Pleasant emotions widen thought-action repertoires, develop long-term resources, and improve reaction time performance: A multi-study examination of the Broaden-and-Build theory among athletes

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Abstract

We investigated relationships between emotions, coping, and resilience across two studies. In Study 1a, 319 athletes completed dispositional questionnaires relating to the abovementioned constructs. In Study 1b 126 athletes from Study 1a repeated the same questionnaires 6 months later. In Study 2, 21 athletes were randomly allocated to an emotional (e.g., pleasant or unpleasant emotions) or control group and undertook a laboratory-based reaction time task across three time-points. Questionnaires and salivary cortisol samples were collected before and after each performance, with imagery-based emotional manipulations engendered during the second testing session. Partial longitudinal evidence of the broadening and build effects of pleasant emotions was found. Pleasant emotions may undo lingering cognitive resource losses, incurred from previous unpleasant emotional experiences. In Study 2, pleasant and unpleasant emotions had an immediate and sustained psychophysiological and performance impact. Taken together, this research supports the application of broaden-and-build theory in framing emotional interventions for athletes.

Keywords: Coping, Cortisol, Psychology, Psychophysiology, Resilience, Sport

Pleasant emotions widen thought-action repertoires, develop long-term resources, and improve reaction time performance: An examination of Broaden-and-Build theory within sporting populations.

Athlete emotional experiences, both pleasant and unpleasant, are interwoven with coping behaviors and sporting performance (Hanin, 2007; Nicholls, Hemmings, et al., 2010). Despite this, unpleasant emotions such as anger and anxiety have dominated the sports emotional research landscape (Campo et al., 2012). With the performance influence of pleasant emotions potentially a subtle and indirect one, their benefits may have hitherto not been wholly realized (McCarthy, 2011). It has been widely suggested that the broaden-and-build theory of emotions (BaB; Fredrickson, 2001) could bridge this theoretical gap (Nicholls et al., 2014; Tamminen et al., 2014). Literature searches revealed that scholars have not attempted to empirically realize this potential among athletes. This research was therefore formulated to systematically assess the application of BaB theory within sport through the use of both cross-sectional and longitudinal theoretical investigations, as well as a controlled experimental study to establish causality.

The Broaden-and-Build Theory of Emotions

The BaB theory (Fredrickson, 2001) states that the existence and experience of pleasant emotions have been evolutionarily driven to aid the survival of an agent by accruing resources for future person-environment interactions, as well as expanding one's attention to offer a wider array of potential coping solutions. In sporting contexts, this means athlete pleasant emotional experiences may *broaden* thought-action repertoires, and thus offer a wider range of coping behaviors associated with improved performance. This translates well on both an empirical and theoretical level. Indeed, just as positive affect facilitates approach behavior (Fredrickson, 2001), pleasant emotions predict task-oriented coping (Thompson et al., 2020), which has been linked with superior sporting performance (Nicholls, Taylor, et al., 2016). Further, the notion that pleasant emotions are beneficial for performance has received empirical support (Lane et al., 2010; Uphill et al., 2014). As such, BaB-rooted pleasant emotional interventions may have the potential to promote more facilitative coping behaviors and improve athletic performance in the short-term.

Fredrickson (2001) also believed that the benefits of pleasant emotions were not limited to the short-term. The *build* hypothesis states that the experience of pleasant emotions may assist in the development of long-term physical, social, and intellectual coping resources, which may help athletes cope sufficiently with future person-environment interactions. Additionally, these benefits are reciprocally deterministic. That is, pleasant emotions predict personal resources and facilitative coping behaviors, which in turn predict further emotional resources. This creates what Fredrickson labelled an *upward spiral*. One such resource within this upward spiral is that of resilience; defined by scholars as “the role of mental processes and behavior in promoting personal assets and protecting an individual from the potential negative effect of stressors” (Fletcher & Sarkar, 2013, p. 16). This definition is useful as it encapsulates both trait and state conceptualizations of resilience (Sarkar & Fletcher, 2014). Psychological evidence of the build hypothesis (Cohn et al., 2009; Fredrickson et al., 2003; Gloria & Steinhardt, 2016) has often centered around the construct of resilience due to its status as an enduring personal resource (Fredrickson, 2001). Cohn et al. discovered that pleasant emotional experiences predicted increases in ego-resilience over the course of a 28-day research study. Further, the relationship between pleasant emotions and resilience has been found to be mediated by coping strategies in research conducted with post-doctoral university students (Gloria & Steinhardt, 2016). This is highly relevant to athletes, as resilience is a construct that has been recognized for the important role it plays in helping athletes to withstand sporting pressures and achieve high levels of performance (Sarkar & Fletcher, 2014). Research that examines the possibility of athlete pleasant emotional experiences broadening thought-action repertoires and subsequently building enduring personal resources such as resilience could be used to form theory-guided emotional interventions that benefit athletic performance and well-being in the short- and long-term. That is, the engendering and monitoring of athlete emotional levels, and their resultant performance and psychological response.

A further tenet of BaB theory (Fredrickson, 2001) that requires attention is the *undoing effect* (Fredrickson et al., 2000). In her “undoing hypothesis”, Fredrickson theorized that if pleasant emotions broaden thought-action repertoires, then hypothetically they should work as effective antidotes to quell the aftereffects of previously experienced unpleasant emotions. That is, if unpleasant emotions generate cardiovascular reactivity and/or diminish resilience levels, the experience of pleasant emotions may "correct" or "undo" these effects to return an individual back to a state of equilibrium. It should be noted that whilst physiological evidence of the 'undoing effect' has been discovered, indexed via physiological measures such as heart rate, peripheral vasoconstriction, and systolic and diastolic blood pressure (Fredrickson et al., 2000; Tugade & Fredrickson, 2004), other researchers have failed to discover any physiological or neuroendocrine association (Polk et al., 2005; Steptoe et al., 2005). At the time of writing, no explicit psychological evidence for the undoing effect exists, despite the emotional and resource benefits that negating the effects of unpleasant emotions may bring. The possibility that longitudinal research may provide preliminary evidence of an undoing effect (Frederickson) is highly exciting and has thus guided our research design.

Underlying Psychophysiological Mechanisms

Fredrickson stated that emotions are "brief, multisystem responses" (Fredrickson, 2013, p. 3) to environmental changes. These responses are manifested across a number of coupled component systems, such as facial expressions, physiological changes, and cognitive processing (Fredrickson, 2001). This has led some scholars to use methods other than just psychometrics in their research (Martinek et al., 2003). With the expression of emotions in sporting competitions influenced by an athlete's neurological and endocrine mechanisms (Parmigiani et al., 2009), cortisol has become a popular physiological stress index amongst researchers. Cortisol is a steroid hormone controlled by the hypothalamic-pituitary-adrenocortical (HPA) axis (Hellhammer et al., 2009). Typically in the psychoneuroendocrinological literature, pleasant emotions have been indexed through a negative relationship to cortisol response, with unpleasant emotions indexed by a positive relationship (Smyth et al., 1998). Within sporting populations, significant relationships between anxiety and increased cortisol levels have been found (Filaire et al., 2007). This has then been linked to decreased performance levels in cases of excessive cortisol secretion (Siart et al., 2017). However, moderate increases in cortisol levels before a competition has been suggested to be beneficial to an athlete (Eubank et al., 1997), as this may prepare them for the physical and mental demands ahead (Salvador et al., 2003). What is more, the catalogue of emotional experiences that an athlete undergoes when succeeding in competition suggests that winning itself may be a physiologically stressful event (Thompson et al., 2020). As such, researchers must consider the physiological response in order to provide a more comprehensive knowledge of athlete emotional experiences.

Aims of the Current Research

The aim of this research program was to assess the applicability of the BaB theory (Fredrickson, 2001) to sporting populations across two distinct yet complementary studies. Study 1 is divided into two parts. Study 1 relates to the theoretical assessment of the BaB theory in sport and investigates cross-sectional (Study 1a) and longitudinal (Study 1b) interactions between emotions, coping, and resilience levels. Study 2 relates to a laboratory-based study designed to measure athlete psychophysiological response and objective performance resulting from athlete emotional states.

Study 1a. Assessing the BaB theory within Sport: A Path Analysis

The purpose of the first part of Study 1 was to investigate the possible existence of the *broaden* and *build* effects (Fredrickson, 2001) within an athletic population. The methodological design is grounded in Fredrickson and Joiner's (2002) research, which measured positive and negative affect, as well as broad-minded coping within undergraduate students across two time points, separated by five weeks. In this present research, we measured the constructs central to BaB theory (Fredrickson), that is, emotions and coping strategies. With these constructs theorized to increase personal resource levels (Fredrickson et al., 2003), we also measured participant resilience levels. Finally, the decision was taken to investigate the aforementioned constructs via a dispositional approach, rather than via a process approach. This decision was taken for two reasons. Firstly, with this study the first data collection point of a six-month longitudinal study, the research team was interested in identifying potential habitual patterns between emotions, coping, and resilience. As one-shot measures of constructs such as coping are not always an accurate representation of an athletes general behavior (Nicholls et al., 2013), a process approach was deemed unsuitable. Secondly, dispositional coping allows scholars to assess coping in a broader context (Hurst et al., 2011); in this case, the potential holistic broaden and build effects.

Hypotheses

Based on Cohn et al.'s (2009) finding, we anticipated that pleasant and unpleasant emotions would positively and negatively relate to resilience, respectively. Further, we also predicted that the relationship between emotions and resilience would be mediated by coping orientation (see Gloria & Steinhardt, 2016). In practice, this would mean that the relationship between pleasant emotions and resilience would be mediated by task-oriented coping, whilst the relationship between unpleasant emotions and resilience would be mediated by both distraction- and disengagement-oriented coping. Following on from the work of Thompson et al. (2020), we predicted that pleasant emotions would be associated with increased task-oriented coping strategies, which in turn would lead to increased resilience. We also predicted that unpleasant emotions would be associated with distraction- and disengagement-oriented coping strategies, which would be inversely associated with resilience. Finally, with distraction-oriented coping having found to be related to task- and disengagement-oriented coping in Thompson et al., it was anticipated that these paths would be replicated in this research. This hypothesized model can be found in Figure 1.

Methods

Participants

We recruited 319 athletes (male n = 210, female n = 109) aged between 16 and 71 (mean = 28.41, SD = 10.33). Participants had an average playing experience of 10.43 years (SD = 8.82) and took part in a variety of both team and individual sports (e.g. football, badminton, and long-distance running). Participating athletes competed at international (n = 15), national (n = 28), county (n = 41), club (n = 171), and beginner (n = 64) levels.

Self-Report Measures

The Sports Emotion Questionnaire (SEQ; Jones et al., 2005) measured athlete emotions. The SEQ comprises of 22-items measuring two pleasant (happiness and excitement) and three unpleasant emotions (anger, anxiety, and dejection) across a five-point Likert-type scale. However, as this study measured the dispositional emotions of athletes rather than their state emotions, the participant instructions were slightly altered. The instruction "indicate on the scale next to each item how you feel right now, at this moment, in relation to your upcoming competition" was modified to read "indicate on the scale next to each item how you normally feel in relation to participating in your chosen sport".

The Dispositional Coping Inventory for Competitive Sport (DCICS; Hurst et al., 2011) was employed to measure athlete dispositional coping strategies. The DCICS is a 37-item questionnaire in which 10 coping behaviors are categorized into three second-order dispositional dimensions (e.g. task-, distraction-, and disengagement-oriented coping. On a 5-point Likert-type scale (1 = not at all to 5 = very strongly), athletes rated how they would "typically" cope in a sporting situation in relation to statements such as 'I analyze the demands of the competition'. Although Hurst et al. did not report internal consistency estimates for a three-factor classification of coping, they did report alpha coefficients for the ten individual coping strategies, ranging from .60 to .80.

The Revised Connor-Davidson Resilience Scale (RCDRS; Campbell-Sills & Stein, 2007) was utilized to measure athlete resilience levels. The RCDRS is a 10-item unidimensional scale that employs a 5-point Likert-type scale (1 = not true at all, 5 = true nearly all of the time) to rate the applicability of statements such as 'I am not easily discouraged by failure'. Some items were slightly amended to make them applicable to sport. For example, the item 'can deal with whatever comes' became 'I can deal with whatever comes our way when I'm competing'. Campbell-Sills and Stein reported a Cronbach's alpha of .85 for the RCDRS, whilst it has also been validated for use in athletic populations (Gucciardi et al., 2011).

Procedure

This study received full ethical approval from a university ethics committee. Participants were contacted online via email as well as via online sportspersons message boards. Recruitment was aided via the offering of a prize draw to win one of three £25 shopping vouchers for participation. Participating athletes were directed to a web page where they signed an online consent form and then completed the questionnaire pack. All questionnaires were completed at the same time.

Data Analysis

Once data collection had ended, the raw data was screened for missing data and outliers. We then conducted a path analysis, using sub-scale scores as observed variables, through MPlus 7. In order to not drift from multivariate normality, we employed the robust maximum likelihood (MLR). Model fit was determined through the use of the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), which were presented as normed and non-normed indices. Further, the Standardized Root-Mean-Square Residual (SRMR) and Root Mean Square Error Approximation (RMSEA) were measured as absolute fit indices. To ascertain whether the model fit was acceptable, we applied (Hu & Bentler, 1999) recommendations for fit indices. That is, CFI > .90, TLI > .90, SRMR < .08, RMSEA < .05 represent an acceptable model fit, with CFI and TLI > .95 suggesting an excellent model fit.

Results

Preliminary Analysis

No missing data or outliers were found whilst all constructs exhibited acceptable univariate skewness (<2) and kurtosis (<2).

Self-Report Measures

As Cronbach's alpha assumes tau equivalence, internal consistency was measured via McDonald's (1999) omega (ω). Firstly, the SEQ (Jones et al., 2005) revealed outputs of ω = .86 for pleasant emotions and ω = .88 for unpleasant emotions. The DCICS (Hurst et al., 2011) produced coefficients of ω = .86 for task-oriented coping, ω = .77 for distraction-oriented coping, and ω = .76 for disengagement-oriented coping. Finally, the RCDRS (Campbell-Sills & Stein, 2007) produced a coefficient of ω = .86 for resilience.

Path Analysis

A path analysis was conducted using MPlus 7 on the hypothesized model (Figure 1). The analysis of this model subsequently produced a model fit of $\chi^2(14) = 354.412$, $p < .001$, CFI = .982, TLI = .936, SRMR = .034, RMSEA = .07 (90% CI = .015, .124). Within this model, pleasant emotions were positively related to both task-oriented coping (β = .362, p < .001, 95% CI = .206, .517) and resilience (β = .232, p < .001, 95% CI = .125, .338), whilst unpleasant emotions were positively related to distraction- (β = .207, p < .001, 95% CI = .110, .304) and disengagement-oriented coping (β = .641, p < .001, 95% CI = .575, .708). Unpleasant emotions were also inversely related to resilience (β = -.156, p = .007, 95% CI = -.269, -.042). In relation to coping behaviors, task-oriented coping did not significantly relate to distraction-oriented coping (β = .124, p = .071, 95% CI = -.011, .259), but positively related to resilience (β = .649, p < .001, 95% CI = .383, .597). Distraction- and disengagement-oriented coping were found to both negatively associate with resilience (distraction-: β = -.099, p = .026, 95% CI = -.187, -.012; disengagement-: (β = -.127, p = .021, 95% CI = -.236, -.019), but positively associated with one another (β = .146, p = .010, 95% CI = .036, .257). We also assessed the strength of indirect paths. These paths were from pleasant emotions to resilience via task-oriented coping, as well as two paths from unpleasant emotions through to resilience via distraction- and disengagement-oriented coping respectively. In regards to the indirect path from pleasant emotions to resilience via task-oriented coping, a positive relationship was found (β = .177, p < .001, 95% CI = .111, .243). A negative indirect path was found from unpleasant emotions to resilience via disengagement-oriented coping (β = -.082, p = .023, 95% CI = -.152, -.011), as well as via distraction-oriented coping (β = -.021, p = .049, 95% CI = -.41, 0). This model can be found in Figure 2.

Discussion

The aim of Study 1a was to assess the applicability of the BaB theory of positive emotions (Fredrickson, 2001) within a sporting population. This was undertaken through a theoretically based (Gloria & Steinhardt, 2016; Tugade & Fredrickson, 2004) hypothesized model consisting of emotions, coping behaviors, and resilience. The excellent model fit, as well as the significant individual and indirect paths between constructs found provide initial support for the supposition of the BaB theory that emotions, coping behaviors, and resilience are interrelated.

As predicted, pleasant emotions were associated with task-oriented coping strategies; a finding which mirrors the literature (Nicholls et al., 2014; Thompson et al., 2020). We suggest that

that pleasant emotions widen an athlete's coping repertoire because there is now preliminary evidence for the occurrence of a broadening effect within sporting populations. Further, and as hypothesized, unpleasant emotions were positively related to distraction- and disengagement-oriented coping. Whilst distraction-oriented coping behaviors may not necessarily be inhibitive by nature (Laborde et al., 2014), disengagement-oriented coping has been linked with decreased performance (Schellenberg et al., 2013) and presented a moderate to large effect size. With the specific action tendencies of unpleasant emotions such as sadness theorized to distract and disengage oneself from a situation, these direct paths are theoretically consistent with BaB theory (Fredrickson, 2001).

We also predicted that pleasant emotions would positively relate to increased levels of resilience. The results of the path analysis showed that pleasant emotions both directly and indirectly related to increased resilience, with the latter relationship partially mediated by task-oriented coping strategies. With resilience a key resource within BaB theory (Fredrickson, 2001), and dispositional coping viewed as a durable personal resource and a facet of trait resilience (Fredrickson et al., 2003), these paths represent preliminary evidence that a 'build' effect may exist within sport. As theorized by Fredrickson (2001), pleasant emotions appear to help athletes behave in novel and creative ways, which help build personal resources for future person-environment interactions, such as sporting competitions. When combined with the associated increases in task-oriented coping, in theory, pleasant emotional experiences may aid athletes in a variety of ways, including through more efficient use of pleasant emotions to buffer against negative events (Fredrickson et al., 2003), through the increased likelihood of pleasant emotional experiences (Fredrickson & Joiner, 2002), and through increased performance (Uphill et al., 2014). Conversely, unpleasant emotions were directly and indirectly associated with diminished levels of resilience, with the latter relationship mediated by disengagement-oriented coping strategies. In accordance with theory (Fredrickson, 2001), unpleasant emotions do appear to narrow thought-action repertoires, with this exchange incurring a personal resource cost. This is important for two reasons. Firstly, unpleasant emotions and disengagement-oriented coping strategies are both linked with inhibited performance (Lane et al., 2010; Schellenberg et al., 2013), with unpleasant emotions also linked with psychophysiological stress (Smyth et al., 1998), indexed via cortisol levels. What is more, athletes with low resilience are more likely to employ disengagement-oriented coping strategies (Joyce et al., 2005). With BaB theory (Fredrickson, 2001) hypothesizing that unpleasant emotions may predict future experiences of unpleasant emotions, athletes may fall into a "downward spirals" process (Fredrickson & Joiner, 2002).

In summary, the findings of Study 1a provide initial support for the application of BaB theory (Fredrickson, 2001) within athletic populations. However, longitudinal research is required to assess the broaden, build, upward spirals, and downward spirals within the BaB theory. Study 1b was therefore undertaken to examine these key components of the BaB theory.

Study 1b: Longitudinal Relationships between Emotions, Coping, and Resilience within Athletic Populations: A Six-month Follow Up Study

Study 1b investigated whether experiences of pleasant emotions predicted levels of task-oriented coping behaviors, trait resilience levels, as well as further pleasant emotional experiences. We also examined the possible existence of a psychological undoing effect, as well as whether unpleasant emotions would have a lasting inhibitive effect on athlete behavior and personal resources. As such, the dispositional constructs of athlete emotions, coping strategies, and resilience were measured at least six months after each athlete had first participated in Study 1a. We chose a time gap of six months as recent research (Wilson et al., 2017) based upon BaB theory (Fredrickson, 2001) has shown this time is sufficient for any potential longitudinal effects to have come to fruition. In the interests of clarity, the baseline completion of questionnaires shall be known as Time Point 1 (TP1), with the following up completion of questionnaires six months later labelled Time Point 2 (TP2).

We hypothesized that the findings of Study 1b would mirror those of Study 1a at both TP1 and TP2, with pleasant emotions positively relating to task-oriented coping and resilience, and unpleasant emotions positively relating to distraction- and disengagement oriented-coping. Unpleasant emotions were also expected to inversely relate to resilience, whilst distraction-oriented coping was expected to relate to disengagement-oriented coping. At both TP1 and TP2, task-oriented coping was expected to positively relate to resilience, with distraction- and disengagement-oriented coping expected to negatively relate to resilience. Further, based on the theoretical assumptions of BaB theory as set out by Fredrickson (2001) and the research which underpins them (Fredrickson et al., 2000; Fredrickson & Branigan, 2005; Fredrickson & Joiner, 2002), we also made the following hypotheses. In light of the "reciprocal relations" between pleasant emotions and broadened thought-action repertoires constructs stated by Fredrickson (2001), we predicted that pleasant emotions, task-oriented coping, and resilience would reciprocally relate to one another across TP1 and TP2. Any significant increases in the use of task-oriented coping would be insinuated as evidence of a "broadening" effect (Fredrickson; 2001), as such behaviors typically require athletes to undertake novel patterns of thought and increase the amount of physical and/or mental resources allocated to a task. What is more, significant levels of task-oriented coping and resilience six months into the future were to be inferred as preliminary evidence for the "build" effect, based upon the work of Fredrickson and Joiner (2002). This is because previous experiences of pleasant emotions may have helped accumulate and compound coping and personal resources via an "upward spiral" effect. Unpleasant emotions were also hypothesized to predict future unpleasant emotions, whilst TP1 task-, distraction-, disengagement-oriented coping, and resilience were anticipated to predict future TP2 levels of task-, distraction-, disengagement-oriented coping, and resilience respectively. That is, the use of such strategies or resources will predict such use of that resource six months into the future. With no psychological evidence for the "undoing effect" (Fredrickson et al., 2000), no hypotheses were made regarding this potential outcome. However, it was decided by the research team that any previously significant and inhibitive path between unpleasant emotions and coping resources which became insignificant over time would be assessed as to its potential validity as an 'undoing effect'. The hypothesized model can be found in Figure 3.

Methods

Participants

One-hundred and twenty-six athletes (male n =85, female n = 41) aged between 16 and 71 (mean = 30.08, SD = 11.61), who participated in Study 1a, took part in this study. Participants had an average playing experience of 10.30 years (SD = 9.25) and took part in team and individual sports (e.g. football, badminton, and long-distance running). The sample included athletes who competed at international (n = 7), national (n = 8), county (n = 18), club (n = 72), and beginner (n = 21) levels.

Self-Report Measures

The self-report measures utilized mirrored those used in Study 1a. That is, athlete dispositional emotions were examined via the Sports Emotion Questionnaire (SEQ; Jones et al., 2005), athlete dispositional coping strategies were measured via the Dispositional Coping Inventory for Competitive Sport (DCICS; Hurst et al., 2011), and athlete dispositional resilience levels were assessed via the Revised Connor-Davidson Resilience Scale (RCDRS; Campbell-Sills & Stein, 2007). As in Study 1a, the instructions given to participants which accompanied the SEQ were amended in order to measure athlete dispositional emotions, whilst the items which comprised the RCDRS were slightly amended to be made more applicable to sport.

Procedure

Full ethical approval was granted from a university ethics committee for this research. Participation was limited to athletes who had completed Study 1a, who were contacted through email addresses they had supplied exactly six months to the day after they had originally completed Study 1a. To combat attrition, participation was encouraged through the use of a prize draw to win one of three £25 shopping vouchers. Participants were directed to an online consent form which then routed them to the questionnaire pack. All questionnaires were completed at the same time.

Data Analysis

A path analysis was conducted using sub-scale scores as observed variables, with the same recommended fit indices barometers (CFI > .90, TLI > .90, SRMR < .08, RMSEA < .05; Hu & Bentler, 1999) applied as in Study 1a.

Results

Preliminary Analysis

There were no issues with missing data or outliers. All constructs demonstrated acceptable univariate skewness (<2) and kurtosis (<2).

Self-Report Measures

McDonald's (1999) omega (ω) was employed to measure internal consistency. Examination of the SEQ (Jones et al., 2005) resulted in coefficients of ω = .84 (TP1) and ω = .86 (TP2) for pleasant emotions, as well as ω = .88 (TP1) and ω = .87 (TP2) for unpleasant emotions. The DCICS (Hurst et al., 2011) produced outputs of ω = .80 (TP1) and .85 (TP2) for task-oriented coping, ω = .77 (TP1) and ω = .76 (TP2) for distraction-oriented coping, and ω = .75 (TP1) and ω = .79 (TP2) for disengagement-oriented coping. Finally, the RCDRS (Campbell-Sills & Stein, 2007) reported outputs of ω = .85 (TP1) and ω = .84 (TP2) for resilience.

Path Analysis

The hypothesized model was examined via a path analysis undertaken using MPlus 7, which revealed an unsatisfactory model fit of $\chi^2(63) = 533.817$, $p < .001$, CFI = .942, TLI = .899, SRMR = .095, RMSEA = .077 (90% CI = .044, .108). To improve model fit, further modifications were made in an iterative process. This resulted in a final acceptable model fit of $\chi^2(63) = 533.817$, $p < .001$, CFI = .976, TLI = .957, SRMR = .086, RMSEA = .05 (90% CI = .00, .086).

As in Study 1a, TP1 pleasant emotions significantly related to TP1 task-oriented coping (β = .289, p = .001, 95% CI = .119, .458) and TP1 resilience (β = .214, p = .011, 95% CI = .049, .379), whilst a new negative path to TP1 distraction-oriented coping was discovered (β = -.216, p = .005, 95% CI = -.367, -.066). Further replicating Study 1a, TP1 unpleasant emotions positively related to both TP1 distraction- (β = .152, p = .027, 95% CI = .017, .287) and TP1 disengagement-oriented coping (β = .539, p < .001, 95% CI = .414, .664), whilst inversely relating to TP1 resilience (β = -.180, p = .009, 95% CI = -.316, -.044). At TP1, task-oriented coping was significantly positively associated with TP1 resilience (β = .414, p < .001, 95% CI = .284, .545), whereas TP1 disengagement-oriented coping was negatively associated to TP1 resilience (β = -.213, p = .001, 95% CI = -.338, -.088). However, distraction-oriented coping at TP1 did not relate to task-oriented coping at TP1 (β = .011, p = .887, 95% CI = -.135, .156). Finally, significant indirect effects were discovered from TP1 pleasant emotions through to TP1 resilience via TP1 task-oriented coping (β = .120, p = .008, 95% CI = .031, .209) and from TP1 unpleasant emotions through to TP1 resilience via TP1 disengagement-oriented coping (β = -.115, p = .003, 95% CI = -.191, -.039).

At TP2, pleasant emotions were positively connected with TP2 task-oriented coping (β = .258, p = .003, 95% CI = .087, .428) and TP2 resilience (β = .184, p = .001, 95% CI = .044, .324), whilst TP2 unpleasant emotions were associated with TP2 disengagement-oriented coping (β = .468, p < .001, 95% CI = .320, .617). TP2 unpleasant emotions were not significantly related to TP2 distraction-oriented coping (β = .098, p = .392, 95% CI = -.126, .322) or TP2 resilience levels (β = -.092, p = .141, 95% CI = -.215, .031). Further, TP2 distraction-oriented coping did not significantly relate to either TP2 pleasant emotions (β = .025, p = .773, 95% CI = -.142, .191) or TP2 task-oriented coping (β = .107, p = .076, 95% CI = -.011, .225). TP2 task- and disengagement-oriented coping were positively and negatively associated with TP2 resilience respectively (task-: β = .423, p < .001, 95% CI = .323, .522; disengagement-: β = -.244, p < .001, 95% CI = -.380, -.108). As at TP1, significant indirect effects were also found at TP2. TP2 pleasant emotions positively related to TP2 resilience via TP2 task-oriented coping (β = .109, p = .008, 95% CI = .028, .190), whilst TP2 unpleasant emotions inversely related to TP2 resilience via TP2 disengagement-oriented coping (β = -.114, p = .004, 95% CI = -.193, -.036).

Significant paths were also found between constructs across the two time points. TP1 pleasant emotions significantly related to subsequent TP2 pleasant emotions (β = .503, p < .001, 95% CI =

.343, .662) and TP2 resilience (β = .185, p = .026, 95% CI = .022, .348), whereas TP1 unpleasant emotions related to TP2 unpleasant emotions (β = .495, p < .001, 95% CI = .311, .680). TP1 Task-, distraction-, and disengagement-oriented coping strategies all positively related to their own TP2 measurements (task-: β = .608, p < .001, 95% CI = .492, .725; distraction-: β = .620, p < .001, 95% CI = .508, .732; disengagement-: β = .378, p < .001, 95% CI = .206, .549), whilst TP1 task-oriented coping also positively related to pleasant emotions at TP2 (β = .220, p = .012, 95% CI = .048, .392). TP1 resilience levels positively related to TP2 resilience levels (β = .621, p < .001, 95% CI = .507, .735). However, pleasant emotions at TP1 did not significantly relate to task-oriented coping at TP2 (β = .064, p = .543, 95% CI = -.142, .270). Figure 4 displays the final parsimonious model with standardized path estimates denoted.

Discussion

Study 1b was conducted to examine within athletes the longitudinal impact of the BaB theory's key constructs (Fredrickson, 2001); that is, emotions, coping, and resilience. Pleasant emotions and task-oriented coping strategies were found to predict future episodes of pleasant emotions and task-oriented coping six months later. These findings provide partial support for our hypothesis that pleasant emotions and task-oriented coping strategies serially enhance one another. This has implications for sport psychology researchers and athletes. Firstly, the bidirectional relationship between emotions and coping (Nicholls, Polman, et al., 2010) has been re-established. Secondly, engendering pleasant emotions and facilitating the execution of task-oriented coping strategies may initiate upward spirals within athletes. That is, pleasant emotions and task-oriented coping reciprocally influence and predict one another over time. Both pleasant emotions (Nicholls et al., 2012; Uphill et al., 2014) and task-oriented coping strategies (Gaudreau et al., 2010) have been associated with subjective and objective measures of performance, with success likely to encourage further pleasant emotions (Wilson & Kerr, 1999). Furthermore, both pleasant emotions and task-oriented coping were positively related to resilience levels at both time points, with pleasant emotions at TP1 even predicting resilience levels six months into the future. Finally, the experience of pleasant emotions, task-oriented coping, and resilience at TP1 positively predicted future levels of pleasant emotions, task-oriented coping, and resilience respectively at TP2, suggesting that pleasant emotional experiences may accumulate over time to build enduring resources. In sum, the positive direction of the path estimates of our model partially suggests that pleasant emotions may broaden the thought-action repertoires of athletes and help build their coping and enduring personal resource levels, which sustain over time. Therefore, even if an athlete does not achieve their sporting aims, they may have built the resource levels required to deal with the situation, and not incur substantial losses. From these findings, we recommend that scholars consider undertaking a randomized controlled trial in order to investigate whether the relationships found within this model translate to established cause and effect.

BaB theory (Fredrickson, 2001) holds that unpleasant emotions elicit cardiovascular and psychological aftereffects that may linger for some time, such as the diminishment of an athlete's resilience levels. It was hypothesized that unpleasant emotions would be negatively associated with resilience, as observed within Study 1a. However, within our model unpleasant emotions were not found to diminish resilience at TP2. This is important, as the abovementioned upwards spirals created by pleasant emotions may have reversed the previously observed diminishment of resilience by unpleasant emotions. In essence, with unpleasant emotions no longer significantly depleting athlete resource levels at TP2, preliminary evidence for a psychological "undoing effect" (Fredrickson et al., 2000) has been found within this study. To our knowledge, this is the first evidence of its kind. Pleasant emotions may not just help athletes create future pleasant experiences; they may also help athletes overcome unpleasant experiences from the past by reducing their psychological resource cost. The potential existence of a psychological undoing effect is noteworthy for both athletic and general populations, and worthy of further investigation. Future research could look to examine emotional response and resilience levels, along with psychophysiological markers including heart rate, blood pressure, and cortisol.

In accordance with Study 1a, unpleasant emotions were related to disengagement-oriented coping, which itself was inversely related to resilience levels. An indirect effect between unpleasant emotions and resilience via disengagement-oriented coping was also found at both time points. Whilst the potential benefits of pleasant emotions are heralded, this research suggests that athletes should remain vigilant as to the potential effect unpleasant emotions may have on their resource levels. Further, a path was also discovered between unpleasant emotions at TP1 and unpleasant emotions at TP2. This is worrying, as it appears that experiences of unpleasant emotions predict future experiences of unpleasant emotions, indicating that athletes may also experience downward negative spirals. Whilst the negative impact of these experiences may potentially be “undone” over time by pleasant emotions, it is important that coaches and practitioners attempt to minimize unpleasant emotional experiences. Suitable interventions include athlete reappraisal (Uphill et al., 2012), perhaps guided by goal adjustment (Nicholls, Levy, et al., 2016).

Use of distraction-oriented coping was found to predict future use of such strategies six months into the future. However, no other significant relationships were found with distraction-oriented coping at TP2. This concurs with the equivocal nature of the literature (Gaudreau et al., 2010; Laborde et al., 2014), and suggests that scholars may need to consider the categorization of distraction-oriented coping strategies in future research. For example, such strategies may be better understood through the examination of a ten-factor model of coping (Gaudreau & Blondin, 2002).

A limitation of Study 1b relates to the sample attrition rate. Indeed, whilst 126 athletes completing repeated measurements across six months may still be considered an acceptable sample, there was a drop from the initial 319 athletes at TP1. However, with minimal variance within the participant demographics noted across the two samples the attrition of this research appears to be unsystematic, meaning its integrity has been maintained (Little et al., 2000). Further, whilst Study 1a and Study 1b investigated the short- and long-term effects of emotions within sport, these studies did not examine how the mechanisms that underpin BaB theory (Fredrickson, 2001) translate to objective athletic performance in a controlled environment. The purpose of Study 2 was therefore to assess the applicability of the BaB theory of emotions to sporting contexts through the use of a controlled laboratory environment.

Study 2: A Psychophysiological Examination of the Broaden-and-Build Theory in Sport via a Lab-Based Reaction Task

Study 2 built upon the findings from Study 1a and Study 1b by investigating the relationship between emotions, coping strategies, trait resilience, and athletic performance using a lab-based reaction task. Across multiple time-points separated each by one week, emotionally manipulated athletes (e.g. pleasant, and unpleasant emotions) and a non-manipulated athlete control group undertook a sport-specific reaction time task designed to measure any immediate or lasting evidence of “broadening” and “building” effects in relation to psychological, neuroendocrine, and performance responses.

We predicted that the reaction time performances of the pleasant emotions group would improve after their emotional manipulation, as pleasant emotions have been linked with increased use of task-oriented coping strategies, which are associated with improved athletic performance (Nicholls, Taylor, et al., 2016). We also theorized that such performance improvement would be sustained within the pleasant emotions group athletes one week later. With unpleasant emotions associated with distraction- and disengagement-oriented coping (Nicholls, Perry, & Calmeiro, 2014), we theorized that the performances of the unpleasant emotions group would diminish immediately after their emotional manipulation; an effect that would sustain for at least one week after. In addition, we examined the relationship between emotions and salivary cortisol secretion. With both positive and negative performance feedback found to invoke a neuroendocrine response in athletes (Thompson et al., 2020), we hypothesized that significant cortisol spikes would occur immediately post-manipulation in both pleasant and unpleasant emotional groups. However, a sustainment of this effect was only expected within the unpleasant emotions group. Finally, we predicted that the psychological response of athletes would replicate the findings of Study 1a and Study 1b. That is, the pleasant emotions group would exhibit heightened levels of pleasant emotions, task-oriented coping, and resilience immediately post manipulation, an effect which would be sustained one week later. We also hypothesized that following the engendering of unpleasant emotions, the unpleasant emotions group would exhibit immediate decreased resilience levels and increased levels of unpleasant emotions, distraction-, and disengagement-oriented coping. This increase in disengagement-oriented coping was predicted to be sustained one week later. No significant psychophysiological or performance changes were predicted in the control group.

Methods

Participants

Twenty-one male athletes aged between 17 and 53 (age 29.67 ± 9.89; height 179.89 cm ± 5.71 cm; weight 80.09 kg ± 11.64 kg) were recruited via email and informational posters to take part in this research, which was conducted over the course of three testing days, each one week apart. To meet the inclusion criteria for the study, athletes were required to be aged from 16-55 years with no health contraindications, refrain from smoking and the consumption of substances which may impact upon cortisol secretion, and to participate in competitive sport. Participants were instructed to be in a hydrated state and avoid caffeine on the testing day, nor consume any food one hour prior to the testing beginning on each of the three testing days. Any strenuous activity was also restricted for 24 hours before testing. The protocol was approved by a university departmental ethics committee.

Self-Report Measures

Self-report measures were completed on each testing day. Participants answered items relating to their state emotions via the Sport Emotion Questionnaire (SEQ; Jones et al., 2005), whilst their use of coping strategies was measured via an altered version of the Coping Inventory for Competitive Sports (CICS; Gaudreau & Blondin, 2002), originally employed by Thompson et al. (2020). In the CICS, 10 strategies are organized into three second-order dimensions consisting of task-, distraction-, and disengagement-oriented coping, rated on a five-point Likert-type scale anchored by 1 = not at all and 5 = very strongly. However, Thompson et al. altered items to become more relatable to a laboratory-based task, whilst also removing items concerning the constructs ‘seeking support’ and ‘distancing from others’ due to a lack of task relevancy. This resulted in a

28-item CICS, with item examples including "I committed myself by giving a consistent effort". Thompson et al. reported McDonald's omega coefficients ranging between .68 and .91 for the amended CICS. Finally, participant resilience levels were measured through the use of the Revised Connor-Davidson Resilience Scale (RCDRS; Campbell-Sills & Stein, 2007).

Physiological Response and Performance

Athlete performance was determined by contrasting the average reaction time for each round of reactions across each day of testing. Reaction time refers to the time taken to respond to a perceived stimulus and is a common dependent variable within psychology (Whelan, 2008).

Athlete neuroendocrine response was indexed via salivary cortisol levels. Cortisol is a steroid hormone produced by the HPA axis and is used as a biomarker of psychological stress (Hellhammer et al., 2009). With a non-invasive sampling procedure via saliva, and significant changes in cortisol occurring just 15 minutes after a sporting performance (Quested et al., 2011), cortisol measurement has become increasingly common within psychophysiological research. Laboratory studies have shown that manipulated negative affect is associated with an increase in cortisol levels, whilst manipulated positive affect is associated with decreased cortisol levels (Buchanan et al., 1999).

Through the use of salivettes (Sarstedt, Rommelsdorf, Germany), participants provided three salivary cortisol samples per testing day. Samples were provided at baseline (Sample 1), immediate post-task (Sample 2), and 15 minutes post-task (Sample 3). Analysis of participant cortisol levels was undertaken through the use of enzyme-linked immunosorbent assays (R&D Systems, Minneapolis, USA).

Procedure

As recommended by Schweizer and Furley (2016), we undertook an a priori power analysis within G*Power 3.1 (effect size F = .35, alpha = .05, power = .80). with a total sample size of 21 suggested. This equated to seven participants per emotional group (pleasant emotions, unpleasant emotions, or control group). Each participant was randomly allocated to a group and took part in three testing sessions involving a FitLight reaction training system (FitLight Sports Corp., Ontario, Canada). The FitLight reaction training system is a wireless reaction training system which utilizes eight LED lights with inbuilt proximity sensors and can be programmed to create a wide range of decision making and agility tasks which require sport-specific movements from athletes. With Helsen and Starkes (1999) reporting no differences in reaction time between intermediate and expert athletes, the FitLight task was seen as suitable for athletes of varying abilities and is an increasingly popular laboratory-based measure of participant reaction time (Reigal et al., 2019; Zwierko et al., 2014). Finally, the FitLight task was also chosen because of the relatively low physiological demands it places on athletes in comparison to other laboratory-based tasks such as cycling time trials. As seen in Thompson et al. (2020), cortisol levels may significantly increase from participation in moderate to high-intensity exercise. As such, any significant cortisol variations between groups in this research are more likely to be due to the effects of the manipulations implemented.

We utilized a similar protocol to that of Zwierko et al. (2014). That is, participants completed 10 rounds of 22 reactions to visual stimuli appearing on the LED lights. With 220 reactions overall in each session, the study protocol met the requirements of 200-300 reactions advised by Sanders (p. 23, 1998) to avoid sequential effects. Each light was placed onto a semi-circle template 110cm from the ground, measuring 11 x 80 cm with gaps of 20 cm between each light, and 45 cm from the designated starting point. Using their dominant hand, participants were required to move their hand from the starting point to the relevant activated light as quickly as possible, before returning their hand to the starting point. Each reaction was separated by a time interval ranging from 0.1 to 3.0 seconds, with a period of 5 seconds between each round. In order to limit reaction anticipation, no auditory sounds were included within the stimulus, with no specific standardized interval between reactions (p. 23-24, Sanders, 1998). To ensure participants faced exactly the same protocol, both the protocol sequence and time intervals between stimuli were devised through the use of a random number generator (www.random.org) and pre-programmed into the FitLight. Each testing session was separated by a week in order to allow for the measurement of any lasting psychological, neuroendocrine, or performance effects from the engendered manipulation in session 2, as well as to reduce the chance of practice effects, which have been found to be non-significant in simple reaction time tasks separated by a week's interval (Falleti et al., 2006). Further, as task familiarity is a necessary consideration when investigating performance variance, a minimum of two familiarization rounds were provided before each testing session but were not included in the final analysis. In order to minimize the effects of diurnal variation, testing sessions occurred at the same time and day.

Other than the manipulations imparted upon participants during session 2, each testing session was exactly the same. Participants began each session by providing a saliva sample (Sample 1), completing the SEQ, and then undergoing their task familiarization. Following this, once the participant indicated that they were ready to begin, the experimental task began. The FitLight reaction time software recorded values for average and total reaction time per round. To assist the emotional manipulations, participants were not provided with any indication of their performance during the task. Once the 10th round was complete, participants provided their second saliva sample (Sample 2) and completed the remaining CICS and RCDRS questionnaires. Finally, participants provided their final saliva sample 15 minutes later (Sample 3), and the testing session concluded.

Manipulation

Emotional manipulations were engendered within all participants via the use of pre-recorded imagery scripts, which can be obtained upon request from the first author. These scripts were based on those used by Woodman et al. (2009) and were devised to contain a high level of detail in relation to a sporting event in order to elicit an appropriate psychophysiological response (Cumming & Williams, 2012). The pleasant emotional group were presented with a script which intended to elicit the emotions of happiness and excitement, whilst the unpleasant emotional group experienced a script intended to elicit the emotions of anger, anxiety, and dejection. These emotions were expressly targeted for two reasons. Firstly, they are the exact emotions measured in Jones et al.'s (2005) SEQ, which was employed in this study. Further, the use of co-occurring emotional groups would result in athletes experiencing aspects of both high and low approach motivation (Gable & Harmon-Jones, 2008), which more adequately encapsulates the wide emotional profile an athlete may experience during the course of a competitive sporting event. Participants within the control group received a neutral emotional script which discussed the process of brushing one's teeth (Kavanagh & Hausfeld, 1986). A control group was included to highlight any practice or treatment effects (Collie et al., 2003). All scripts were played to participants via a CD player placed within the laboratory, which was activated whilst the researcher was outside of the room.

Results

Demographics

To check whether the randomization process was effective, a one-way ANOVA was undertaken. The results showed no significant differences in relation to age (p = .57), height (p = .38), weight (p = .97), or amount of physical activity (p = .77).

Manipulation Checks

Independent Samples t-tests were conducted to test whether the pleasant and unpleasant groups had been engendered with the relevant emotions. All t-tests examined data from session 2 only, as this was when all manipulations were provided. In regards to pleasant emotions, the pleasant emotions group were found to score significantly higher than both the unpleasant emotions group (t (12) = 3.34, p = 0.006, g = 1.67) and the control group (t (12) = 3.03, p = 0.010, g = 1.52). Further, the unpleasant emotions group exhibited a significantly larger unpleasant emotions index value than both the pleasant emotions group (t (12) = 2.53, p = 0.026, g = 1.27) and the control group (t (12) = 2.62, p = 0.023, g = 1.31).

Self-Report Measures

McDonald's (1999) omega (ω) measured internal consistency. When examining the SEQ (Jones et al., 2005), it was revealed that there was no variance in the scores of unpleasant emotions items 2, 7, 12, and 22 for session 1, nor for the unpleasant emotions items 1, 2, 4, 7, 9, 12, and 14 for session 3. As such, their ω values could not be reported. The SEQ's coefficients were ω = .92 (session

1), ω = .94 (session 2), and ω = .96 (session 3) for pleasant emotions, and ω = .92 (session 2) for unpleasant emotions. Due to a lack of variance in item 27 of the modified CICS (Gaudreau & Blondin, 2002), no ω output was recorded for disengagement-oriented coping for session 1. Nonetheless, coefficients of ω = .70 (session 1), ω = .89 (session 2), and ω = .87 (session 3) were found for task-oriented coping, ω = .31 (session 1), ω = .93 (session 2), and ω = .81 (session 3) for distraction-oriented coping, and ω = .85 (session 2) and ω = .90 (session 3) for disengagement-oriented coping. Lastly, analysis of the RCDRS (Campbell-Sills & Stein, 2007) revealed coefficients of ω = .88 (session 1), ω = .90 (session 2), and ω = .93 (session 3). A repeated-measures analysis of variance (ANOVA) was undertaken to assess any potential psychological changes in the participating athletes over the course of the three testing sessions. The possibility of A type I error resulting from multiple comparisons was corrected through the use of Benjamini-Hochberg q, which was obtained from calculating the False Discovery Rate (FDR; Benjamini & Hochberg, 1995). If $p < q$ and the 95% confidence interval did not contain zero, the null hypothesis was rejected.

Pleasant and Unpleasant Emotions

Pairwise comparisons revealed that on the second day of testing the pleasant emotions group displayed significantly higher levels of pleasant emotions than on the first day of testing ($p = .033$, $g = .51$), although this finding did not pass the FDR ($p > q$). Further, participants in the pleasant emotions group reported significantly higher pleasant emotions than those in both the unpleasant emotions group ($p = .003$, $g = 1.67$) and the control group ($p = .007$, $g = 1.52$) during session 2, a finding which also satisfied the FDR ($q = .006$ and .011 respectively). Conversely, the unpleasant emotional group exhibited significantly lower levels of pleasant emotions during the 2nd session than during the 1st ($p = .017$, $g = .72$), although this finding failed to satisfy the FDR ($p > q$). A medium effect was also discovered between the 2nd and 3rd sessions, with the unpleasant emotional group experiencing less pleasant emotions in session 2 ($p = .051$, $g = .58$).

A significant between-subject effect was found for unpleasant emotions (F (2) = 7.66, $p = .004$), which sustained following post-hoc testing ($q = .007$). Participants within the unpleasant emotions group displayed higher levels of unpleasant emotions during session 2 than on session 1 (p = .004, g = 1.07) and session 3 (p < .000, g = 1.15), whilst participants within the pleasant emotions group displayed higher unpleasant emotional levels during session 1 than session 3 (p = .015, g = 2.64). All three of these findings passed the FDR, with outputs of q = .017, .033, and .017 respectively. Finally, the unpleasant emotions group exhibited significantly higher levels of unpleasant emotions during session 2 than the pleasant emotions (p = .007, g = 1.27) and the control (p = .005, g = 1.31) group. The resultant q outputs of q = .017 and .006 meant that the null hypothesis was rejected for both findings. This same relationship was also found during session 3, with the unpleasant emotions group again significantly higher than the pleasant emotions (p = .009, g = 1.21) and control (p = .006, g = 1.31) group. Both p values subsequently passed the FDR, with q = .022 and .011 respectively.

Coping Strategies

A large coping effect was found between the pleasant emotions group and the control group during session 2, with the pleasant emotion group using more task-oriented coping strategies (p = .064, g = 1.26). During session 3 the pleasant emotions group also utilized significantly more task-oriented coping strategies than both the unpleasant emotions (p = .034, g = 1.16) and the control (p = .028, g = 1.13), although in both cases $p > q$. The unpleasant emotions group also displayed significantly less task-oriented coping strategies during session 3 than they had done in session 1 (p = .002, g = 0.87), with q = .017 indicating that this result was post-hoc significant.

One final significant effect discovered in relation to coping strategies involved distraction-oriented coping strategies. During session 1, the control group exhibited higher levels of distraction-oriented coping than the pleasant emotions group (p = .048, g = 1.19), although this did not pass the FDR ($p > q$).

Resilience

Group pairwise comparisons revealed that both the pleasant and unpleasant emotions groups displayed higher levels of resilience during session 1 than the control group, with large effects found (pleasant emotions: $p = .014$, $g = 1.18$; unpleasant emotions: $p = .051$, $g = 1.28$). A medium effect was found during session 2, with the unpleasant emotions group displaying higher levels of resilience than the control group ($p = .051$, $g = .56$). However, none of the aforementioned findings satisfied the FDR ($p > q$).

Physiological Response

The decision was taken to only measure between-group comparisons due to diurnal variation across participants (Hayes et al., 2012), whilst effect size was used to express neuroendocrine response, as recommended by Denson, Spanovic, and Miller (2009). The descriptive statistics for each group's cortisol levels are detailed in Table 1.

During session 1, the cortisol levels of the pleasant emotions group decreased from TP1 to TP2, creating a medium effect of $g = .67$. Medium effects were also found from TP1 to TP3 ($g = .50$) and TP2 to TP3 ($g = .52$). Similar medium effects were discovered during session 2, with cortisol levels within the pleasant emotions group dropping from TP1-TP2 ($g = .77$) and TP1-TP3 ($g = .65$). During session 3, a spike in cortisol levels within the pleasant emotions group from TP1-TP3 was sufficient to generate a large effect size of $g = .80$. Finally, a cortisol level increase within the unpleasant emotions group between TP2 and TP3 produced a moderate effect of $g = .72$.

A number of medium to large effect sizes were discovered across sessions, also. When TP1 salivary samples were contrasted, an increase in cortisol levels was discovered between sessions 1 and 2 for the unpleasant emotions group, producing an effect of $g = .65$. Conversely, cortisol levels within the control group for TP1 were lower during session 3 than sessions 1 and 2, with effects of $g = .62$ and $g = .66$ respectively. For TP2, the pleasant emotions group exhibited higher levels of cortisol during their third Session. Analysis showed that this increase was enough for a large effect size in comparison to session 1 ($g = .85$), and a moderate effect size in comparison to session 2 ($g =.71$). In regards to the unpleasant emotions group, a decrease in TP2 cortisol levels from session 1 to session 3 was enough for a moderate effect ($g = .64$), as was a decrease from session 2 to session 3 ($g = .79$). Medium effects were also observed at TP2 between sessions 1 and 3 ($g = .51$) and sessions 2 and 3 (g

= .76) for the control group. Finally, TP3 cortisol levels with the pleasant emotions group produced two large effects. It was found that the session 3 TP3 levels increased substantially in comparison to session 1 ($g = .88$) and session 2 ($g = 1.13$). A medium effect was also found for this time point in the control group between sessions 1 and 3 ($g = .51$).

Reaction Time Performance

Athlete performance on the FitLight task was calculated via the average reaction time across the course of each testing session. Analyses showed that the performances of the pleasant emotions group were significantly better during sessions 2 and 3 than they were during session 1 (session 2: $p < .001$, $g = .55$; session 3: $p = .001$, $g = .58$). These effects were sustained following post-hoc analyses, with $q = .017$ and .033 respectively. The unpleasant emotions group exhibited similar performance improvement, with sessions 2 and 3 also significantly quicker on average than session 1 (session 2: $p = .003$, $g = .56$; session 3: $p = .004$, $g = .70$). Both of these performance improvements subsequently satisfied the FDR ($q = .017$ and .033 respectively). No significant performance changes were found within the control group, with all effect sizes also found to be trivial. The mean performance time of each group across sessions 1 to 3 can be viewed in Figure 5.

Group Pairwise comparisons revealed that whilst there was no significant performance difference between the groups during the baseline day of testing, there were some performance differences during sessions 2 and 3. Participants within the pleasant emotions produced performances that were significantly better than the control group during sessions 2 and 3 (session 2: $p = .003$, $g = 1.11$; session 3: $p = .035$, $g = 1.01$), both with notably large effect sizes. However, neither of these results satisfied the FDR ($p > q$).

Discussion

We investigated whether emotional manipulations would have both an immediate and sustained impact on participants' psychophysiological response and performance on a reaction-time task. The results demonstrate that pleasant emotions improved athletic performance immediately, with performance benefits sustained a week later. This finding supports our hypothesis and concurs with the sport psychological literature that pleasant emotions benefit athletic performance (Lane et al., 2010; Uphill et al., 2014). One potential explanation for this performance facilitation is that pleasant emotions may assist in both an attentional and mechanistic fashion. Indeed, the work of Vast et al. (2010) has suggested that the emotions of excitement and happiness, as measured within this research, may be associated with both a broad attentional focus and automaticity of movement, which does not incur an attentional capacity cost and is linked with enhanced performance on well-learned physical tasks (Abernethy et al., 2007). With the athletes within this research undertaking common sport-specific movements with a broad yet untaxed attentional focus, they were potentially in an ideal condition to produce a consistently strong reaction-time response. Sport psychology practitioners should engender pleasant emotions within their athletes to facilitate the development of psychological resources and increase the chances of optimal performance. Methods to engender pleasant emotions can include pleasantly valenced imagery scripts (Cumming & Williams, 2012).

Contrary to our predictions, unpleasant emotions facilitated athletic performance, an effect which was sustained a week later. Such an effect may be explained by the concept of emotional approach motivation (Gable & Harmon-Jones, 2008). Whilst unpleasant emotions may narrow thought-action repertoires, unpleasant emotions high in approach motivation such as anger may activate a specific action tendency (Lazarus, 1999) which matches the movements required by the sporting task, thereby improving performance (Woodman et al., 2009). Indeed, the emotion of anger possesses the action tendency to attack (Lazarus, 2000), which can be inferred to mirror the FitLight task kinetic requirements of a lashing motion. With unpleasant emotions engendered athletes potentially experiencing anger before the FitLight task, they may have subsequently been physiologically prepared for a lashing out movement, as indexed by their increased post-manipulation cortisol levels during session 2. This high activation arousal would explain their strong post-manipulation performance, with moderate cortisol increases associated with improved performance (Eubank et al., 1997). It can therefore be inferred that both pleasant and unpleasant emotions are both potential sports performance catalysts. However, there are inherent psychophysiological costs associated with the experience of unpleasant emotions, including anxiety

(Campo et al., 2012), and heightened cortisol levels (Filaire et al., 2007), which may result in long-term health implications (Burns, 2006). When compared with the benefits of pleasant emotions, it is clear that athlete stakeholders should always look to facilitate pleasant emotional experiences over unpleasant emotional experiences.

In relation to the control group, our analyses revealed no significant performance, psychological, or salivary cortisol change, supporting our hypotheses. It can therefore be inferred that both the task and the neutral manipulation engendered within the control group did not induce any psychological or neuroendocrine response within athletes. Further, with no performance change detected over three days of testing, it can be determined that no practice effect exists within this research. This suggests that the psychophysiological and performance changes witnessed within both emotional groups were solely due to the manipulations engendered.

It was hypothesized that further evidence would be found for the existence of the broaden and build (Fredrickson, 2001) effects. The broaden effect was anticipated to be indexed by increased use of task-oriented coping strategies, whilst evidence of the build effect could be suggested by increased levels of task-oriented coping or resilience one week later within the pleasant emotions group. Whilst post-hoc tests were not found to be significant, increases in task-oriented coping by the pleasant emotions group in relation to the control group were observed in Session 2 and Session 3, as well as the unpleasant emotions group during Session 3. Very large effect sizes provide partial support for the existence of such effects. The immediate increase and sustained usage of task-oriented coping strategies by the pleasant emotions group suggest that pleasant emotions may broaden one's attention to novel coping behaviors, which may potentially build resources for future encounters. Further, this may explain why participants within the pleasant emotions group also exhibited significantly lower levels of unpleasant emotions during their final testing session. Indeed, through increased coping resources, pleasant emotional experiences may therefore not only predict future experiences of pleasant emotions (as evidenced within Study 1b), but also lessen the chance of future unpleasant emotional experiences. Finally, athletes engendered with unpleasant emotions exhibited significantly lower levels of task-oriented coping strategies during session 3 than in session 1, despite no longer experiencing significantly high levels of unpleasant emotions. This research suggests that whilst unpleasant emotional experiences may be ephemeral by nature, they may have sustained behavioral consequences.

Cortisol levels within the pleasant emotions group were found to spike during session 3, with levels gradually heightening across the session. Indeed, cortisol levels at the final sampling point were found to be larger than sessions 1 and 2 by very large effects. These results suggest that the prospect of success is physiologically stressful when it is temporally close, concurring with previous research (Thompson et al., 2020). It is plausible that this stress may arise in an athlete through both the excitement of being close to achieving sporting success, as well as the fear of making a crucial mistake that costs victory. Future research into the stress of winning, and what specifically elicits it, is essential. Finally, the unpleasant emotions group exhibited cortisol spikes during session 2 in comparison to sessions 1 and 3, indicating a correlation between unpleasant emotional experiences and heightened neuroendocrine response. It is notable that when unpleasant emotional experiences subsided from their high during session 2 back to lower levels during session 3, athlete cortisol levels followed suit. As such, whilst an immediate neuroendocrine response was detected within this study, no long-term effects were found.

No significant results were found regarding athlete resilience levels across this research study. This finding may be due to the fact that trait resilience, rather than process-oriented resilience, was measured. This decision was taken as the RCDRS (Campbell-Sills & Stein, 2007) is currently the only measure of resilience within sport which has been validated among athletes (Gucciardi et al., 2011). However, reliance on a trait approach has been criticized by scholars (Bonanno, 2012), with arguments made that resilience is a construct which develops in the context of person-environment interactions (Fletcher & Sarkar, 2013). The development of a process-oriented resilience scale for athletes would be of great use to the sport psychological literature (Galli & Gonzalez, 2015).

Some limitations of this research may be addressed within future studies. Firstly, the FitLight task was deemed unsuitable to measure the coping strategies “distancing” and “seeking support”. Research that allows these strategies to be employed in a controlled environment will enable scholars to better understand the relationship between emotions, coping, and performance. Further, potentially interesting comparisons in neuroendocrine response across groups may have been missed within this study due to a lack of control of diurnal variation. An experimental pre-assessment which arranged participants according to baseline cortisol levels, who would then undergo the FitLight task at the same time of day would allow for comparisons to be made across manipulation groups. Finally, there is a possibility that the imagery manipulations imparted upon participants may have generated some level of expectancy effects. Scholars may wish to minimize this risk in future studies by utilizing a similar approach to Post et al. (2012), who inferred to participants that imagery scripts may not influence sporting performance.

General Discussion

Empirical findings among non-athletic samples (e.g. Fredrickson et al., 2003) have shown that pleasant emotions broaden individual thought-action repertoires and build enduring personal resources. The applicability of this model among athletes, however, has never been explicitly tested. This research, which was grounded in BaB theory (Fredrickson, 2001), provides partial support for the application of BaB theory within sport. Our findings demonstrate the benefits of pleasant emotional experiences. That is, pleasant emotions may have short- and long-term performance and psychological benefits, including broadening one's attention to facilitative coping strategies and 'building' enduring resources. Furthermore, this research also provides the first preliminary psychological evidence of the 'undoing effect' (Fredrickson et al., 2000). Study 1a and Study 1b illustrated that the experience of pleasant emotions not only predict future pleasant emotional experiences but may also reverse the impact of previously incurred unpleasant emotional experiences on durable personal resources such as resilience. Related to this effect, Study 2 showed that the engendering of pleasant emotions may decrease the likelihood of unpleasant emotional experiences in the future. Taken together, this research contributes both to the sport and general emotion literature regarding how the undoing effect may be manifested.

The implications of this research are not solely limited to the impact of pleasant emotions. Unpleasant emotions predicted further unpleasant emotions six months later, promoted the selection of disengagement-oriented coping strategies over task-oriented coping strategies, and induced cortisol spikes within athletes. Indeed, whilst the experience of unpleasant emotions may be transient (Fredrickson, 2001), their psychophysiological and behavioral impact may not. As such, decreases in task-oriented coping may be indicative of early downward spirals within athletes, given task-oriented coping's positive association with performance (Nicholls, Taylor, et al., 2016), and psychological well-being (Nicholls, Levy, et al., 2016). Practitioner monitoring of athlete emotions via psychometrics and/or observation may therefore help prevent the negative impact of unpleasant emotions before they have the chance to exert an influence.

A limitation of this paper relates to the sample in Study 2. Indeed, whilst this study was sufficiently powered, it can still be considered limited and did not include female athletes. Research studies such as Thompson et al. (2020) that utilized gender-balanced samples better reflect the 'real' world of sports participation, and offer a fruitful future avenue for scholars. Further, there was a disparity in participant age within Study 1a and Study 1b, which ranged between 16 and 71. Research has suggested that there are coping differences between young and adult athletes (Nicholls & Polman, 2007) and higher levels of resilience displayed in older adults (Gooding et al., 2012). However, age differences were not investigated in this research. It may well be that pleasant emotions have a larger potential for resource building within younger athletes, as younger athletes have had less time to develop effective coping behaviors and build personal resources. However, this research avenue requires further investigation.

With emotion considered an organized psychophysiological response (Lazarus, 2000), the employment of multiple psychophysiological markers is a logical next step for advancing knowledge of emotions in sport. Such markers include testosterone, which has been associated with faster reaction time and cardiovascular efficiency (Neave & Wolfson, 2005); heart rate variability, a physiologic substrate used as a stress marker and indicator of cognitive processing (Laborde et al., 2011), and; quiet eye duration, in which athlete attentional efficiency can be monitored (Moore et al., 2012). Aside from testosterone, the remaining psychophysiological markers mentioned have rarely been researched in relation to emotions in sport. Research in which emotions are engendered within athletes and measured across the course of a sporting competition could aid understanding of how sympathetic-adrenomedullary (SA) and HPA axis activation relate to athlete reappraisal, emotions, coping, performance, and the temporal imminence of potential success (or ‘success stress’; Thompson et al., 2020). From this, the development of psychophysiological emotional profiles, perhaps in a similar ilk to IZOF profiles (Hanin, 2000) could have real-world implications for modern-day athletes. Indeed, it is plausible that elite-level sporting teams would be able to use psychophysiological markers to assist their athlete into an optimum performance state. For example, knowledge of how emotions influence SA and HPA axis activation could be used to engender a specific approach-motivated emotion labelled as an HPA axis catalyst in order to raise salivary cortisol levels to performance beneficial levels (Eubank et al., 1997). While this level of knowledge within the sport psychophysiological literature is a long way off, the abovementioned techniques offer undoubted opportunities for scholars to make key contributions.

Researchers within the field of sport psychology may also wish to consider the combination of trait and state approaches within a singular research design. For example, research could examine how consistent personality constructs such as those within the “Big Five” (i.e. conscientiousness, agreeableness, neuroticism, openness, and extraversion; Goldberg, 1993) impact emotional response, or how coping interventions may override personality traits. Indeed, when one considers the negative impact personality types such as Type D (Polman et al., 2010) can have upon athletes (such as burnout), state-based interventions could offer an adaptive solution to athletes. Scholars within the literature have already begun to advocate a combined state-trait approach to researching athlete coping behaviors (Anshel & Si, 2008). Finally, there are a number of constructs that could affect athlete emotional experiences, such as social support or non-competitive stressors (Tamminen & Gaudreau, 2014). Studies which incorporate such variables into BaB rooted models could provide another dimension to the emotions in sport debate.

Conclusions

To conclude, the present multi-study research is the first work to provide preliminary support for the use of BaB theory (Fredrickson, 2001) within sporting populations. The engendering of pleasant emotions may broaden athlete attention towards more facilitative coping, build enduring coping resources, aid athletic performance, and potentially undo inhibitive psychological effects from previous unpleasant emotional experiences. Interventions that promote pleasant emotions may have sustained benefits for athletes.

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