Sports Specific Metacognitions:

Associations with Flow State in Triathletes

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Abstract

Objective: This study investigated the associations between triathletes' sports-specific metacognitive beliefs (i.e., the Metacognitive Beliefs about Performances Questionnaire), metacognitive processes (i.e., the Metacognitive Processes during Performances Questionnaire) measured prior to a triathlon (*n* = 193), and in-event flow (i.e., the Short Flow State Scale) measured post event (*n* = 76). **Method:** The Metacognitive questionnaires were administered to participating triathletes one day prior to the event, and the flow scale was administered just following the event. Bivariate correlations were used to test relationships with individual flow dimensions, while stepwise regressions were used to determine the strongest metacognitive predictors of meta processes and flow. **Results:** Correlations indicated that metacognitive beliefs were negatively associated with various specific dimensions of flow (Cohen's f^2 = .28), while metacognitive processes positively associated with flow dimensions (Cohen's f^2 = .49). Stepwise regressions revealed that specific metacognitive beliefs were negatively associated with metacognitive processes during competition (Cohen's f^2 = .08 to .49), including the coordination, evaluation and control of cognition. Further stepwise regressions demonstrated that negative beliefs about competitive thinking, thought control, and cognitive coordination predicted experience of flow during competition. **Conclusions:** Overall, this study demonstrated that sports specific metacognitive beliefs and processes may influence the regulation of flow during a competition, however, further research using longitudinal and qualitative methodologies is required to understand the relationships on a deeper level.

Keywords: Metacognitive beliefs, Metacognitive processes, Flow State, Triathletes, Self-Regulation.

Sports Specific Metacognitions: Associations with Flow State in Athletes

The prospect of flow state in sports performance has long been a topic of investigation by psychological researchers for its theoretical potential to enhance athletes' performances and experiences during competition. Flow is a state of optimal being because it allows athletes to completely absorb into an activity and therefore enable attentional resources to completely engage in a task (Csikszentmihalyi, 2002). According to Csikszentmihalyi (1997), athletes have commonly endorsed nine psychological factors during flow: challenge-skill balance; clear goals; focused concentration; action-awareness merging; sense of control; loss of self-consciousness; unambiguous feedback; intrinsically rewarding experiences; and the transformation of time.

In attempts to better understanding the occurrence of flow, researchers have identified several relevant cognitive factors that have shown to be associated with flow, including: goals; focus; arousal; motivation; confidence; thoughts; and emotions (Chavez, 2008; Jackson, 1992, 1995; Jackson, Ford, Kimiecik, & Marsh, 1998; Stein, Kimiecik, Daniels, & Jackson, 1995; Sugiyama & Inomata, 2005; Young, 2000). However, Swann, Keegan, Piggott, and Crust's (2011) systematic review highlighted the difficulties in standardising flow studies in stressful situations such as competition, because some dimensions of flow are considered to be more easily experienced than others, and that different tasks require different resources. As such, Swann et al. (2011) concluded that flow is responsive to an interaction of internal states, external factors (e.g., environmental and situational conditions), and behavioural factors (e.g., preparation). Although, attentional focus and positive feedback have also been consistent throughout studies as positive facilitators of flow, before and during its occurrence (Swann et al., 2011).

With such variations in the occurrence of flow, it is questionable as to whether viewing flow as a single state benefits the research and sports performance community, or whether its collection of ‘sub-category’ processes and experiences are better approaches. Swann et al. (2011) explained that to better understand flow, future research should redirect focus from trying to define the concept of flow, but rather seek to explain the processes involved with it. Nakumura and Csikszenmihalyi (2014) align with this suggestion, in that directing and regulating attention is vital to flow encapsulation, as experiences are shaped by what occupies attention. Nakumura and Csikszenmihalyi (2014) also hold high regard for flow state and the autotelic personality, which is defined by intrinsic curiosity, persistence, low self-centeredness, and considered ideal for effective task absorption. In addition, higher-order factors relating to self-concept (e.g., mind, body, and skill), self-regulatory skills (i.e., imagery use, goal setting, activation, relaxation, self-talk, emotional control, and automaticity), and the perceived ability to enter flow state, have been found to be significantly associated with flow (Jackson, Thomas, Marsh, & Smethurst, 2001; Wilson & Moneta, 2016).

The concept of metacognition, which encapsulates both self-concept and regulatory components, has recently received attention surrounding associations with sporting performance and flow (see Love, Kannis-Dymand, & Lovell, 2018a, 2018b). Metacognition, refers to the content of cognition dedicated to regulating cognition, and is conceptualised from: a) metacognitive knowledge, referring to memory and beliefs about the nature and effects of cognition; and b) metacognitive regulation, which refers to the cognitive behaviours and processes used to regulate cognition, in accordance with an individual’s beliefs (Schraw & Moshman, 1995; Wells & Mathews, 2014). Metacognitive theory has since further developed to incorporate Wells and Mathews’ (1994;1996) *Self-Regulatory Executive Function* (S-REF) model. This model proposes that thinking is governed by three interacting levels of cognition: a) a stimulus operated lower-level network, which designates implicit processing to the environment, as it occurs; (b) a higher level of conscious processing, which appraises and regulates the lower-level network; and (c) a store of long-term meta-memory about the processes and outcomes of the higher-level.

Bringing the metacognitive framework to the domain of sports performance, Brick, MacIntyre, and Campbell (2014, 2015, 2016) performed research explaining two distinct processes, metacognitive skills and metacognitive experiences that athletes' experience and which are critical for controlling and coordinating cognitions. Metacognitive skills include planning before performances, monitoring thoughts during performances, and evaluating thoughts after performances. Metacognitive experiences encompass metacognitive feelings and judgements about performance-based thoughts and thinking strategies. Moran (2016) expands on the knowledge components of metacognition, explaining that effective regulation in sports is dependent on three further components: meta-memory, referring to knowledge on the memory system; meta-comprehension, referring to the understanding of the memory system; and meta-attention, being the most promising to concentration, is concerned with knowledge about the operation and control of the attentional system.

Hogan, Dwyer, Harney, Noone, and Conway (2015) explain that while the development of the metacognitive self-concept and executive function are fundamental to effective higher-order thinking skills and control over cognition, higher-order reflective judgement and critical thinking are developed alongside effortful self-regulation, such as mindfulness. Bishop et al. (2014) operationally defines mindfulness through two primary components: the self-regulation of attention (i.e. directing attention to thoughts and experiences) and a positive orientation towards experiences in the present moment (i.e. curiosity, openness and acceptance). Theoretically, this allows individuals to process information as new, rather than through biased schemas and regulation strategies (i.e., the cognitive attention syndrome; Hofman, Sawyer, Witt, & Oh, 2010).

Because of the similarities between mindfulness and flow, mindfulness has been heavily researched in the context of flow state. For example, high levels of awareness and a present-focused mindset are key psychological factors for experiencing flow, and such factors can be developed through the process of mindfulness (Jackson, 2012). However, research has also argued their differences, in that flow requires losing self-awareness while performing an activity, whereas mindfulness requires maintaining self-awareness. From this perspective, the states of flow and mindfulness would position these states to be difficult to experience simultaneously (Sheldon, Prentice, & Halusic, 2015). Sheldon et al. (2015) supported this in their study, revealing differences in daily goal behaviours, signal behaviours and task experiences, but only in the absorption aspect of flow, not in the sense of control. This indicates that metacognitive procedural knowledge may play a part in initiating attention regulation strategies, at different times. Nonetheless, several studies have shown support for the relationship between mindfulness and the experience of flow (see Bervoets, 2013; Cathcart, McGregor, & Groundwater, 2014; Kaufman, Glass, & Arnkoff, 2009; Scott-Hamilton, Schutte, Moyle, & Brown, 2016).

Two recent studies by Love et al. (2018a; 2018b) have investigated the role that pre-race generalised metacognitions may play in competing triathletes. Results from Love et al.'s (2018a) examination of associations between metacognitive beliefs, state anxiety dimensions (i.e., cognitive, somatic and confidence), and concentration revealed four key findings. It was found that: a) positive beliefs about worry were positively related to cognitive anxiety, but negatively related to confidence; b) negative beliefs about the uncontrollability and danger of worry was positively associated with cognitive and somatic anxiety; c) beliefs about the need for thought control were positively related to confidence; and d) concentration was negatively related to negative beliefs about worry and cognitive anxiety (Love et al., 2018a).

Love et al. (2018b) further investigated the relationships between pre-race generalised metacognitions and mindfulness facets with in-event flow in triathletes, reporting that metacognitions were significantly related to mindfulness facets. Specifically, Love et al. (2018b) found that: a) cognitive self-consciousness was positively related to observing thoughts, acting with awareness, describing thoughts, non-reactivity to thoughts, but negatively related to non-judgement of thoughts; b) positive beliefs about worry were negatively related to non-reactivity to thoughts; c) need for control beliefs were negatively related to non-judgement; d) lack of cognitive confidence was negatively related to acting with awareness and describing thoughts; and e) negative beliefs about worry were negatively associated to non-reactivity, acting with awareness, describing, and non-judgement of thoughts. Flow was found to be negatively associated with positive beliefs about worry, but positively associated with need to control, cognitive confidence, and only acting with awareness from the mindfulness factors.

Despite the useful findings and conclusions offered by Love et al. (2018a, 2018b), the metacognitive measures used were aimed at everyday life and not specifically directed towards competitive environments. This potentially represents an important limitation to the interpretation of Love et al.'s findings based on two major concerns. Firstly, a competitive endurance event is likely to exhibit increased threat responses in participants and activate heightened metacognitive reactions (Wells & Mathews, 1996). This was evident in findings by Love et al. (2018a), in that typically dysfunctional metacognitions (e.g., negative beliefs about worry) were higher in the triathletes closer to their event times. Therefore, the generalised metacognitions measured, as also used by previous studies, may not relate to competitive situations where metacognitions are potentially elevated. Secondly, the generalised questionnaires used do not measure beliefs about rumination and arousal, which have shown to be relative to attentional performance (Love, Kannis-Dymand, & Lovell, 2019).

Based on the limitations of previous research, the current study intended to investigate the associations between pre-race sports specific metacognitive beliefs and processes measured before a competition, with in-event flow measured post-competition. Specifically, three research aims were developed. Firstly, to investigate the associations between sports specific metacognitive beliefs and processes with flow state and its dimensions (i.e., challenge-skill balance, action/awareness merging, clear goals, unambiguous feedback, concentration on task, loss of self-consciousness, autotelic experience, transformation of time, and sense of control). Secondly, to assess relationships between sport specific metacognitive beliefs and sports specific metacognitive processes. Thirdly, to assess the relationships between metacognitive beliefs and processes with the subjective occurrence of flow during a triathlon. In comparison to the previous findings of Love et al., the results of this study should provide further insight towards the differences of generalised and sports specific metacognitive interactions in competitive environments, but also provide guidance for the sporting community as to the role that metacognitions play in controlling cognition and initiating flow state. This in turn could support the evidence-based design of intervention targeting dysfunctional thinking styles in athletes, and thus facilitate flow states during performances.

Method

Design

This investigation employed a correlational design with self-report questionnaire measures of sport specific metacognitive beliefs and processes, along with demographic information, collected prior to a triathlon, with questionnaire data relating to participants' experience of flow state during the triathlon collected immediately post event.

Participants and Procedure

Following institutional ethics approval from the University of the Sunshine Coast Human Research Ethics Committee, 193 open level triathletes were recruited prior to competition during event check-ins, at two different open triathlon events (59.1% male, M_{age}= 38.8 years, SD_{age} = 11.7 years, $M_{Experience}$ = 6.2 years $SD_{experience}$ = 7.0 years, $M_{training\ time}$ = 9.4 hours/week, $SD_{training\ time}$ = 4.4 hours/week). Following informed consent, participants voluntarily completed a pen and paper questionnaire capturing their experience of generalised and sports specific metacognitions, and demographic information (age, gender, training in hours/week, and experience in years), one day prior to competing in a triathlon. Participants (*n* = 76) were asked complete a second half of the questionnaire relating to their experience of flow state during the event. The post-race questionnaires were distributed outside of the recovery area, where refreshments and a prize draw of three $100 vouchers were used as incentives. This study was conducted in accordance with the Declaration of Helsinki (World Medical Association, 2013).

Measures

Metacognitive Beliefs. The *Metacognitive Beliefs about Performances Questionnaire* (MBPQ; Love et al., 2019) was used to assess participants' metacognitive beliefs experienced about their performance-based thinking. The MBPQ contains a total of 16 items, concerned with five types of sport specific metacognitive beliefs: a) positive beliefs about the usefulness of competitive worry (MBPQ-PW; e.g., "worrying helps me organise my thoughts before a competition."); b) positive beliefs about the usefulness of competitive arousal (MBPQ-PA; e.g., "I perform at my best if I am aroused from by anxiety."); c) positive beliefs about the usefulness of competitive rumination (MBPQ-PR; e.g., "consistently analysing my poor past performances will help me prevent future mistakes and failures."); d) negative beliefs about competitive thinking (MBPQ-NT; e.g., "when I think about past performance failures, I cannot think about anything else."); and e) beliefs about the need for competitive thought control (MBPQ-NC; e.g., "my performance will suffer if I cannot completely control my thoughts."). Each item is rated on a five-point scale of agreeableness (1 = strongly disagree; 2 = disagree;

3 = neither agree or disagree; 4 = agree; 5 = strongly agree), with higher scores indicating stronger beliefs. The MBPQ has demonstrated adequate psychometric properties with reliability coefficients ranging from 0.74 to 0.80 (Love et al., 2019).

Metacognitive Processes. The Metacognitive Processes during Performances Questionnaire (MPPQ; Love et al., 2018c) was used to measure metacognitive processes that athletes implement during competitions. The MPPQ is a 15 item questionnaire that is concerned with three key self-regulatory processes: a) cognitive coordination (MPPQ-CC; e.g., "I set specific goals before approaching a competition"); b) thought control and detachment (MPPQ-TC; e.g., "when something bad happens during a competition, I can easily refocus my attention back towards the event."); and c) cognitive evaluation and monitoring (MPPQ-CE; e.g., "I summarise what I've learnt about my thinking strategies after a competition."). Each of the items is rated on a five-point scale of agreeableness (1 = strongly disagree; 2 = disagree; 3 = neither agree or disagree; 4 = agree; 5 = strongly agree), with higher scores indicating higher implementation of the corresponding process. The MPPQ demonstrated appropriate psychometric properties, with reliability coefficients ranging from .73 to .85 (Love et al., 2018c).

Flow State. In-event flow was assessed by the *Short Flow State Scale* (SFSS-2; Jackson, Martin, & Eklund, 2008) in the post-event cool down areas. The SFSS-2 consists of nine-items, with each measuring a distinct component of flow: perceived challenge-skill balance (FSS-PC); action/awareness merging (FSS-AA); clear goals (FSS-CG); unambiguous feedback (FSS-UF); concentration on task (FSS-CT); loss of self-consciousness (FSS-LS); autotelic experience (FSS-AE); transformation of time (FSS-TT); and sense of control (FSS-SC). For each item, participants are asked to rate the extent to which they experienced each of the nine factors (e.g., "I was completely focused on the task at hand"), ranging on a 1 to 5 scale (1 = strongly disagree; 2 = disagree; 3 = neither agree or disagree; 4 = agree; 5 = strongly agree). Higher scores on the SFFS-2 indicate higher levels of flow experienced. The S-FSS-2 has demonstrated acceptable model fit, reliability and validity (α = .78; Jackson et al., 2008).

***Competitive Information and Demographics*.** To identify the characteristics of the sample and determine participants' competitive information, a short questionnaire was also implemented that asked for participants' gender, age, event, event experience (years), training quantity (hours per week), and competitiveness (recreational, social, or competitive).

Data Analyses

Participant responses were manually inputted into statistical analysis software: SPSS (v25). Data input was audited to assure accurate input and variables were tested for appropriate assumptions (e.g., normality). Correlations and step-wise regressions were used to assess the associations between the variables. Step-wise regressions were chosen as this was the first study to investigate the relationships between sports specific metacognitions and flow, and therefore, we wanted to determine which of the metacognitive factors were the most significant contributors to flow experiences in their subsets (i.e., metacognitive beliefs; metacognitive processes).

Based on theoretical foundations on the differences between concepts of metacognitive knowledge and regulation, and potential overlapping of variances between holding beliefs about the control of thoughts and implementing thought control strategies, the MBPQ and MPPQ variables were grouped in separate analyses. Interpretations of effect size cut-offs were applied for correlations (.10 = small, .30 = medium, .50 = large), partial eta squared (.02 = small, .06 = medium, .14 = large), Cohens f^2 (.10 = small, .25 = medium, .40 = large), and partial r squared (.02 = small, medium = .13, large = .26), as suggested by Cohen (1988), and J Cohen, Cohen, West, and Aiken (2003). Multicollinearity was checked by confirming Durbin-Watson (1.84 - 2.05), VIF (< 2.76), tolerance (> 0.36), and correlations (< 0.70) were in appropriate ranges. Plots were also checked for linearity and homoscedasticity issues. Priori power analysis using GPower3 and a power of .80 indicated that 92 participants would be needed to accurately detect medium effect sizes (f^2 = .15).

Results

Data screening and descriptive statistics indicated that all variables were appropriate for analysis, except for experience, which was strongly and positively skewed. The experience variable was therefore Log transformed and demonstrated normal distribution. Descriptive statistics of the data and reliability coefficients are presented in Table 1.

Research Aim 1: Associations between Sports-Specific Metacognitions with Flow State and its Dimensions.

Bivariate correlations between metacognitive beliefs and processes showed that cognitive coordination (MPPQ-CC) had small positive associations with positive beliefs about the usefulness of competitive arousal (MBPQ-PA; *r* = .17) and beliefs about the need for competitive thought control (MBPQ-NC; *r* = .21), but a medium negative relationship to negative beliefs about competitive thinking (MBPQ-NT; *r* = -.33). Cognitive evaluation and monitoring (MPPQ-CE) demonstrated a small positive association to positive beliefs about the usefulness of competitive arousal (MBPQ-PA; *r* = .15), and a small negative relationship with negative beliefs about competitive thinking (MBPQ-NT; *r* = -.21). Thought control and detachment (MPPQ-TC) demonstrated small to large negative relationships with positive beliefs about the usefulness of competitive worry (MBPQ-PW; *r* = -.15); positive beliefs about the usefulness of competitive rumination (MBPQ-PR; *r* = -.22), and negative beliefs about competitive thinking (MBPQ-NT; *r* = -.57).

With regard to relationships between metacognitions and flow dimensions, total flow shared medium to large positive associations with metacognitive processes (cognitive coordination (MPPQ-CC; *r* = .45), and thought control and detachment (MPPQ-TC; *r* = .52), but a negative medium association with negative beliefs about competitive thinking (MBPQ-

NT; *r* = -.47). Individually, perceived competence (FSS-PC) had negative medium sized correlation with negative beliefs about competitive thinking (MBPQ-NT; *r* = -.43), but positive small to medium sized relationships with cognitive coordination (MPPQ-CC; *r* = .44), cognitive evaluation and monitoring (MPPQ-CE; *r* = .25), and thought control and detachment (MPPQ-TC; *r* = .42). Action-awareness merging (FSS-AA) had a small positive correlation with thought control and detachment (MPPQ-TC; *r* = .25). Clear goals (FSS-CG) had a medium sized positive relationship with cognitive coordination (MBPQ-CC; *r* = .39). Unambiguous feedback (FSS-UF) shared a medium negative relationship with and negative beliefs about competitive thinking (MBPQ-NT; *r* = -.42), but positive medium relationships with cognitive coordination (MPPQ-CC; *r* = .36) and thought control and detachment (MPPQ-TC; *r* = .34). Concentration (FSS-CT) shared a medium negative relationship with negative beliefs about competitive thinking (MBPQ-NT; *r* = -.34) and a positive relationships with cognitive coordination (MPPQ-CC; *r* = .28), and thought control and detachment (MPPQ-TC; *r* = .32). Transformation of time (FSS-TT) had a small positive relationship with positive beliefs about the usefulness of competitive rumination (MBPQ-PR; *r* = .15). Sense of control (FSS-SC) had a medium sized negative correlations with positive beliefs about the usefulness of competitive rumination (MBPQ-PR; *r* = -.23) and negative beliefs about competitive thinking (MBPQ-NT; *r* = -.44), but medium positive correlations with cognitive coordination (MPPQ-CC; *r* = .27) and thought control and detachment (MPPQ-TC; *r* = .47). Finally, loss of self-consciousness (FSS-LS) had negative medium associations with positive beliefs about the usefulness of competitive rumination (MBPQ-PR; *r* = -.29) and negative beliefs about competitive thinking (MBPQ-NT; *r* = -.36), but positive associations with cognitive coordination (MPPQ-CC; *r* = .25), and thought control and detachment (MPPQ-TC; *r* = .49).

Correlations involving experience and training schedule revealed that experience had a small negative relationship with negative beliefs about competitive thinking (MBPQ-NT; *r* = -

.21), but small positive relationships with cognitive coordination (MPPQ-CC; $r = .14$), and thought control and detachment (MPPQ-TC; $r = .21$). Training was positively related to cognitive coordination (MPPQ-CC; $r = .42$), cognitive evaluation and monitoring (MPPQ-CE; $r = .28$), and thought control and detachment (MPPQ-TC; $r = .15$). The correlations, including *p* values, can be found in Table 1 (right).

INSERT TABLE 1 APPROXIMATELY HERE

Research Aim 2: Contributions of Metacognitive Beliefs towards Metacognitive Processes.

To examine the contributions that the metacognitive belief MBPQ subscales posed towards the metacognitive process MPPQ variables, three stepwise regressions were run with the MBPQ variables predicting each of the MPPQ variables (Table 2). Assumptions were deemed met, with Durbin-Watson, VIF, tolerance and correlations indicating an absence of multicollinearity, whilst plots indicated that linearity and homoscedasticity were acceptable.

The first stepwise regression predicting cognitive coordination (MPPQ-CC), demonstrated negative beliefs about competitive thinking (MBPQ-NT) as the most important predictor in step one, explaining 11.1% of the total variance (F (1, 192) = 23.75, $p < .001$). In step two, beliefs about the need for competitive thought control (MBPQ-NC) was added to the model and explained a total 18.2% of the variance (F (2,192) = 21.14, $p < .001$). In step three, positive beliefs about the usefulness of competitive arousal (MBPQ-PA) was included in the model and explained a total of 21.6% of the variance in cognitive coordination (MPPQ-CC; F (3, 192) = 17.32, $p < .001$). Overall, the total effect size (Cohen's $f^2 = .28$) was medium, while the individual contributions of negative beliefs about competitive thinking (MBPQ-NT; $\beta = -.38$, $t = -5.85$, $p < .001$, $r^2 = .15$), beliefs about the need for competitive thought control (MBPQ-

NC; β = .27, t = 4.19, p < .001, r^2 = .08), and positive beliefs about the usefulness of competitive arousal (MBPQ-PA; β = .18, t = 2.85, p < .001, r^2 = .03) were small to medium in size.

The second stepwise regression predicting cognitive evaluation and monitoring (MPPQ-CE) revealed negative beliefs about competitive thinking (MBPQ-NT) as the most important predictor in step one, explaining 4.4% of the total variance (F (1, 192) = 8.69, p = .004). In step two, positive beliefs about the usefulness of competitive rumination (MBPQ-PR) was added to the model and explained 7.1% of the variance (F (2,192) = 7.28, p = .001). Overall, the total effect size (Cohen's f^2 = .08) and the individual contributions of negative beliefs about competitive thinking (MBPQ-NT; β = -.28, t = -3.68, p < .001, r^2 = .07), and beliefs about the need for competitive thought control (MBPQ-NC; β = .18, t = 2.38, p = .018, r^2 = .03) were small. Thirdly, for the stepwise regression predicting thought control and detachment (MPPQ-TC), negative beliefs about competitive thinking (MBPQ-NT) was the only significant predictor, explaining 32.9% of the total variance (F (1, 192) = 93.68, p < .001). The total effect size (Cohen's f^2 = .49) of negative beliefs about competitive thinking (MBPQ-NT; β = -.57, t = -9.68, p < .001, r^2 = .33) was large.

INSERT TABLE 2 APPROXIMATELY HERE

Research Aim 3: Contributions of Sports Specific Metacognitions towards Flow State

To investigate the contributions that the metacognitive belief MBPQ and metacognitive process MPPQ subscales had towards total flow, two further stepwise regressions were performed, with the MBPQ and MPPQ variables as predictors and flow as the dependent variable (Table 3). The metacognitive beliefs and metacognitive processes were grouped in two separate regressions to avoid overlapping variance between the two factors (e.g., negative beliefs about control; thought control) contributing to possible type II errors. Assumptions were met, as Durbin-Watson, VIF, tolerance and correlations indicated an absence of multicollinearity, whilst plots indicated that linearity and homoscedasticity were acceptable. Results for the stepwise regression involving MBPQ subscales, demonstrated negative beliefs about competitive thinking (MBPQ-NT) as the only significant predictor, explaining 21.8% of the variance in flow (F (1, 75) = 20.62, $p < .001$). The total effect size (Cohen's $f^2 = .28$) of negative beliefs about competitive thinking (MBPQ-NT; $\beta = -.47$, $t = -4.54$, $p < .001$, $r^2 = .22$) was medium in size.

For the stepwise regression with metacognitive processes predicting flow, the initial step revealed thought control and detachment (MPPQ-TC) as the most important predictor, explaining 26.5% of the variance (F (1, 75) = 26.68, $p < .001$. In step two, cognitive coordination (MPPQ-CC) was included, and the total model explained 32.8% of the variance in flow (F (2, 75) = 17.78, $p < .001$). Overall, the main effect (Cohen's $f^2 = .49$) was large, while the individual contributions of cognitive coordination (MBPQ-CC; $\beta = .39$, $t = 3.67$, $p < .001$, $r^2 = .16$), and thought control and detachment (MPPQ-TC; $\beta = .28$, $t = 2.61$, $p = .009$, $r^2 = .09$) were small to large. The results can be found in Table 3.

INSERT TABLE 3 APPROXIMATELY HERE

Discussion

This study contained three research aims: a) to investigate the associations between individual flow state dimensions (i.e., perceived challenge-skill balance, action/awareness merging, clear goals, unambiguous feedback, concentration on task, loss of self-consciousness, autotelic experience, transformation of time, and sense of control) with sports-specific metacognitive beliefs and processes among competing athletes; b) to investigate the contributions that sports-specific metacognitive beliefs had towards metacognitive processes used during competitions; and c) to investigate the contributions that sports specific metacognitive beliefs and processes had towards total flow experienced during a triathlon.

Associations between Metacognitions, with Individual Flow Dimensions.

For the first research aim, bivariate correlations were performed on the MBPQ, MPPQ, and FSS subscales. The results showed that in general, the metacognitive belief subscales were negatively associated flow dimensions, while the processes subscales were positively associated with flow dimensions. This was particularly notable for the metacognitive belief subscale negative beliefs about competitive thinking (MBPQ-NT) and the two metacognitive process subscales of cognitive coordination (MPPQ-CC) and thought control and detachment (MPPQ-TC). These three subscales displayed significant relationships with several dimensions of flow (positive for metacognitive processes and negative for metacognitive beliefs), including challenge-skill balance, unambiguous feedback, concentration on task, sense of control, and loss of self-consciousness. Individually, the cognitive coordination (MPPQ-CC) metacognitive process scale was also positively related to clear goals. The thought control and detachment (MPPQ-TC) metacognitive process scale was positively related to action-awareness merging. With the cognitive evaluation and monitoring (MPPQ-CE) metacognitive process scale positively relating to challenge-skill balance. Whereas the positive beliefs about the usefulness of competitive rumination (MBPQ-PR) metacognitive beliefs scale was negatively related to a sense of control and loss of self-consciousness, but positively associated with transformation of time.

Several relationships between metacognitive beliefs and metacognitive processes were observed. Negative beliefs about competitive thinking (MBPQ-NT) was negatively associated with all three MPPQ metacognitive process subscales. positive beliefs about the usefulness of competitive worry (MBPQ-PW) were negatively associated with the metacognitive process thought control and detachment scale (MPPQ-TC). Positive beliefs about the usefulness of competitive arousal (MBPQ-PA) was positively associated with the metacognitive processes subscales of cognitive coordination (MPPQ-CC) and cognitive evaluation and monitoring (MPPQ-CE). Positive beliefs about the usefulness of competitive rumination (MBPQ-PR) was negatively related to thought control and detachment (MPPQ-TC). Beliefs about the need for competitive thought control (MBPQ-NC) were positively associated with the metacognitive processes subscale of cognitive coordination (MPPQ-CC). Additionally, correlations between the metacognitive variables with experience (in years) and training (hours per week) showed that more experienced athletes were more likely to score lower on the negative metacognitive beliefs' subscales, but higher on the metacognitive process cognitive coordination (MPPQ-CC), and thought control and detachment (MPPQ- TC) subscales. Furthermore, those who trained more each week were more likely to score higher in all three metacognitive processes. This finding may suggest that changes in metacognitive processes may be more readily manipulated than metacognitive beliefs, as they demonstrated a positive relationship with training times, however, results are discussed below in further detail.

Contributions of Metacognitive Beliefs towards Metacognitive Processes

For the second research aim, three stepwise multiple regressions were run with metacognitive beliefs predicting processes. The results showed that similar to the correlations, all three metacognitive processes were most strongly and negatively predicted by negative beliefs about competitive thinking. This indicates that holding a negative belief about the effectiveness and controllability of thoughts during performances, is influential to the ability to plan and co-ordinate cognition; the ability to detach, inhibit and shift attention; and the monitoring and evaluation of competitive thoughts. This result is supportive of previous findings by Love et al. (2018b), in that negative beliefs about the uncontrollability and danger of worry was the strongest predictor of mindfulness facets. This current finding also aligns with Spada, Papageorgiou, and Wells (2010) who reported that negative beliefs were associated with lower attentional control. Furthermore, these findings also side with the S-REF model that attributes negative beliefs about thought controllability as those that contribute to the development of a biased cognitive attentional syndrome and reduced cognitive flexibility (Wells, 1996; Mathews & Wells, 2004).

Conversely, several metacognitive beliefs, were positively associated with metacognitive process MPPQ variables. Both beliefs about the need for competitive thought control (MBPQ-NC) and positive beliefs about the usefulness of competitive arousal (MBPQ-PA) positively predicted cognitive coordination metacognitive processes (MPPQ-CC). This finding is theoretically consistent, as beliefs about the need to control thoughts are directed at procedural processes, and thus would be more likely to influence planning and coordination strategies to better control cognition (Wells & Cartwright-Hatton, 2003). Furthermore, individuals who plan their thinking strategies before an event are more likely to have more positive interpretations of arousal, when it occurs. Alternatively, positive beliefs about competitive rumination was found to positively predict cognitive evaluation. This again is theoretically consistent, as those who view rumination as a helpful strategy to prevent future failures, are more likely to monitor and evaluate their thinking patterns (Mathews & Wells, 2004).

Contributions of Sports Specific Metacognitions towards Flow State

For the third research aim, two stepwise regressions were performed on flow state, with metacognitive beliefs and metacognitive processes separately grouped as independent predictors. For metacognitive beliefs, the results showed that only negative beliefs about competitive thinking (MBPQ-NT) significantly predicted flow in a negative fashion, however, the effect was large. With consideration of the correlations, this appears to have been attributed from a number of factors including: reduced perceptions of competence and control; increases in self-consciousness; and thus, increases in task irrelevant thoughts. As discussed with the previous research aim, this is consistent with metacognitive theory, in that negative beliefs are responsible for cognitive dysfunction, while positive beliefs are inherently benign, unless they lead to the development of negative metacognitive beliefs (Wells, 1996; Mathews & Wells, 2004).

The results regarding metacognitive beliefs and flow did not support that of Love's et al. (2018b) findings, which found that flow associated negatively with positive beliefs about worry and a lack of cognitive confidence, but positively to need to control beliefs. However, the direction of the metacognitive beliefs between Love's et al. measures (2018b), which were aimed at everyday life, compared to the present study, which were aimed at thoughts during competitions, may partly explain this. Wells and Mathews (1994; 1996) explain that when individuals encounter stressful situations, metacognitive beliefs and their accompanying processes are activated in response. In the previous study, the generalised positive beliefs may have shown significance, because positive beliefs in everyday life may have more opportunity to develop into negative beliefs and biased coping strategies when encountering the stress of a competition. Whereas, in the current study, negative beliefs may have yielded stronger associations because they are the response from maladaptively developed positive beliefs held prior to competition, in everyday life. Therefore, sports specific positive metacognitive beliefs may be influential to mental performance, dependent on the reasoning behind the belief (i.e., to direct cognition or to control worry). Nonetheless, the interaction of metacognitive beliefs from a longitudinal perspective is an area that still needs further investigation before conclusions can be made.

For the regression involving metacognitive processes, thought control and detachment (MPPQ-TC) and cognitive coordination (MPPQ-CC) were found to significantly predict flow state. Comparisons to correlations, indicated that this relationship was also due to a number of interactions with flow dimensions, including: increases in perceptions of competence; clearer goals; decreases in self-consciousness; decreases in task-irrelevant thoughts; and action-awareness merging. These results were partially supportive of Love's et al. (2018b) in that acting with awareness was found to be a significant predictor of flow, as the coordination and control of cognition is needed to bring attention to the present moment. However, overall the processes measure in the current study demonstrated stronger associations with the occurrence of flow, than mindfulness factors used by Love et al. (2018b).

The only flow dimensions that did not show a relationship to the metacognitive processes variables were a transformation of time and an autotelic experience. These dimensions seem to be both characterised by an absorption into the experience, and therefore may have stronger associations to a mindful 'relationship to thoughts' component of metacognition, allowing an individual to let go of conscious control and allow the unconscious self-regulation of cognitive and emotional activity (see Williams, Bargh, Nocera, & Gray, 2009). Consistent with Sheldon et al. (2015), meta mindful components were related to the control aspect of flow, but not the factors involved with the absorption aspect. However, the expertise of athletes must also be considered, as athletes cannot rely on automatic processing if schemas have not first accommodated successful regulation.

Summary of the Metacognition-Flow Relationship

The current study demonstrated several key findings in the metacognition-flow relationship: a) sports specific metacognitive beliefs are significantly related to sports specific metacognitive processes; b) sports specific metacognitive beliefs and processes are significantly associated to the experience of flow in triathletes; c) these associations appear to be due to several underlying relationships with individual flow dimensions; d) there is an absorption aspect of flow that is not currently explained by metacognitive components; and e) there is a complex interaction between generalised everyday metacognitions and metacognitions experienced during competitions, that is likely in part explained by the purpose for activating particular metacognitive beliefs (i.e., activating control beliefs to control every day worry, versus activating beliefs to control attention during a stressful competition).

Limitations were present in the current study that need to be considered when interpreting our findings. Firstly, self-report measures were used, and the analyses were correlational in nature, meaning that causation cannot be implied. However, given there is no current alternative method to assess the subjective experience of cognitive phenomena, and that the questionnaires were administered at the opportune moment (pre- and post-competition), this is currently the best option for quantitative investigation. Secondly, there was significantly bad weather during the competition, with strong winds and heavy rain, which over the course of a three-hour event, may have led to some deflated observations of experienced flow. This may give some further explanation behind the lack of association between metacognition and the attentional absorption aspects flow (i.e., a transformation of time; an autotelic experience). Another potential limitation was that there was a large drop out rate between the pre and posts questionnaires. However, due to participant exhaustion and the extreme size of the crowds, this was an expected set back, and was considered a negligible interference on results, apart from the resulting sample size ($n = 76$). Post hoc power analysis indicated that the post-event sample was only able to accurately detect effect sizes of .19 or larger, at a power of .82. This may have resulted in type 2 errors for some of the weaker relationships.

Based on the implications and limitations discussed, future research could benefit from investigating the interactions of metacognitions throughout the experience of competition from both qualitative and longitude methodological designs. This would allow researchers to examine the specific content of metacognitions (e.g., belief reasonings) and how they interact with existing schemas and self-regulatory processes, as athletes transfer from everyday life to the stressful environments, where regulatory responses are required. Furthermore, future research could build on the literature by investigating the relationships between metacognition and flow under different sporting demographics, as different sports have been shown to associate with different characteristics of flow and attentional styles. This information could be used by the sporting community to assist athletes and sports performance coaches to enhance cognitive variables and experience flow characteristics more readily.

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Table 1. *Descriptive statistics, reliability coefficients and bivariate correlations of the MBPQ, MPPQ, FSS scales, experience and training schedule.*

Variables	**N**	**M**	**SD**	**α**	**MBPQ-PW**	**MBPQ-PA**	**MBPQ-PR**	**MBPQ-NC**	**MBPQ-NT**	**MPPQ-CC**	**MPPQ-CE**	**MPPQ-TC**
MBPQ-PW	193	2.46	.86	.80								
MBPQ-PA	193	2.84	.91	.81	.35**							
MBPQ-PR	193	2.74	.88	.77	.26**	.13						
MBPQ-NC	193	2.31	.66	.75	-.14**	-.01	.16*					
MBPQ-NT	193	3.34	.82	.76	.19*	.03	.39**	.16*				
MPPQ-CC	193	3.63	.74	.78	-.04	.17*	-.02	.21*	-.33**			
MPPQ-CE	193	3.28	.78	.84	.02	.15*	.07	.05	-.21*	.64**		
MPPQ-TC	193	3.47	.64	.73	-.15*	.03	-.22*	-.02	-.57**	.41**	.24*	
FSS-Total	76	35.46	4.40	.75	-.11	-.01	-.20	-.02	-.47**	.45**	.21	.52**
FSS-PC	76	4.09	.64	-	-.17	.12	-.18	-.10	-.43**	.44**	.25*	.42**
FSS-AA	76	3.67	.91	-	-.06	-.02	-.13	-.04	-.19	.14	.12	.25*
FSS-CG	76	4.16	.61	-	-.10	.05	-.11	.02	-.20	.39**	.14	.18
FSS-UF	76	3.91	.85	-	-.14	.05	-.12	.02	-.42**	.36**	.20	.34*
FSS-CT	76	4.14	.74	-	-.13	-.01	-.12	-.07	-.34*	.28*	.12	.32*
FSS-SC	76	3.67	.94	-	.06	-.07	-.23*	.04	-.44**	.27*	.07	.47**
FSS-LS	76	3.79	1.12	-	-.06	-.15	-.29*	-.05	-.36*	.25*	.11	.49**
FSS-TT	76	3.58	1.04	-	.04	.13	.15*	.13	.00	.10	.04	.03
FSS-AE	76	4.45	.60	-	-.08	-.10	.03	-.10	-.09	.14	.10	.18
Experience	193	6.23	7.04	-	-.02	.02	-.10	.00	-.21*	.14*	.10	.21*
Training	193	9.40	4.45	-	-.14	.04	-.10	.07	-.09	.42**	.28**	.15*

* p =/< .05, ** p =/< .001; MBPQ-PW = Positive beliefs about the usefulness of competitive worry; MBPQ-PA = Positive beliefs about the usefulness of competitive arousal; MBPQ-PR = Positive beliefs about the usefulness of competitive rumination; MBPQ-NC = Beliefs about the need for competitive thought control; MBPQ-NT = Negative beliefs about competitive thinking; MPPQ-CC = Cognitive coordination; MPPQ-CE = cognitive evaluation and monitoring; MPPQ-TC = Thought control and detachment; FSS-PC = Challenge/Skill Balance; FSS-AA = Action/awareness merging; FSS-CG = Clear goals; FSS-UF = Unambiguous feedback; FSS-CT = Concentration on task; FSS-SC = Sense of control; FSS-LS = Loss of self-consciousness; FSS-TT = Transformation of time; FSS-AE = Autotelic experience.

Table 2.

Five stepwise regressions with metacognitive beliefs predicting metacognitive processes.

	Predictors	B	*SE*	β	*t*	r^2	*p*	R^2	*F*
MPPQ-CC									
Step 1							<.001	.11	23.75
	MBPQ-NT	-.29	.06	-.33	-4.87	.11	<.001		
Step 2							<.001	.18	21.14
	MBPQ-NT	-.33	.06	-.38	-5.65	.14	<.001		
	MBPQ-NC	.20	.05	.27	4.07	.08	<.001		
Step 3							<.001	.22	17.32
	MBPQ-NT	-.34	.06	-.38	-5.85	.15	<.001		
	MBPQ-NC	.20	.05	.27	4.19	.08	<.001		
	MBPQ-PA	.12	.04	.18	2.85	.03	.005		
MPPQ-CE									
Step 1							.004	.04	8.69
	MBPQ-NT	-.24	.08	-.21	-2.95	.04	.004		
Step 2							.001	.07	7.28
	MBPQ-NT	-.32	.09	-.29	-3.68	.07	<.001		
	MBPQ-PR	.16	.07	.18	2.38	.03	.018		
MPPQ-TC									
Step 1							<.001	.33	93.68
	MBPQ-NT	-.53	.05	-.57	-9.68	.33	<.001		

MBPQ-PW = Positive beliefs about the usefulness of competitive worry; MBPQ-PA = Positive beliefs about the usefulness of competitive arousal; MBPQ-PR = Positive beliefs about the usefulness of competitive rumination; MBPQ-NC = Beliefs about the need for competitive thought control; MBPQ-NT = Negative beliefs about competitive thinking.

Table 3.

Two Stepwise Regressions with the Metacognitive Variables as Predictors and Total Flow as the Dependant Variable.

Regression	**Step**	**Predictors**	**B**	***SE***	**β**	***t***	***r***^{2}	***p***	***R***^{2}	***F***
Metacognitive Beliefs										
	Step 1							<.001	.22	20.62
		MBPQ-NT	-.2.83	.62	-.47	-4.54	.22	<.001		
Metacognitive Processes										
	Step 1							<.001	.27	26.68
		MPPQ-TC	3.14	.61	.52	5.16	.27	<.001		
	Step 2							<.001	.33	17.78
		MPPQ-TC	2.39	.65	.39	3.67	.16	<.001		
		MPPQ-CC	1.94	.74	.28	2.61	.09	.011		

MBPQ-NT = Negative beliefs about competitive thinking; MPPQ-CC = Cognitive coordination; MPPQ-TC = Thought control and detachment.