang, Zyphur, & Preacher, 2009). To examine within-individual (level-1) relationships between the study variables, a series of HLM was performed in which: (a) appraisal, coping, and emotions were separately regressed onto performance; (b) appraisal and coping were separately regressed onto emotions; and (c) appraisal was regressed onto coping. In order to further test our hypotheses and to ascertain more precisely the mediation effects between the study variables, a further series of HLM was performed, in which: (a) appraisal, coping, and emotions were simultaneously regressed onto performance; and (b) appraisal and coping were simultaneously regressed onto emotions. A series of Sobel tests (Sobel, 1982) was also used to test whether: (a) disengagement-oriented coping mediates the relationship between threat and negative emotions; (b) task-oriented coping mediates the relationship between challenge and

positive emotions; (c) disengagement-oriented coping and negative emotions mediate the relationship between threat appraisal and performance; and (d) task-oriented coping and positive emotions mediate the relationship between challenge appraisal and performance.

Results

Before proceeding to test the hypotheses, we analysed the systematic within- and between-individual variance in momentary study variables. The results of the null models (see Table 2) indicated that there was substantial within- and between-individual variance for all the variables (σ^2 ranged from .81 to 2.71; τ_{00} ranged from .05 to 1.03). The intraclass correlations (ICC = τ_{00} / (σ^2 + τ_{00})) for the study variables ranged from .02 to .53, indicating that between-individual variance accounts for 2 to 53% percent of the total variance in the study variables. This would suggest that between 47 and 98% of the overall variance (both systematic and error) is attributable to within-individual variation, suggesting that study variables vary considerably from situation to situation.

We then tested whether individuals' coping, emotion, and performance ratings were randomly distributed or serially dependent (Fullagar et al., 2013)[5]. Lagged parameters were found to be significant predictors of coping (task-oriented coping: γ_{10} = .29, $p < .001$; disengagement-oriented coping: γ_{10} = .33, $p < .001$) and emotion (negative emotions: γ_{10} = .42, $p < .001$; positive emotions: γ_{10} = .44, $p < .001$) but not of performance (γ_{10} = .02, $p > .05$) (see Table 3). Since time-series data violate the

[5] It is noteworthy that the random effect of the lagged parameter was included in the emotion models because the addition of this parameter provided a significant improvement to the model as indexed by the chi square tests ($\Delta \chi^2$ (2) = 54.73 and 21.28 for negative and positive emotions respectively, $p < .001$), whereas it was not included within the coping ($\Delta \chi^2$ (2) = 3.40 and 1.68 for task- and disengagement-oriented coping respectively, $p > .10$) and performance ($\Delta \chi^2$ (2) = 1.17, p > .10) models.

assumption that residual effects are independent, all subsequent models controlled for lagged effects.

In order to test the relationships between the study variables, we ran a series of random coefficient regression models controlling for lagged effects. The results of these analyses are presented in Tables 4, 5 and 6. When challenge and threat appraisals were simultaneously entered as predictors of coping, emotion and performance in the random coefficient regression models, the regression coefficients of challenge and threat were significantly different from zero (after controlling for lagged effects) for predicting task-oriented coping (β = .85 and -.32 for challenge and threat respectively, $p < .001$), disengagement-oriented coping (β = -.48 and .39, $p < .001$), negative emotions (β = -.29 and .34, $p < .001$), positive emotions (β = .64 for challenge, $p < .001$), and performance (β = .73 and -.42, $p < .001$). Hence, the direction of the regression coefficients supported Hypothesis 1.

When task-oriented and disengagement-oriented coping were simultaneously entered as predictors of emotion and performance in the random coefficient regression models, the results of the regression coefficients showed that: (a) task-oriented coping significantly predicted positive emotion (β = .37, $p < .001$) and performance (β = .56, $p < .001$); and (b) disengagement-oriented coping significantly predicted negative emotion (β = .38, $p < .001$) and performance (β = -.44, $p < .001$). Thus, the direction of the regression coefficients supported Hypothesis 2.

In order to test the mediational effect of coping on the appraisal-emotion relationship, we computed two further random coefficient regression models, in which perceived challenge, perceived threat, and task-oriented and disengagement-oriented

coping were simultaneously entered as predictors of negative emotions and positive emotions (see Table 5). In addition to the aforementioned significant relationship between threat and disengagement-oriented coping (β = .39, p < .001), results also showed that the relationship between threat and negative emotions decreased from .34 (p < .001) to .23 (p < .001) when disengagement-oriented coping was entered additionally as a predictor of negative emotions (β = .29, p < .001). This suggests that disengagement-oriented coping partially mediated the relationship between threat and negative emotions (Sobel test = 2.99, p = .003). Similarly, in addition to the aforementioned significant relationship between challenge and task-oriented coping (β = .85, p < .001), results also showed that the relationship between challenge and positive emotions decreased from .64 (p < .001) to .32 (p < .001) when task-oriented coping was added as a predictor of positive emotions (β = .24, p < .01). This suggests that task-oriented coping partially mediated the relationship between challenge and positive emotions (Sobel test = 2.93, p = .003). In summary, the present results supported hypothesis 3.

In order to test the mediational effects of emotion and coping on the appraisal-performance relationship, we computed two further random coefficient regression models, in which: (a) perceived challenge, perceived threat, and task-oriented and disengagement-oriented coping were simultaneously entered as predictors of performance; and (b) perceived challenge, perceived threat, and positive and negative emotions were simultaneously entered as predictors of performance (see Table 6). In addition to the aforementioned significant relationships between threat and disengagement-oriented coping (β = .39, p < .001), results moreover showed that the relationship between threat and performance decreased from -.42 (p < .001) to -.09 (p >

.05) when disengagement-oriented coping was also entered as a predictor of performance (β = -.39, p < .001), suggesting that disengagement-oriented coping mediated the relationship between threat and performance (Sobel test = -3.24, p = .001). In contrast, results of the random coefficient regression models controlling for lagged effects showed that when negative emotions and threat appraisal were simultaneously entered as predictors of performance, the effect of negative emotions on performance was non-significant (β = -.20, p > .05), suggesting that negative emotions did not mediate the relationship between threat appraisal and performance (Sobel test = -1.39, p = .17).

Further to the aforementioned significant relationships between challenge and task-oriented coping (β = .85, p < .001), results also showed that the relationship between challenge and performance decreased from .73 (p < .001) to .25 (p < .05) when task-oriented coping was added as a predictor of performance (β = .45, p < .001). This suggests that task-oriented coping partially mediated the relationship between challenge and performance (Sobel test = 3.99, p < .001). Similarly, in addition to the aforementioned significant relationships between challenge and positive emotions (β = .64, p < .001), results showed that the relationship between challenge and performance decreased from .73 (p < .001) to .52 (p < .001) when positive emotions were also entered as a predictor of performance (β = .36, p < .001), suggesting that positive emotions partially mediated the relationship between challenge and performance (Sobel test = 2.33, p = .02). Overall, results of the random coefficient regression models controlling for lagged effects partially supported hypothesis 4.

Discussion

Grounded in Lazarus's (1991, 1999, 2000) CMRT of emotion, the current research set out to gain insight into the relationship between the constructs central to the CMRT of emotion and performance over the course of an international fencing match. Specifically, this study aimed to determine the relationships between cognitive appraisal, coping, emotion and objective performance within a match during real high-level competition.

Firstly, the results showed a positive relationship between challenge appraisal, task-oriented coping, positive emotions, and performance, as well as for threat appraisal, disengagement-oriented coping and negative emotions. Conversely, challenge appraisal, disengagement-oriented coping and negative emotions were negatively correlated, as were threat appraisal, task-oriented coping and performance. Using a different methodological approach, our results were similar to those observed in Nicholls et al. (2012, 2014), with the exception that they took into account objective performance and the recursive nature of these constructs. The patterns of results highlighted distinct positive and negative dynamic relationships between these constructs and their link with objective performance during high-level competitions. The relationship between these constructs as they are experienced by athletes in matches seems important for the objective performance (Doron & Gaudreau, 2014; Doron & Martinent, 2015). Overall, these constructs, as a conceptual unit, can be seen to reflect self-regulatory processes that provide an individual with the capacity to modulate thoughts, emotions, and behaviours over time and across changing environments (e.g., Compas et al., 2001). Specifically, through challenge appraisals, pleasant emotions and task-oriented coping strategies, athletes may have a broader attention on the task at hand which may result in more

flexible and creative thinking (Fredrickson, 2001). Greater flexibility and creativity, according to Fredrickson (2001), should result in more effective coping. As such, the transient allocation of self-regulatory resources toward or away from the task at hand seemed respectively to facilitate or hinder a person's level of achievement in a specific performance situation, here a fencing world cup match (Gaudreau et al., 2010). As such, it appears that athletes who perform better may be more efficient self-regulators (e.g., Kitsantas & Zimmerman, 2002).

In addition, the findings provided a more detailed analysis of the relationship between the psychological constructs and performance in a specific sport performance situation. Results showed that athletes' task-oriented coping strategies act as a partial mediator of relationships between challenge appraisal and positive emotions, whereas disengagement-oriented coping strategies act as a partial mediator of relationships between threat appraisal and negative emotions. This study extended the work of Nicholls et al. (2012; 2014) by examining the mediating role of coping. Although, Nicholls et al. (2014) provided support for the mediating role of emotion in the relationship between appraisal and coping, our results found also support for the mediating role of coping (Lazarus, 1999, 2000). As such, coping strategies may influence the emotions a fencer experiences during match and may mediate the relationship between appraisal and the subsequent level of emotional states (Lazarus, 1999, 2000). Challenge and threat relational meanings generated respectively positive or negative emotions through the ways of coping in specific sport performance situations (international matches). Specifically, challenge appraisal and task-oriented coping appear to be linked to better

emotional adjustment during a competitive event (Gaudreau & Blondin, 2004; Nicholls et al., 2010).

Furthermore, this study also aimed to ascertain whether the relationship between appraisal and objective performance was mediated by emotion and coping. The results showed that disengagement-oriented coping mediated the relationship between threat and performance, whereas task-oriented coping and positive emotions (partially) mediated the relationship between challenge and performance. While the relationships between subjective sporting performance and cognitive appraisal, coping, and emotion have been explored previously (e.g., Nicholls et al. 2012), our results provided a deeper understanding of the overall sequence of the constructs central to the CMRT of emotion and their links with performance over the course of an international fencing match. Because Nicholls et al. (2012, 2014) did not explore the mediating effects of coping and emotions, these authors may have missed some key relationships, which were identified in the present study. In accordance with previous research (e.g., Calmeiro et al., 2010, 2014; Doron & Gaudreau, 2014; Doron & Martinent, 2015; Gaudreau et al., 2010; Haney & Long, 1995; Nicholls et al., 2010, 2012; Smith & Christensen, 1995), the present study also supported the notion that task-oriented coping is associated with more effective coping than are disengagement-oriented strategies regarding performance. In addition, positive emotions seem to facilitate adaptive coping by counteracting the effects of negative emotions (Fredrickson & Branigan, 2005). In line with Lazarus's (1991, 1999, 2000) recommendations, our findings indicated that stress, coping, and emotion are inter-related psychological constructs that should not be examined in isolation when exploring the way elite athletes perform and cope with the various demands of sport performance

situations. The ways these constructs are inter-related influence objective performance within competitive settings.

A limitation of this paper related to the exclusion of stress appraisals of harm and benefit, and distraction-oriented coping strategies. Future research should expand the definitional approach by including the four stress appraisals and distraction-oriented coping in order to more reflect the key psychological constructs of the CMRT of emotion. In addition, the use of a delayed retrospective video recall method might lead to a potential memory bias in the point-by-point measures of psychological constructs (Stone et al., 1998). The athletes have potentially confounded psychological constructs elicited by reviewing the match and psychological constructs experienced at the time of the competition. Immediate retrospective recall could potentially reduce this bias (Evans et al., 2014). Although Lazarus (2000) advocated the implementation of process-oriented methods, a weakness of this study is that the participant sample was small. Samples of elite athletes are inherently homogeneous, thus limiting the generalizability of findings. Nevertheless, the present research replicated Doron and Martinent's (2015) study design using another sample group (i.e., foil fencers) and added information about the relationship between psychological states and performance over the course of a match. Moreover, as Nicholls et al. (2012) suggested, experimental research could in future be used to provide clear evidence for the causality between appraisal, emotion, coping, and performance.

Perspectives

Through the implementation of an original process-oriented method and statistical approach, this study provided additional support for Lazarus's (1991, 1999, 2000) contention that the key constructs of the CMRT of emotion are intertwined in a dynamic

relationship and form a conceptual unit within competitive sport settings. This study also helped to increase researches' interest in examining the micro-analytical aspects of transactional processes during sport performance situations and their links with performance (e.g., Calmeiro et al., 2010, 2014; Doron & Gaudreau, 2014; Doron & Martinent, 2015; Evans et al., 2014; Gaudreau et al., 2010). It is important from both theoretical and applied perspectives that researchers and practitioners have a greater understanding of the overall experience of athletes in stressful competitions, in order to develop theory-guided interventions (Nicholls et al., 2010). As such, "video-mediated recall may be used qualitatively in applied interventions designed to establish athletes' awareness of cognitive, emotional and behavioural processes" (Evans et al., 2014, p. 374). Sport psychologists may wish to teach athletes to (re)appraise the ongoing match as series of challenges for which they can then develop effective coping strategies.

References

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2014). *lme4: Linear mixed-effects models using Eigen and S4*. R package version 1.0-6. http://CRAN.R-project.org/package=lme4

Bryk, A.S., & Raudenbush, S.W. (1992). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.

Calmeiro, L., Tenenbaum, G., & Eccles, D. (2010). Event sequence analysis of appraisals and coping during trapshooting performance. *Journal of Applied Sport Psychology*, *22*, 392-407. doi: 10.1080/10413200.2010.495325

Calmeiro, L., Tenenbaum, G., & Eccles, D. (2014). Managing pressure: patterns of appraisals and coping strategies of non-elite and elite athletes during competition, *Journal of Sports Sciences*, *32*, 1813-1820. doi: 10.1080/02640414.2014.922692

Compas, B. E., Connor-Smith, J. K., Saltzman, H., Thomsen, A. H., & Wadsworth, M. E. (2001). Coping with stress during childhood and adolescence: Problems, progress, and potential in theory and research. *Psychological Bulletin*, *127*(1), 87-127. doi: 10.1037/0033-2909.127.1.87

Doron, J., & Gaudreau, P. (2014). A point by point analysis of performance in a fencing match: psychological processes associated with winning and losing streaks. *Journal of Sport & Exercise Psychology*, *36*, 3-13. doi: 10.1123/jsep.2013-0043

Doron, J., & Martinent, G. (2015). Trajectories of psychological states of women elite fencers during the final stages of international matches. *Journal of sports sciences*, 1-7. doi: 10.1080/02640414.2015.1075056

Evans, M. B., Hoar, S. D., Gebotys, R. J., & Marchesin, C. A. (2014). Endurance athletes' coping function use during competitive suffering episodes. *European Journal of Sport Science, 14,* 368-375. doi: 10.1080/17461391.2013.832803

Folkman, S. (1997). Positive psychological states and coping with severe stress. *Social Science and Medicine, 45,* 1207-1221. doi: 10.1016/S0277-9536(97)00040-3

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56,* 218-226. doi:10.1037/0003-066X.56.3.218

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion, 19,* 313-332. doi:10.1080/02699930441000238

Fullagar, C. J., Knight, P. A., & Sovern, H. S. (2013). Challenge/skill balance, flow, and performance anxiety. *Applied Psychology: An International Review,* 62, 236-259. doi: 10.1111/j.1464-0597.2012.00494.x

Gaudreau, P., & Blondin, J. P. (2004). Different athletes cope differently during a sport competition: A cluster analysis of coping. *Personality and Individual Differences, 36,* 1865-1877. doi: 10.1016/j.paid.2003.08.017

Gaudreau, P., & Blondin, J-P. (2002). Development of a questionnaire for the assessment of coping strategies employed by athletes in competitive sport settings. *Psychology of Sport and Exercise, 3,* 1-34. doi: 10.1016/S1469-0292(01)00017-6

Gaudreau, P., Blondin, J. P., & Lapierre, A. M. (2002). Athletes' coping during a competition: Relationship of coping strategies with positive affect, negative affect,

and performance-goal discrepancy. *Psychology of Sport and Exercise*, *3*, 125-150. doi: 10.1016/S1469-0292(01)00015-2

Gaudreau, P., Nicholls, A., & Levy, A. R. (2010). The ups and downs of coping and sport achievement: An episodic process analysis of within-person associations. *Journal of Sport & Exercise Psychology*, *32*, 298-311.

Haney, C. J., & Long, B. C. (1995). Coping effectiveness: a path analysis of self-efficacy, control, coping, and performance in sport competitions. *Journal of Applied Social Psychology*, *25*, 1726-1746. doi: 10.1111/j.1559-1816.1995.tb01815.x

Kitsantas, A., & Zimmerman, B. J. (2002). Comparing self-regulatory processes among novice, non-expert, and expert volleyball players: A microanalytic study. *Journal of Applied Sport Psychology, 14*, 91-105. doi: 10.1080/10413200252907761

Kowalski, K. C., & Crocker, P. R. (2001). Development and validation of the Coping Function Questionnaire for adolescents in sport. *Journal of Sport & Exercise Psychology*, *23*, 136-155.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Lazarus, R. S. (1999). *Stress and emotion: A new synthesis*. London: Free Association Books.

Lazarus, R. S. (2000). How emotions influence performance in competitive sports. *The Sport Psychologist*, *14*, 229-252.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York, NY: Springer.

Lorber, M. F. (2007). Validity of video-mediated recall procedures for mothers' emotion and child ratings. *Journal of Family Psychology, 21*, 520-528. doi: 10.1037/0893-3200.21.3.520

Martinent, G., Campo, M., & Ferrand, C. (2012). A descriptive study of emotional process during competition: Nature, frequency, direction, duration and co-occurrence of discrete emotions. *Psychology of Sport and Exercise, 13*, 142-151. doi: 10.1016/j.psychsport.2011.10.006

Nicholls, A. R., & Polman, R. C. J. (2008). Think aloud: Acute stress and coping during golf performances. *Anxiety, Stress, and Coping*, 21, 283-294. doi: 10.1080/10615800701609207

Nicholls, A. R., Hemmings, B., & Clough, P. J. (2010). Stress appraisals, emotions, and coping among International adolescent golfers. *Scandinavian Journal of Medicine & Science in Sports*, *20*, 346-355. doi:10.1111/j.1600-0838.2009.00894.x

Nicholls, A. R., Perry, J. L, & Calmeiro, L. (2014). Pre-competitive Achievement goals, appraisal, emotions, and coping in sport. *Journal of Sport & Exercise Psychology*, *36*, 433-445. doi: http://dx.doi.org/10.1123/jsep.2013-0266

Nicholls, A. R., Holt, N. L., Polman, R. C. J., & James, D. W. G. (2005). Stress and coping among international adolescent golfers. *Journal of Applied Sport Psychology*, *17*, 333-340. doi: 10.1080/10413200500313644

Nicholls, A. R., Levy, A. R., Jones, L., Rengamani, M., & Polman, R. J. (2011). An exploration of the two-factor schematization of relation meaning and emotions among professional rugby union players. *International Journal of Sport and Exercise Psychology, 9*, 78-91. doi:10.1080/1612197X.2011.563128

Nicholls, A. R., Polman, R. C. J., & Levy, A. R. (2010). Coping self-efficacy, pre-competitive anxiety, and subjective performance among athletes. *European Journal of Sport Science, 10*, 97-102. doi: 10.1080/17461390903271592

Nicholls, A. R., Polman, R. C. J., & Levy, A. R. (2012). A path analysis of stress appraisal, emotion, coping and performance satisfaction among athletes. *Psychology of Sport and Exercise, 13*, 263-270. doi: 10.1016/j.psychsport.2011.12.003

Ptacek, J. T., Smith, R. E., Espe, K., & Raffety, B. (1994). Limited correspondence between daily coping reports and retrospective coping recall. *Psychological Assessment, 6*, 41-48. doi: 10.1037/1040-3590.6.1.41

Raffety, B. D., Smith, R. E., & Ptacek, J. T. (1997). Facilitating and debilitating trait anxiety, situational anxiety, and coping with an anticipated stressor: A process analysis. *Journal of Personality and Social Psychology, 72*, 892-906. doi: 10.1037/0022-3514.72.4.892Skinner, E. A., Edge, K., Altman, J., & Sherwood, H. (2003). Searching for the structure of coping: A review and critique of category systems for classifying ways of coping. *Psychological Bulletin, 129,* 216-269. doi: 10.1037/0033-2909.129.2.216

Smith, R. E., & Christensen, D. S. (1995). Psychological skills as predictors of performance and survival in professional baseball. *Journal of Sport & Exercise Psychology*, *17*, 399-415.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural models. In S. Leinhardt (ed.), *Sociological methodology* (pp. 290-312). San Francisco, CA: Jossey-Bass.

Stone, A. A., Schwartz, J. E., Neale, J. M., Shiffman, S., Marco, C., Hickcox, M., Paty, J., Porter, L. S., & Cruise,L. J. (1998). A comparison of coping assessed by ecological momentary analysis and retrospective recall. *Journal of Personality and Social Psychology*, *74*, 1670-1680. doi: 10.1037/0022-3514.74.6.1670

Zhang, Z., Zyphur, M. J., & Preacher, K. J. (2009). Testing multilevel mediation using hierarchical linear models: Problems and solutions. *Organizational Research Methods, 12*, 695-719. doi: 10.1177/1094428108327450

Table 1.

Definition of psychological processes

Threat appraisal	Appraisal of a potential for loss.
Challenge appraisal	Appraisal of an anticipated gain (difficult to attain).
Task-oriented coping	Task-oriented coping represents strategies aimed at dealing directly with a match situation or at solving a problem you are facing in a match. It includes efforts to concentrate, to seek information or advice from the training staff, to analyse the point, to manage your time in a point, to enhance your effort, to manage your goals, to identify solutions, to create and use a plan of action to make your actions more efficient, efforts to relax, reinterpret the situation in a positive way, seek social support to emotional reasoning, etc.
Disengagement-oriented coping	Disengagement-oriented coping represents the strategies through which a person withdraws from the process of actively striving toward the realization of desirable outcomes, including strategies such as mental and behavioural disengagement, denial, venting of unpleasant emotions, self-blame, blame of others, etc.
Positive Affects	Interested, excited, strong, enthusiastic, proud, alert, inspired, determined, attentive, active, etc.
Negative Affects	Distressed, annoyed, scared, guilty, nervous, afraid, anxious, etc.

Table 2.

Parameter Estimates and Variance Components of the Null models

Model equations	Fixed effects γ_{00} (SE)	Random effects σ^2 (SD)	τ_{00} (SD)	-2*log likelihood
$Challenge_{ij} = \beta_{0j} + r_{ij}$	3.18*** (.22)	.81 (.90)	.68 (.82)	1679.4
$Threat_{ij} = \beta_{0j} + r_{ij}$	1.83*** (.22)	.83 (.91)	.68 (.82)	1689.7
Task-oriented $coping_{ij} = \beta_{0j} + r_{ij}$	3.24*** (.19)	1.56 (1.25)	.47 (.68)	2064.4
Disengagement-oriented $coping_{ij} = \beta_{0j} + r_{ij}$	1.69*** (.20)	1.28 (1.13)	.52 (.72)	1950.9
Negative $emotion_{ij} = \beta_{0j} + r_{ij}$	2.12*** (.27)	1.37 (1.17)	1.03 (1.01)	1999.6
Positive $emotion_{ij} = \beta_{0j} + r_{ij}$	3.19*** (.23)	1.08 (1.04)	.74 (.86)	1850.3
Self-confidence for $touch_{ij} = \beta_{0j} + r_{ij}$	3.32*** (.22)	.57 (.75)	.65 (.81)	1462.4
Self-confidence for $match_{ij} = \beta_{0j} + r_{ij}$	3.17*** (.26)	.88 (.94)	.94 (.97)	1730.1
$Performance_{ij} = \beta_{0j} + r_{ij}$	3.08*** (.09)	2.71 (1.65)	.05 (.23)	2278.7
$\beta_{0j} = \gamma_{00} + U_{0j}$				

Note. SE = Standard errors; SD = Standard deviations; β_{0j} is the average level of psychological states for individuals; γ_{00} is the group mean of psychological state scores; $\sigma^2 = var(r_{ij})$ variance in level-1 residual (i.e. variance in r_{ij}); $\tau_{00} = var(U_{0j})$ variance in level-2 residual (i.e. variance in U_{0j}). * $p < .001$.

Table 3.

Parameter Estimates and Variance Components of the Serial Dependent Models

	Fixed effects		Random effects			-2*log likelihood
Model equations	γ_{00} (SE)	γ_{10} (SE)	σ^2 (SD)	τ_{00} (SD)	τ_{11} (SD)	
Task-oriented coping$_{ij}$ = β_{0j} + β_{1j} (Task-oriented coping$_{ij.t\text{-}1}$) + r_{ij}	3.24*** (.19)	.29*** (.04)	1.44 (1.20)	.47 (.69)	–	1976.0
Disengagement-oriented coping$_{ij}$ = β_{0j} + β_{1j} (Disengagement-oriented coping$_{ij.t\text{-}1}$) + r_{ij}	1.70*** (.20)	.33*** (.04)	1.15 (1.07)	.53 (.73)	–	1844.0
Negative emotion$_{ij}$ = β_{0j} + β_{1j} (Negative emotion$_{ij.t\text{-}1}$) + r_{ij}	2.14*** (.28)	.42*** (.08)	.92 (.96)	1.06 (1.02)	.08 (.28)	1730.2
Positive emotion$_{ij}$ = β_{0j} + β_{1j} (Positive emotion$_{ij.t\text{-}1}$) + r_{ij}	3.18*** (.24)	.44*** (.07)	.77 (.88)	.76 (.87)	.05 (.22)	1626.2
Performance$_{ij}$ = β_{0j} + β_{1j} (Performance$_{ij.t\text{-}1}$) + r_{ij}	3.08*** (.10)	.02 (.04)	2.70 (1.64)	.07 (.26)	–	2147.1
β_{0j} = γ_{00} + U_{0j} ; β_{1j} = γ_{10} + U_{1j} or γ_{10}						

Note. SE = Standard errors; SD = Standard deviations; β_{0j} is the average level of psychological states for individuals; γ_{00} = intercept of level-2 regression predicting β_{0j}; γ_{10} = intercept of level-2 regression predicting β_{1j}; $\sigma 2$ = var(r_{ij}) variance in level-1 residual (i.e. variance in r_{ij}); $\tau 00$ = var(U_{0j}) variance in level-2 residual (i.e. variance in U_{0j}). * $p < .05$ ** $p < .01$ *** $p < .001$.

Table 4.

Results for the Random-Coefficient Regression Models of Task- and Disengagement-oriented Coping Controlling for Lagged Effects

	Fixed effects				Random effects				-2*log likelihood
Model equations	γ_{00} (SE)	γ_{10} (SE)	γ_{20} (SE)	γ_{30} (SE)	σ^2 (SD)	τ_{00} (SD)	τ_{22} (SD)	τ_{33} (SD)	
Task-oriented coping$_{ij}$ = β_{0j} + β_{1j} (Task-oriented coping$_{ij.t-1}$) + β_{2j} (Challenge$_{ij}$) + β_{3j} (Threat$_{ij}$) + r_{ij}	3.24*** (.19)	.10*** (.03)	.85*** (.15)	-.32*** (.11)	.61 (.78)	.49 (.70)	.28 (.53)	.14 (.37)	1527.20
Disengagement-oriented coping$_{ij}$ = β_{0j} + β_{1j} (Disengagement-oriented coping$_{ij.t-1}$) + β_{2j} (Challenge$_{ij}$) + β_{3j} (Threat$_{ij}$) + r_{ij}	1.69*** (.20)	.11*** (.03)	-.48*** (.07)	.39*** (.09)	.61 (.78)	.53 (.72)	.04 (.21)	.08 (.28)	1504.6
$\beta_{0j} = \gamma_{00} + U_{0j}$; $\beta_{1j} = \gamma_{10}$; $\beta_{2j} = \gamma_{20} + U_{2j}$; $\beta_{3j} = \gamma_{30} + U_{3j}$									

Note. SE = Standard errors; SD = Standard deviations; γ_{00} = intercept of level-2 regression predicting β_{0j}; γ_{10}, γ_{20} and γ_{30} = intercept of level-2 regression predicting β_{1j}, β_{2j} and β_{3j}; σ^2 = var(r_{ij}) variance in level-1 residual (i.e. variance in r_{ij}); τ_{00} = var(U_{0j}) variance in level-2 residual (i.e. variance in U_{0j}); τ_{22} and τ_{33} = variance in level-2 residual for models predicting β_{2j} and β_{3j} (i.e. variance in U_{2j} and U_{3j}). * $p < .05$ ** $p < .01$ *** $p < .001$.

Table 5.

Results for the Random-Coefficient Regression Models of Positive and Negative Emotion Controlling for Lagged Effects

	Fixed effects						Random effects						-2*log likelihood
Model equations	γ_{00} (SE)	γ_{10} (SE)	γ_{20} (SE)	γ_{30} (SE)	γ_{40} (SE)	γ_{50} (SE)	σ^2 (SD)	τ_{00} (SD)	τ_{11} (SD)	τ_{22} (SD)	τ_{33} (SD)	τ_{44} (SD)	τ_{55} (SD)	
Negative emotion$_{ij}$ = β_{0j} + β_{1j} (Negative emotion$_{ij.t-1}$) + β_{2j} (Challenge$_{ij}$) + β_{3j} (Threat$_{ij}$) + r_{ij}	2.13*** (.28)	.30*** (.08)	-.29*** (.06)	.34*** (.06)	–	–	.72 (.85)	1.06 (1.03)	.07 (.26)	.02 (.16)	.03 (.16)	–	–	1607.0
Negative emotion$_{ij}$ = β_{0j} + β_{1j} (Negative emotion$_{ij.t-1}$) + β_{2j} (Task-oriented coping$_{ij}$) + β_{3j} (Disengagement-oriented coping$_{ij}$) + r_{ij}	2.13*** (.28)	.34*** (.08)	-.06 (.04)	.38*** (.07)	–	–	.69 (.83)	1.06 (1.03)	.07 (.27)	.00 (.06)	.05 (.22)	–	–	1574.2
Negative emotion$_{ij}$ = β_{0j} + β_{1j} (Negative emotion$_{ij.t-1}$) + β_{2j} (Challenge$_{ij}$) + β_{3j} (Threat$_{ij}$) +β_{4j} (Task-oriented coping$_{ij}$) + β_{5j} (Disengagement-oriented coping$_{ij}$) + r_{ij}	2.13*** (.28)	.30*** (.08)	-.12¥ (.06)	.23*** (.05)	.00 (.05)	.29*** (.07)	.65 (.80)	1.06 (1.03)	.07 (.26)	.01 (.11)	.01 (.10)	.01 (.09)	.04 (.20)	1543.9
Positive emotion$_{ij}$ = β_{0j} + β_{1j} (Positive emotion$_{ij.t-1}$) + β_{2j} (Challenge$_{ij}$) + β_{3j} (Threat$_{ij}$) + r_{ij}	3.19*** (.23)	.26*** (.05)	.64** (.21)	-.15 (.10)	–	–	.44 (.67)	.76 (.87)	.02 (.14)	.59 (.77)	.12 (.34)	–	–	1349.7

Positive emotion$_{ij}$ = β_{0j} + β_{1j} (Positive emotion$_{ij.t-1}$) + β_{2j} (Task-oriented coping$_{ij}$) + β_{3j} (Disengagement-oriented coping$_{ij}$) + r_{ij}	3.19*** (.24)	.40*** (.06)	.37*** (.07)	-.11 (.08)	–	–	.46 (.68)	.76 (.87)	.03 (.18)	.06 (.24)	.06 (.25)	–	–	1359.5
Positive emotion$_{ij}$ = β_{0j} + β_{1j} (Positive emotion$_{ij.t-1}$) + β_{2j} (Challenge$_{ij}$) + β_{3j} (Threat$_{ij}$) +β_{4j} (Task-oriented coping$_{ij}$) + β_{5j} (Emotion-oriented coping$_{ij}$) + r_{ij}	3.19*** (.23)	.27*** (.04)	.32*** (.10)	-.05 (.04)	.24** (.07)	-.03 (.06)	.39 (.63)	.76 (.87)	.01 (.11)	.09 (.30)	.01 (.08)	.06 (.24)	.04 (.19)	1281.3
$\beta_{0j} = \gamma_{00} + U_{0j}$; $\beta_{1j} = \gamma_{10} + U_{1j}$; $\beta_{2j} = \gamma_{20} + U_{2j}$; $\beta_{3j} = \gamma_{30} + U_{3j}$; $\beta_{4j} = \gamma_{40} + U_{4j}$; $\beta_{5j} = \gamma_{50} + U_{5j}$														

Note. SE = Standard errors; SD = Standard deviations; γ_{00} = intercept of level-2 regression predicting β_{0j}; γ_{10}, γ_{20}, γ_{30}, γ_{40} and γ_{50} = intercept of level-2 regression predicting β_{1j}, β_{2j}, β_{3j}, β_{4j} and β_{5j}; σ^2 = var(r_{ij}) variance in level-1 residual (i.e. variance in r_{ij}); τ_{00} = var(U_{0j}) variance in level-2 residual (i.e. variance in U_{0j}); τ_{11}, τ_{22}, τ_{33}, τ_{44} and τ_{55}= variance in level-2 residual for models predicting β_{1j}, β_{2j}, β_{3j}, β_{4j} and β_{5j} (i.e. variance in U_{1j}, U_{2j}, U_{3j}, U_{4j} and U_{5j}). * $p < .05$ ** $p < .01$ *** $p < .001$.

Table 6.

Results for the Random-Coefficient Regression Models of Performance Controlling for Lagged Effects

	Fixed effects								Random effects								-2*log likelihood
Model equations	γ_{00} (SE)	γ_{10} (SE)	γ_{20} (SE)	γ_{30} (SE)	γ_{40} (SE)	γ_{50} (SE)	γ_{60} (SE)	γ_{70} (SE)	σ^2 (SD)	τ_{00} (SD)	τ_{22} (SD)	τ_{33} (SD)	τ_{44} (SD)	τ_{55} (SD)	τ_{66} (SD)	τ_{77} (SD)	
$Performance_{ij} = \beta_{0j} + \beta_{1j}$ ($Performance_{ij.t-1}$) + β_{2j} ($Challenge_{ij}$) + β_{3j} ($Threat_{ij}$) + r_{ij}	3.08*** (.09)	-.08* (.04)	.73*** (.14)	-.42*** (.09)	–	–	–	–	1.81 (1.34)	.08 (.28)	.16 (.40)	.03 (.16)	–	–	–	–	1941.8
$Performance_{ij} = \beta_{0j} + \beta_{1j}$ ($Performance_{ij.t-1}$) + β_{2j} (Task-oriented $coping_{ij}$) + β_{3j} (Disengagement-oriented $coping_{ij}$) + r_{ij}	3.08*** (.10)	-.08* (.03)	.56*** (.06)	-.44*** (.08)	–	–	–	–	1.60 (1.27)	.08 (.29)	.00 (.05)	.04 (.21)	–	–	–	–	1873.4
$Performance_{ij} = \beta_{0j} + \beta_{1j}$ ($Performance_{ij.t-1}$) + β_{2j} (Negative $emotion_{ij}$) + β_{3j} (Positive $emotion_{ij}$) + r_{ij}	3.09*** (.09)	-.07 (.04)	-.32* (.15)	.65*** (.10)	–	–	–	–	1.88 (1.37)	.06 (.25)	.25 (.50)	.07 (.26)	–	–	–	–	1969.6
$Performance_{ij} = \beta_{0j} + \beta_{1j}$ ($Performance_{ij.t-1}$) + β_{2j} ($Challenge_{ij}$) + β_{3j} ($Threat_{ij}$) + β_{4j} (Task-oriented $coping_{ij}$) + β_{5j} (Disengagement-oriented $coping_{ij}$)	3.08*** (.09)	-.09** (.03)	.25* (.11)	-.09 (.09)	.45*** (.08)	-.39*** (.08)	–	–	1.55 (1.24)	.07 (.27)	.07 (.27)	.05 (.22)	.02 (.16)	.01 (.12)	–	–	1858.8

$+r_{ij}$																	
$Performance_{ij} = \beta_{0j} + \beta_{1j}$ $(Performance_{ij.t-1}) + \beta_{2j}$ $(Challenge_{ij}) + \beta_{3j}$ $(Threat_{ij}) + \beta_{4j}$ $(Negative\ emotion_{ij}) + \beta_{5j}$ $(Positive\ emotion_{ij}) + r_{ij}$	3.09*** (.09)	-.10** (.03)	.52*** (.14)	-.29** (.09)	-.20 (.14)	.36*** (.10)	–	–	1.53 (1.24)	.07 (.27)	.14 (.38)	.03 (.16)	.23 (.48)	.04 (.20)	–	–	1873.2
$Performance_{ij} = \beta_{0j} + \beta_{1j}$ $(Performance_{ij.t-1}) + \beta_{2j}$ $(Challenge_{ij}) + \beta_{3j}$ $(Threat_{ij}) + \beta_{4j}$ $(Task\text{-}oriented\ coping_{ij}) + \beta_{5j}$ $(Disengagement\text{-}oriented\ coping_{ij}) + \beta_{6j}$ $(Negative\ emotion_{ij}) + \beta_{7j}$ $(Positive\ emotion_{ij}) + r_{ij}$	3.08*** (.09)	-.10** (.03)	.18 (.14)	-.09 (.09)	.35*** (.08)	-.30*** (.07)	-.15 (.14)	.28*** (.08)	1.33 (1.15)	.08 (.29)	.14 (.38)	.03 (.17)	.03 (.17)	.01 (.11)	.21 (.46)	.01 (.11)	1801.3
$\beta_{0j} = \gamma_{00} + U_{0j}$; $\beta_{1j} = \gamma_{10}$; $\beta_{2j} = \gamma_{20} + U_{2j}$; $\beta_{3j} = \gamma_{30} + U_{3j}$; $\beta_{4j} = \gamma_{40} + U_{4j}$; $\beta_{5j} = \gamma_{50} + U_{5j}$; $\beta_{6j} = \gamma_{60} + U_{6j}$; $\beta_{7j} = \gamma_{70} + U_{7j}$																	

Note. SE = Standard errors; SD = Standard deviations; γ_{00} = intercept of level-2 regression predicting β_{0j}; γ_{10}, γ_{20}, γ_{30}, γ_{40}, γ_{50}, γ_{60} and γ_{70} = intercept of level-2 regression predicting β_{1j}, β_{2j}, β_{3j}, β_{4j}, β_{5j}, β_{6j} and β_{7j}; σ^2 = var(r_{ij}) variance in level-1 residual (i.e. variance in r_{ij}); τ_{00} = var(U_{0j}) variance in level-2 residual (i.e. variance in U_{0j}); τ_{22}, τ_{33}, τ_{44}, τ_{55}, τ_{66} and τ_{77} = variance in level-2 residual for models predicting β_{2j}, β_{3j}, β_{4j}, β_{5j}, β_{6j} and β_{7j} (i.e. variance in U_{2j}, U_{3j}, U_{4j}, U_{5j}, U_{6j} and U_{7j}). * $p < .05$ ** $p < .01$ *** $p < .001$.