



LEEDS
BECKETT
UNIVERSITY

Citation:

Stanger, N and Chettle, R and Whittle, J and Poolton, J (2018) The role of pre-performance and in-game emotions on cognitive interference during sport performance: The moderating role of self-confidence and reappraisal. *The Sport Psychologist*, 32 (2). pp. 114-124. DOI: <https://doi.org/10.1123/tsp.2017-0001>

Link to Leeds Beckett Repository record:

<https://eprints.leedsbeckett.ac.uk/id/eprint/4225/>

Document Version:

Article (Accepted Version)

The aim of the Leeds Beckett Repository is to provide open access to our research, as required by funder policies and permitted by publishers and copyright law.

The Leeds Beckett repository holds a wide range of publications, each of which has been checked for copyright and the relevant embargo period has been applied by the Research Services team.

We operate on a standard take-down policy. If you are the author or publisher of an output and you would like it removed from the repository, please [contact us](#) and we will investigate on a case-by-case basis.

Each thesis in the repository has been cleared where necessary by the author for third party copyright. If you would like a thesis to be removed from the repository or believe there is an issue with copyright, please contact us on openaccess@leedsbeckett.ac.uk and we will investigate on a case-by-case basis.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

The role of pre-performance and in-game emotions
on cognitive interference during sport performance: The moderating role of self-confidence
and reappraisal

¹Nicholas Stanger, ¹Ryan Chettle, ¹Jessica Whittle & ^{1,2}Jamie M. Poolton
¹Institute for Sport, Physical Activity & Leisure, Leeds Beckett University
²Faculty of Medicine, University of Hong Kong

Manuscript accepted: 22nd October, 2017

Address Correspondence to: Nicholas Stanger
Institute for Sport, Physical Activity & Leisure
Fairfax Hall, Headingley Campus
Leeds Beckett University
Leeds, LS6 3QS, UK
Telephone: (+44) 113 8123525
E-mail: N.Stanger@leedsbeckett.ac.uk

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

Abstract

In this research we examined whether prevalent pre-performance (Study 1) and in-game (Study 2) emotions were associated with cognitive interference (i.e., thoughts of escape, task irrelevant thoughts and performance worries), and whether any effects were moderated by reappraisal and self-confidence. In Study 1, we found team sport players' *pre-performance* anxiety positively, and excitement negatively, predicted cognitive interference during a competitive match. However, no moderating effects for reappraisal or confidence were revealed. In Study 2, we found that badminton players' *in-game* anxiety, dejection and happiness positively predicted, whereas excitement negatively predicted, cognitive interference during a competitive match. Moreover, reappraisal and confidence moderated the relationships for excitement and happiness with task irrelevant thoughts. Our findings underscore the role that pre-performance and in-game emotions can play on athletes thought processing during sport performance, as well as highlight the importance of considering self-confidence and reappraisal on the role of in-game emotions on cognitive interference.

Key words: concentration, confidence, emotion, emotion regulation, sport performance.

Emotion and Cognitive Interference

1 The role of pre-performance and in-game emotions on cognitive interference during sport
2 performance: The moderating role of self-confidence and reappraisal

3 There is growing research interest on how emotions can influence sport performance
4 (e.g., Campo, Mellalieu, Ferrand, Mertinent, & Rosnet, 2012; Uphill, Groom & Jones, 2014).
5 Given the limits of information processing (e.g., Eysenck & Calvo, 1992), concentration,
6 defined as the focus of mental effort on the task at hand while ignoring distractions (e.g.,
7 Schmid & Peper, 1998), is a key determinant of successful performance. However, emotions
8 can influence concentration by affecting cognition and attentional control (e.g., Eysenck,
9 Derekshan, Santos, & Calvo, 2007; Gable & Harmon-Jones, 2010), and pre-performance and
10 in-game emotions have been associated with in-game concentration (e.g., Allen, Jones,
11 McCarthy, Sheehan-Mansfield, & Sheffield, 2013; McCarthy, Allen, & Jones, 2013; Vast,
12 Young, & Thomas, 2010) and attentional processing (e.g., Wilson, Vine, & Wood, 2009).
13 However, research has neglected to examine how emotions experienced before and during
14 performance are linked with specific internal thought disruptions (i.e., cognitive interference),
15 or tested for amenable moderators of such relationships. Such research would guide ways for
16 sport practitioners (e.g., coaches, sport psychologists) to help athletes regulate emotions in
17 preparation for, as well as during, competition.

18 **Emotions and Cognitive Interference**

19 Though emotion has been conceptualised in various ways, there is some agreement
20 that emotions are conscious or unconscious cognitively appraised responses to an event
21 which “trigger a cascade of response tendencies manifested across loosely coupled response
22 systems, such as subjective experiences, facial expressions, cognitive processing and
23 physiological changes” (Frederickson, 2001, p.218; cf. Jones, Lane, Bray, Uphill, & Catlin,
24 2005). In many studies unpleasant emotions have been grouped together and regarded as
25 polar opposites of pleasant emotions (e.g., Bolger 1990). However, unpleasant emotions such

Emotion and Cognitive Interference

1 as anxiety and anger can be both facilitative and detrimental to performance (e.g., Eysenck et
2 al., 2007; Lazarus, 2000; Woodman et al., 2009). Accordingly, researchers have begun to
3 investigate how an array of discrete emotions (both pleasant and unpleasant) are associated
4 with performance related outcomes (e.g., McCarthy et al., 2013; Woodman et al., 2009).

5 Cognitive interference has been used to refer to internal thoughts which can disrupt
6 concentration through task-irrelevant, or self-preoccupied thinking including components of
7 worry about performance (Sarason, Sarason, & Pierce, 1990). Specifically, cognitive
8 interference comprises of three components; performance worries (e.g., “I am concerned
9 about how I am performing), thoughts of escape (e.g., “I want to quit”) and task irrelevant
10 thoughts (e.g., “I wonder what I’m going to do later”) (Hatzigeorgiadis & Biddle, 2000).
11 Studies have found that cognitive interference is associated with higher concentration
12 disruption (McCarthy et al., 2013) and poorer performance in physical tasks (e.g., Young,
13 2012).

14 An emotion that has received substantial research interest in sport is anxiety. Anxiety
15 is considered to reflect uncertainty regarding goal attainment and coping which is manifested
16 by feelings of tension and apprehension accompanied by activation or arousal of the central
17 nervous system (Jones et al., 2005; Lazarus, 2000; Spielberger, 1966). It has been
18 summarised to reflect “facing uncertain or existential threat” (Lazarus, 2000 p. 234).
19 Theoretical perspectives to explain the potential effects of anxiety on sport performance
20 generally agree that anxiety affects attention (e.g., Eysenck & Calvo, 1992; Eysenck, et al.,
21 2007; Masters & Maxwell, 2008). For instance, attentional control theory proposes that
22 anxiety causes stimulus driven attentional control to prevail over attentional control that is
23 task goal directed (Eysenck et al., 2007). As such, individuals are more likely to direct
24 attention to potential threats in the environment, are less adept at shifting attention to salient
25 information and less capable of inhibiting pre-potent thoughts whilst performing (Miyake et

Emotion and Cognitive Interference

1 al., 2000). Research has supported that anxious performers concentrate more often on
2 threatening or irrelevant stimuli during a game (e.g., Murray & Janelle, 2003; Wilson et al.,
3 2009) and that pre-performance anxiety is positively associated with concentration disruption
4 (Allen et al., 2013; McCarthy et al., 2013) and cognitive interference (McCarthy et al., 2013).

5 Though the attentional control theory is focused on how anxiety may influence
6 cognitive processing, it is likely that a range of emotions can affect goal-directed attention
7 (Derekshan & Eysenck, 2010; Lazarus, 2000). For instance, in their *motivational-*
8 *dimensional model* of affect, Gable and Harmon-Jones (2010) posited that high-approach
9 affective states (e.g., anger, excitement) result in attentional narrowing, whereas low-
10 approach affective states (e.g., dejection/ sadness, happiness) result in broadening of
11 attentional focus. Specifically, positive high-approach affective states (e.g., excitement,
12 desire) are expected to assist in goal-directed cognitions by shutting out irrelevant stimuli. In
13 contrast, positive low-approach affective states (e.g., happiness), which may be helpful for
14 exploratory behaviours, can be maladaptive for goal-directed attention by inducing an “easing
15 back” or conservation of energy that may result in lower goal-directed mental effort.
16 Likewise, a low-approach affective state (e.g., sadness, dejection) will likely result in “low-
17 effort” focus and widening of attentional breadth. Though it is argued that negative affective
18 states high in motivational intensity could be helpful to avoid danger (e.g., fight vs. flight),
19 the implications of narrowed attentional focus caused by high approach affective states (e.g.,
20 anger) on goal directed attention in sport is less clear and probably depends on the
21 performance objective. To this end, research would benefit from examining the contribution
22 that prevalent emotions experienced in sport (cf. Jones et al., 2005) differing in valence and
23 levels of approach motivation may have on cognitive interference.

24 Anger is a negatively valenced high approach emotion that has received much
25 research attention in sport. Specifically, anger is a high arousal emotion that represents a

Emotion and Cognitive Interference

1 response to an event that is perceived as a demeaning offense against me or mine (Lazarus,
2 2000). Anger can result in aggressive behavior, particularly if accompanied by intentions to
3 harm another person or following provocation (e.g., Isberg, 2000; Stanger, Kavussanu,
4 McIntyre, & Ring, 2016), and has been associated with both poor performance (e.g., Dewar
5 & Kavussanu, 2011) and good performance (e.g., Woodman et al., 2009). The potential
6 reasons for this discrepancy is the sources of information which anger is directed. Based on
7 Lazarus' cognitive motivational relational theory (2000), emotions are guided by a core
8 relational theme and its associated action tendency, and the influence of emotions on
9 performance can depend on a complex relationship between the individual and the situation.
10 Anger has a core relational theme of "a demeaning offense against me or mine" and an action
11 tendency of "a powerful impulse to counterattack" (Lazarus, 2000, p.242-243). Therefore, if
12 anger is directed inwards towards self-blame or to irrelevant information (e.g., on harming an
13 opponent) this is likely to impair performance (e.g., Lane & Terry, 2000). However, as anger
14 is a high-approach emotion, if applied to a task that is cognizant to "lashing out" which is
15 closely aligned to the action tendency of anger (e.g., weight lifting) then this may facilitate
16 focus and tenacity to the benefit of performance (e.g., Lazarus, 2000; Rathschlag &
17 Memmert, 2013; Woodman et al., 2009). Given these potential differences in how anger may
18 direct attention, studies have revealed that anger has been both positively associated with
19 concentration disruption (e.g., Allen et al., 2013; McCarthy et al., 2013), and negatively
20 associated with concentration (e.g., Vast et al., 2010) in sports that do not clearly resemble
21 skills where lashing out is necessary or vital for effective performance (e.g., golf, racket
22 sports, soccer, softball).

23 Dejection is another emotion commonly experienced by athletes during sport
24 performance, but has received limited research attention (Jones et al., 2005). Dejection is
25 closely connected to depressed mood and proposed to be a low intensity negative emotion

Emotion and Cognitive Interference

1 characterised by feelings of deficiency and sadness (Jones et al., 2005). It is likely to arise if
2 one perceives they are not making sufficient expected progress towards meaningful goals, or
3 following actual or perceived failure to achieve a meaningful goal (Frijda, 1994). Though
4 dejection is rarely experienced before competition (e.g., Jones et al., 2005) relative to during
5 competition (e.g., Vast et al., 2010), when dejection is experienced this is likely to impair
6 concentration. Specifically, as dejection (likened to sadness) is a low-approach emotion that
7 arises through an appraisal whereby one perceives failure or that they are not making
8 sufficient progress, this may widen attention and/or direct focus internally towards cognitions
9 irrelevant to the task at hand. Accordingly, athletes report higher levels of pre-performance
10 dejection in relation to poor performance compared to good performance (e.g., Allen et al.,
11 2013). Furthermore, pre-performance dejection has been positively associated with cognitive
12 interference in youth sport players (McCarthy et al., 2013) and concentration disruption in
13 both youth and adult athletes (e.g., Allen et al. 2013; McCarthy et al., 2013). Moreover, in-
14 game dejection has been linked with lower levels of concentration in softball players (e.g.,
15 Vast et al., 2010). However, it is yet to be determined how in-game dejection may be
16 associated with cognitive interference in sport.

17 Two pleasant emotions commonly experienced by athletes are happiness and
18 excitement (e.g., Jones et al., 2005). Happiness refers to a low intensity form of joy that
19 reflects the process of making reasonable progress towards a goal(s) to which one is striving
20 (Lazarus, 2000). Excitement is typically considered a high arousal pleasant emotion and is
21 thought to occur when a person has a positive expectation in their ability to cope and reach a
22 goal(s) or complete a task in challenging situations (Jones, 1995).

23 Fredrickson's (2001) *broaden-and-build theory* suggests pleasant emotions broaden
24 an individual's momentary mind-set which can aid performance by directing attention to the
25 most relevant resources and cues. However, based on the premises of the *motivational-*

Emotion and Cognitive Interference

1 *dimensional model* (Gable & Harmon-Jones, 2010) high-approach positive affective states
2 (e.g., excitement) narrow attention to facilitate focus on attaining the desired goal, whereas
3 low-approach affective states (e.g. happiness) broaden attentional focus. These propositions
4 would suggest that excitement would be negatively correlated with cognitive interference due
5 to it narrowing attentional focus on relevant cues; although, it remains possible that over-
6 excitement could hinder performance through excessive attentional narrowing. In contrast,
7 although happiness could facilitate the broadening and scope of attention, happiness as a low
8 approach emotion may reflect post-goal attainment resulting in the “easing off” of attentional
9 effort and thereby being drawn to task-irrelevant cues (cf. Gable & Harmon-Jones, 2010).

10 Studies have shown that pre-performance happiness did not predict cognitive
11 interference when controlling for other emotions (e.g., excitement) (McCarthy et al., 2013),
12 and has been positively associated with concentration disruption in some research (Allen et
13 al., 2013). In contrast, pre-performance excitement has been shown to be negatively
14 associated with concentration disruption and thoughts of escape (McCarthy et al., 2013). In
15 sum, these findings suggest that excitement may be more beneficial for effective information
16 processing during sport performance than happiness. However, more research is required to
17 improve our understanding on the role of pleasant emotions on cognitive interference.

18 Given that some emotions (e.g., anxiety, anger and happiness) have been somewhat
19 equivocally associated with concentration, it is important to examine their discrete roles on
20 cognitive interference. Moreover, apart from one study which investigated the moderating
21 role of age in youth sport players (McCarthy et al., 2013), research has yet to investigate
22 potential amenable moderators of the emotion-cognitive interference relationship. Appraisal
23 of literature reveals two primary candidates; self-confidence and emotion regulation (e.g.,
24 Eysenck & Calvo, 1992; Hanton, Mellalieu, & Hall, 2004; Uphill, Lane, & Jones, 2012).

25 **Self-Confidence and Emotion Regulation**

Emotion and Cognitive Interference

1 Self-confidence refers to the belief that one can successfully execute a specific
2 activity (Feltz, 1988) and has been shown to be positively associated with sport performance
3 across numerous studies (see Woodman & Hardy, 2003). The premises of some theories that
4 have been applied to explain the anxiety-sport performance relationship suggest that under
5 conditions of high confidence, anxiety may be facilitative for attentional control and
6 performance by exerting more goal-directed mental effort (Eysenck & Calvo, 1992).
7 However, it is when confidence is low that anxiety may be more likely to divert attention
8 away from relevant information. Thus, when one has reasonable belief in success, this can
9 reduce attention being drawn towards irrelevant thoughts (e.g., performance worries) when
10 anxious. Studies suggest that anxiety (e.g., Hanton et al., 2004; Neil, Mellalieu, & Hanton,
11 2006; Robazza & Bortoli, 2007) and anger (e.g., Robazza & Bortoli, 2007) are interpreted as
12 being more facilitative for performance when self-confident. Therefore, suggesting that
13 confidence may have a role to play on how anxiety and anger is interpreted for performance,
14 and potentially influence the relationship between both anxiety and anger with cognitive
15 interference. Moreover, given that dejection arises when one perceives they are not making
16 sufficient progress towards a goal, confidence may promote the provision of resources to
17 cope and succeed, which reduce the adverse impact dejection may have on cognition.
18 However, research has yet to investigate the potential moderating role of pre-performance
19 confidence on the relationships between emotions and cognitive interference.

20 Emotion regulation can be defined as the evocation of thoughts or behaviours that
21 influence emotions and how people experience or express these emotions (e.g., Richards &
22 Gross, 2000; Uphill et al., 2014). Though there is a considerable amount of ways that
23 emotions can be regulated, one prominent and adaptive approach to control emotions is
24 through reappraisal (Uphill et al., 2012). Specifically, reappraisal is an antecedent focused
25 form of emotion regulation which reflects a cognitive change that construes a potentially

Emotion and Cognitive Interference

1 emotion-eliciting situation in a way that modifies its emotional impact (Gross & John, 2003).
2 For instance, if an athlete believes they may feel overly anxious before competition, they may
3 adapt the way they perceive the event to reduce the anxiety and/or change the emotions they
4 **experience. An example** could be an athlete reappraising thoughts such as “I am daunted by
5 the prospect of not performing well against our arch-rivals” to “I feel excited to perform
6 against our rivals”. Accordingly, research has supported that reappraisal can be an effective
7 way for players to cope (e.g., Balk, Adrienne, De Riddler, & Evers, 2013) and perform better
8 (e.g., Brooks, 2014) under pressure situations.

9 Reappraisal may also influence relationships between emotions and performance
10 related outcomes. Uphill et al. (2012) found that despite unpleasant emotions including anger
11 and dejection being interpreted on average as debilitating for performance, the correlations
12 between reappraisal use and an interpretation of these unpleasant emotions being facilitative
13 were in a positive direction. Thus, it is possible that athletes who employ reappraisal find
14 unpleasant emotions including dejection and anger as less disruptive for cognition than those
15 who do not. Furthermore, Uphill and colleagues (2012) showed that athletes’ interpretation
16 of happiness being facilitative for performance was associated with higher reappraisal use.
17 Taken together, research implies that reappraisal may have moderating effect on relationships
18 between a range of emotions and cognitive interference, however research has yet to address
19 this possibility.

20 **The Present Study**

21 Previous research has highlighted that some emotions are associated with
22 concentration and performance. However, the association between a range of pre-
23 performance and in-game emotions with cognitive interference in adult athletes has yet to be
24 conducted. Moreover, given the equivocal findings between emotions and indices of attention
25 in previous research, the study of potential variables that moderate these relationships has

Emotion and Cognitive Interference

1 been neglected: self-confidence and reappraisal are likely moderators. To this end, the aim of
2 this research is to address these issues. In Study 1, to extend the only previous study
3 investigating the link between pre-performance emotions and cognitive interference (McCarthy
4 et al., 2013), we tested whether *pre-performance* emotions were associated with cognitive
5 interference, and if any relationships were moderated by self-confidence and reappraisal. In
6 Study 2, we examined whether *in-game* emotions were associated with cognitive
7 interference, and whether self-confidence and reappraisal moderated these relationships.

8 Informed by the literature reviewed, it is hypothesized that pre-performance and in-
9 game anxiety, dejection and happiness will be positively associated with cognitive
10 interference, whereas excitement will be negatively associated. Due to the previous
11 contradictory evidence, the relationship between anger and cognitive interference was less
12 clear. Though exploratory in nature, any relationships were expected to be stronger for in-
13 game than pre-game emotions due to the closer temporal proximity of in-game emotions with
14 in-game cognitions. We also predicted that both reappraisal and confidence would moderate
15 the relationships between anxiety, anger and dejection with cognitive interference, as well as
16 reappraisal moderating the relationships between happiness and cognitive interference.
17 However, the moderating role of both reappraisal and confidence on the effect of all emotions
18 will be explored. Finally, as confidence and reappraisal are approaches used to facilitate
19 coping resources that may influence how emotions are interpreted (e.g., Hanton et al., 2004;
20 Uphill et al., 2012), we also explored whether these potential moderators (reappraisal,
21 confidence) interact with emotions on relationships with cognitive interference.

Study 1

Method

24 **Participants.** One hundred and five team sport players (58 males, 47 females) with
25 an average age of 20.62 ($SD = 1.54$) years took part in this study. Participants competed in

Emotion and Cognitive Interference

1 hockey (n = 21), soccer (n = 16), rugby (n = 16), lacrosse (n = 15), water polo (n = 9), cricket
2 (n = 7), American football (n = 5), tchouckball (n = 5), volleyball (n = 5), netball (n = 4), and
3 basketball (n = 2) across a range of teams. At the time of data collection participants
4 competed in their respective sport for an average of 7.61 ($SD = 4.55$) years and competed at
5 club (35%), county/ regional (41%), and national/ international (24%) level.

6 **Measures**

7 **Emotions.** Emotions were measured using the 22-item Sport Emotion Questionnaire
8 (SEQ) (Jones et al., 2005). The SEQ comprises adjectives that measure anxiety (5 items; e.g.,
9 “anxious”), anger (4 items; e.g., “annoyed”), dejection (5 items; e.g., “dejected”), excitement
10 (4 items; e.g., “excited”), and happiness (4 items; e.g., “pleased”). Each item was rated
11 following the stem “during the last 10 minutes before my latest sport performance I felt” on a
12 5-point Likert type scale anchored from 1 (*not at all*) to 5 (*extremely*). Athletes can
13 accurately recall the emotions they experience (e.g., Jokela & Hanin, 1999) and there is
14 psychometric support for the factorial validity and internal consistency (α 's .77 to .87) for the
15 SEQ to measure emotions experienced retrospectively over a period of time (e.g., over the
16 past month; Arnold & Fletcher, 2015). Therefore, consistent with previous research (e.g.,
17 McCarthy et al., 2013), participants were asked to complete the SEQ after a performance
18 rather than immediately beforehand to avoid disrupting participants pre-performance routine.
19 A mean score for each subscale was calculated for analysis. Jones et al. (2005) provided
20 psychometric support for the measure's subscales with alpha coefficients ranging from .81 to
21 .88 in adult athletes from team and individual sports.

22 **Cognitive Interference.** Cognitive interference was measured using the 17-item
23 Thought Occurrence Questionnaire for Sport (TOQS) (Hatzigeorgiadis & Biddle, 2000). The
24 measure comprises of three subscales; namely, performance worries (6 items; e.g., “about
25 previous mistakes I have made”), task-irrelevant thoughts (5 items; e.g., “about other

Emotion and Cognitive Interference

1 activities”) and thoughts of escape (6 items; e.g., “that I want to quit”). Participants
2 responded to each item in relation to the following stem “During my latest match I had
3 thoughts” on a 7-point Likert type scale anchored from 1 (*almost never*) to 7 (*very often*). A
4 mean score was calculated for each subscale, as well as a mean composite score of all 17
5 items. Higher scores represent more frequent occurrences of cognitive interference.
6 Hatzigeorgiadis and Biddle (2000) provided psychometric support for each subscale, as well
7 as the composite score of cognitive interference, with alpha coefficients ranging from .78 to
8 .90 in adult athletes from team and individual sport.

9 ***Self-confidence.*** Self-confidence was measured using the 5-item subscale from the
10 Competitive State Anxiety Inventory 2-Revised (Cox, Martens, & Russell, 2003).
11 Specifically, players were asked to rate their response to a range of statements in terms how
12 they felt before their latest match on a 5-point Likert scale anchored from 1 (*not at all*) to 5
13 (*extremely*). An example item is “I felt self-confident”. A mean score of the 5 items was
14 taken. Cox et al. (2003) provided psychometric support for this measure with alpha
15 coefficients ranging from .86 to .91 in adult athletes from team and individual sport.

16 ***Reappraisal.*** To measure players’ use of reappraisal to regulate their emotions in
17 sport, the six-item reappraisal subscale from the Emotion Regulation Questionnaire (ERQ;
18 Gross & John, 2003) was used. Specifically, players were asked to complete each item in
19 relation to competing in sport and rate their level of agreement on a 7-point Likert type scale
20 anchored by 1 (*strongly disagree*) to 7 (*strongly agree*). An example item is “When I want to
21 feel less negative emotion (such as sadness and anger), I change the way I think about the
22 situation”. Higher scores represent greater use of reappraisal to regulate emotions whilst
23 participating in their sport. In the context of sport, Uphill et al. (2012) provided psychometric
24 support for this measure, including factorial validity and internal consistency, with an alpha
25 coefficient of .82 in adult athletes from team and individual sports.

Emotion and Cognitive Interference

1 **Procedure.** Following ethical approval from the University ethics committee,
2 participants were approached by one of the investigators at a training session during the
3 competitive season and provided a participant information sheet informing them of the study
4 purpose, that participation was voluntary and anonymity was assured. After signing a consent
5 form, participants were asked to complete the measures described above with reference to
6 their most recent match. All participants reflected on matches that had taken place less than 1
7 week earlier. Following completion, participants returned the questionnaire directly back to
8 the researcher and were thanked for their participation.

9 **Results**

10 **Data screening.** Prior to the main analyses, preliminary analysis was conducted to
11 check for outliers and to evaluate the assumptions underlying correlation and regression
12 analyses. Anger and dejection were not normally distributed (i.e., skewness and kurtosis
13 scores were not between -2 and 2), which was a consequence of many participants reporting a
14 score of zero for anger (69% of participants reported zero for all items; $M = 0.21$, $SD = 0.44$)
15 and dejection (84% of participants reported zero for all items; $M = 0.10$, $SD = 0.34$).
16 Consistent with research that had similar findings (e.g., McCarthy et al., 2013), anger and
17 dejection were removed from subsequent analysis. All other variables were normally
18 distributed and there was no evidence of multicollinearity (tolerance $> .35$, variance inflation
19 factor < 3).

20 **Descriptive statistics, correlations, and internal consistency.** Descriptive statistics,
21 correlations and internal consistency are shown in Table 1. Mean values reflected on average,
22 athletes experienced “a little” anxiety, and moderately experienced excitement and happiness
23 before the latest performance as well as occasionally had interfering thoughts during
24 performance. Cronbach’s (1951) alpha coefficients were good to very good for all remaining
25 scales.

Emotion and Cognitive Interference

1 **Emotions on cognitive interference.** To test whether emotions predicted cognitive
2 interference, and whether self-confidence and reappraisal moderated any relationships, a
3 series of four hierarchical regression analyses were conducted on each of the three subscales
4 as well as the composite score of cognitive interference (i.e., Aiken & West, 1991). The
5 variables were entered in a 4-step process. We entered emotions in Step 1, and self-
6 confidence and reappraisal in Step 2. In Step 3, we included the 2-way interactions of
7 confidence \times each emotion, confidence \times reappraisal, and reappraisal \times each emotion using
8 the product term of each mean centered variable. In Step 4, to explore for any conjunctive
9 moderating effect for confidence and reappraisal we entered the 3-way interaction of
10 confidence \times reappraisal \times each emotion using the product term of each mean-centered
11 variable (e.g., Aiken & West, 1991).

12 As we conducted several regression analyses which may increase the chance of Type I
13 error, an adaptation of Fisher's protected t test was applied (Cohen, Cohen, West, & Aiken,
14 2003). Specifically, similar to previous research (e.g., Dewar & Kavussanu, 2011), we only
15 investigated the significance of individual predictors when the F value of a specific step in a
16 regression was significant. Accordingly, coefficients for interactions are only reported in
17 Table 2 when the F value for the respective step is significant. However, we have reported
18 the coefficients for the main effects for confidence and reappraisal despite the F change for
19 Step 2 not being significant in any model.

20 Emotions accounted for 21% of the variance in performance worries ($R^2 = .21$, $F_{3,101} =$
21 8.92 , $p < .001$), 9% of the variance in task irrelevant thoughts ($R^2 = .09$, $F_{3,101} = 3.19$, $p = .03$),
22 12% of the variance in thoughts of escape ($R^2 = .12$, $F_{3,101} = 4.37$, $p < .01$), and 19% of the
23 variance in overall cognitive interference ($R^2 = .19$, $F_{3,101} = 7.85$, $p < .001$). Specifically, in
24 each model anxiety was a positive predictor and excitement a negative predictor of cognitive
25 interference and each of its sub-components. Happiness did not predict cognitive

Emotion and Cognitive Interference

1 interference. The F change in Steps 2, 3 and 4 were not significant in any of the models,
2 thereby no interactions amongst reappraisal, confidence and emotions were noted.

3 **Discussion**

4 Our findings are similar to those found in youth sport athletes (McCarthy et al., 2013).
5 Higher levels of pre-performance anxiety were associated with more frequent interfering
6 thoughts during performance. In contrast, higher levels of pre-performance excitement were
7 associated with less frequent interfering thoughts during performance, implying that
8 excitement may help protect effective information processing. However, confidence and
9 reappraisal did not moderate any of the relationships between pre-performance emotions and
10 cognitive interference.

11 It is possible that the role of emotions on cognitive interference and the moderating
12 role of confidence and reappraisal may be less sensitive for pre-performance states compared
13 to in-game emotions. The tendency to use reappraisal to regulate emotion may also depend
14 on context and is not necessarily stable over time (e.g., an athlete may need to employ
15 emotion regulation strategies differently across separate matches) (e.g., Uphill et al., 2012).
16 Moreover, dejection and anger appears to be experienced with higher intensity during than
17 before performance (e.g., Vast et al., 2010). To extend Study 1 we tested to see which in-
18 game emotions predict cognitive interference and if any relationships are moderated by pre-
19 performance confidence, and use of reappraisal during the match. We measured pre-
20 performance rather than in-game confidence to ensure we captured confidence before rather
21 than after emotions were experienced. This approach is conceptually aligned to the temporal
22 sequencing argued in processing efficiency theory (e.g., Eysenck & Calvo, 1992) and
23 suggested in previous research (e.g., Hanton et al., 2004; Neil et al., 2006; Robazza &
24 Bortoli, 2007), whereby confidence acts as a potential moderator on relationships between
25 (in-game) emotions and information processing (or performance).

1 **Study 2**2 **Method**

3 **Participants.** One hundred and sixty-six badminton players (108 men, 58 women)
4 with an average age of 32.25 years (S.D = 12.53) across of range of university and club teams
5 took part in this study. Participants competed in the sport for an average of 14.73 years (S.D =
6 10.99) and competed at club (45%), county/ regional (44%), and national/ international (11%)
7 level.

8 **Measures.**

9 ***Emotions, cognitive interference, reappraisal, and self-confidence.*** Like Study 1,
10 in-game emotions were measured using the SEQ (Jones et al., 2005) but this time participants
11 responded to each item in response to the following stem “during my latest match I felt”.
12 Although the original SEQ was validated to measure pre-performance emotions, the
13 questionnaire items were developed by asking athletes to retrospectively think about
14 emotions experienced during their latest sport performance. Accordingly, researchers have
15 used the SEQ to assess in-game emotions (e.g., Dewar & Kavussanu, 2011; Vast et al., 2010).

16 Reappraisal was measured with reference to its use during the most recent match
17 using an adapted version of the ERQ (Gross & John, 2003). An example of an adapted item is
18 “When I wanted to feel less negative emotion (such as sadness and anger), I changed the way
19 I thought about the situation”. Uphill et al. (2012) reported questionable stability for the
20 ERQ subscales potentially due to the fluctuating context of sport whereby the need to use
21 certain emotion regulation strategies may not be consistent over time (i.e., between different
22 matches). A confirmatory factor analysis (Maximum Likelihood) using Stata version 14 on
23 the subscale on the sample in this study revealed significant factor loadings for all items
24 (between .54 to .82) and an excellent model fit, $\chi^2(9) = 8.613, p = .47, RMSEA = 0.000, CFI$
25 $= 1.000, TLI = 1.003, SRMR = 0.028$.

Emotion and Cognitive Interference

1 Pre-performance confidence (CSAI-2R; Cox et al., 2003) and in-game cognitive
2 interference (TOQS; Hatgeorgiadis & Biddle, 2000) were measured as per Study 1.

3 **Procedure.** Prior to data collection, the study was approved by the university research
4 ethics committee. Following informed consent, participants completed the questionnaire
5 battery shortly after a competitive match (i.e., approximately 10-30 minutes) in relation to
6 their most recent match. Participants handed their responses directly back to the researcher
7 and were thanked for their participation.

8 **Results**

9 **Data screening.** Prior to the main analyses, preliminary analysis revealed two
10 outliers for anger and dejection (values greater than 3 SDs from the mean). Due to the
11 potential impact that outliers can have on results particularly for correlation analyses
12 (Osborne & Overbay, 2004), the outliers were both removed from subsequent analysis.
13 Normality of the data was then checked by examining skewness and kurtosis scores which all
14 lied between -2 and 2 indicating no significant deviation from normality. No evidence of
15 problems with multicollinearity was found (tolerance > .25, variance inflation factor < 4.1).

16 **Descriptive statistics, correlations, and internal consistency.** Descriptive statistics,
17 correlations and internal consistency are shown in Table 3. Cronbach's (1951) alpha
18 coefficients for dejection, anxiety and excitement reflected acceptable levels of internal
19 consistency, all other measures comprised of good to very good internal consistency. The
20 mean values were similar to those in Study 1, apart for emotions, particularly dejection and
21 anger, which were reported slightly higher in this sample (i.e., during performance).

22 **Emotions on cognitive interference.** To test whether in-game emotions predicted
23 cognitive interference, and whether reappraisal and confidence moderated any relationships,
24 as in Study 1, a series of four hierarchical regression analyses were conducted (i.e., Aiken &
25 West, 1991). The results of these analyses are presented in Table 4.

Emotion and Cognitive Interference

1 **Performance worries.** Emotions accounted for 17% of the variance ($R^2 = .17$, $\Delta F_{5,158} =$
2 6.46, $p < .001$) in performance worries. Anxiety, dejection and happiness were significant
3 positive predictors of performance worries. Anger and excitement were not significant
4 predictors. Both Step 3 and Step 4 were not significant, therefore no interactions were
5 evident.

6 **Task irrelevant thoughts.** Emotions predicted 7% of variance ($R^2 = .07$, $F_{5,158} = 2.36$, p
7 $= .04$) in task irrelevant thoughts. Specifically, happiness was a significant positive predictor,
8 and excitement was a significant negative predictor, of task irrelevant thoughts. Both Step 2
9 and Step 3 were not significant in the model. However, the F change for Step 4 was
10 significant which accounted for an additional 9% of variance ($\Delta R^2 = .09$, $\Delta F_{5,140} = 3.16$, $p = .$
11 01). Specifically, significant 3 way interactions for reappraisal \times confidence \times excitement and
12 reappraisal \times confidence \times happiness were revealed. As presented in Figure 1A, excitement
13 was a stronger negative predictor of task irrelevant thoughts for those high in reappraisal and
14 low in confidence. Moreover, as shown in Figure 1B, happiness was a more salient positive
15 predictor of task irrelevant thoughts for players low in both reappraisal and confidence. Thus,
16 these findings suggest a moderating effect of reappraisal and confidence on the relationship
17 between both in-game excitement and happiness with task irrelevant thoughts.

18 **Thoughts of escape.** Emotions accounted for 19% of variance ($R^2 = .19$, $F_{5,158} = 7.56$, p
19 $< .001$) in thoughts of escape. Anxiety and dejection were significant positive predictors
20 whereas excitement was a significant negative predictor of thoughts of escape. Step 3 was
21 significant ($\Delta R^2 = .12$, $\Delta F_{11,146} = 2.36$, $p = .01$) and revealed significant reappraisal \times dejection
22 as well as confidence \times happiness interactions. Dejection was a stronger positive predictor of
23 thoughts of escape for players with lower use of reappraisal compared to those reporting
24 higher use of reappraisal. Moreover, happiness was a stronger positive predictor of thoughts
25 of escape for those who reported lower confidence.

Emotion and Cognitive Interference

1 ***Overall cognitive interference.*** Emotions accounted for 17% of the variance in
2 overall cognitive interference ($R^2 = .17$, $F_{5,158} = 6.65$, $p < .001$). Anxiety, dejection and
3 happiness were significant positive predictors whereas excitement was a negative predictor of
4 cognitive interference. No further steps in the regression model were significant.

5 **Discussion**

6 Findings from Study 2 highlight the role that in-game emotions could play on
7 cognitive interference and underscore the importance of considering the moderating role of
8 confidence and reappraisal. Anxiety, dejection and happiness were positive predictors of
9 cognitive interference during performance. Specifically, all three emotions were positive
10 predictors of interference from performance worries, whereas only anxiety and dejection
11 were positive predictors of thoughts of escape, and only happiness positively predicted task
12 irrelevant thoughts. Moreover, the positive relationship between dejection and thoughts of
13 escape was more pronounced for those lower in reappraisal, and the positive relationship
14 between happiness and task irrelevant thoughts was more salient for players low in both
15 reappraisal and confidence. In addition, confidence also moderated the relationship between
16 happiness and thoughts of escape, whereby this positive relationship was more pronounced
17 for those low in confidence. On the other hand, excitement was a negative predictor of
18 cognitive interference, particularly task irrelevant thoughts and thoughts of escape. Moreover,
19 the negative relationship between excitement and task irrelevant thoughts was more
20 pronounced for individuals high in reappraisal and low in confidence.

21 **General Discussion**

22 Previous research investigating the link between pre-performance emotions and
23 cognitive interference has only been undertaken in youth sport players. Research has yet to
24 investigate whether in-game emotions predict cognitive interference, or test variables that
25 may moderate these relationships. The purpose of this research was to address these issues by

Emotion and Cognitive Interference

1 investigating whether (a) a range of pre-performance (Study 1) and in-game (Study 2)
2 emotions predicted cognitive interference during competitive sport performance, and (b)
3 examine whether these relationships were moderated by confidence and reappraisal.

4 **Unpleasant Emotions and Cognitive Interference**

5 Anxiety was positively associated with cognitive interference in both studies.
6 Specifically, similar to previous research in youth sport athletes (e.g., McCarthy et al., 2013),
7 pre-performance anxiety positively predicted all dimensions of cognitive interference in
8 Study 1. Moreover, in-game anxiety positively predicted performance worries and thoughts
9 of escape in Study 2, which is in accordance with previous research indicating that in-game
10 anxiety was associated with lower concentration levels (Vast et al., 2010). Taken together,
11 these findings are in line with theoretical perspectives which posit that anxiety can distract
12 attention away from salient performance information towards the processing of information
13 that is unlikely to facilitate performance (Eysenck & Calvo, 1992; Eysenck et al., 2007).
14 Specifically, thoughts not directly associated with the task at hand, concerns about
15 performance failure or thoughts associated with avoidance behaviour. Confidence and use of
16 reappraisal did not moderate the relationships between anxiety and cognitive interference in
17 both studies. Though some scholars have argued that when confidence is high, anxiety may
18 be facilitative for attentional processing (e.g., Eysenck & Calvo, 1992), the lack of
19 moderating effect for confidence in the anxiety-cognitive interference relationships in our
20 research does not support this prediction.

21 As expected, dejection positively predicted cognitive interference in Study 2.
22 Specifically, these findings suggest that when athletes feel dejected this is associated with
23 having more frequent thoughts relating to performance worries and thoughts of escape. These
24 findings are aligned with previous research showing pre-performance dejection is positively
25 associated with cognitive interference in youth athletes (McCarthy et al., 2013, Study 1),

Emotion and Cognitive Interference

1 concentration disruption (Allen et al., 2013), as well as research showing dejection is
2 negatively associated with concentration (Vast et al., 2010). Interestingly, dejection was not
3 associated with task irrelevant thoughts in our research. Given that dejection reflects a low-
4 approach emotion (cf. Gable & Harmon-Jones, 2010), and feelings of deficiency and sadness
5 that arise from a perceived lack of progress towards a goal (e.g., Frijda, 1994; Jones et al.,
6 2005), dejection may be more likely to arise from deficiency in relation to a task.
7 Accordingly, when dejected it may be expected that attention is broadened and consumed by
8 concerns about not reaching performance objectives (performance worries) and thoughts
9 about not wanting to continue or give up (i.e., thoughts of escape), rather than cognitions
10 irrelevant to the task.

11 Reappraisal moderated the relationship between in-game dejection and thoughts of
12 escape, whereby dejection was a stronger positive predictor of thoughts of escape for
13 individuals low in the use of reappraisal. These findings suggest that by regulating dejection
14 through the use of reappraisal this may help protect athletes from some disruptive thoughts
15 during competition. Changing how events are appraised may allow more productive goal-
16 directed information processing rather than attending to thoughts of escape (e.g., giving up).
17 There is accumulating evidence that dejection is disruptive to efficient information
18 processing. However, promoting the use of reappraisal (e.g., via cognitive restructuring or
19 positive self-talk) to regulate dejection when it is experienced may help reduce disruptive
20 thoughts.

21 In-game anger was positively associated with performance worries and thoughts of
22 escape factors of cognitive interference consistent with the literature (e.g., Allen et al., 2013;
23 McCarthy et al., 2013). However, when other emotions were statistically controlled for, anger
24 did not predict any aspect of cognitive interference, implying a negligible association. There
25 are at least two possible explanations for this. First, if appropriately controlled, in some

Emotion and Cognitive Interference

1 instances anger may help direct attention toward task relevant information, particularly if the
2 situation or task aligned to the action tendency such as “lashing out” (e.g., Lazarus, 2000;
3 Woodman et al., 2009). However, if anger is not suitably controlled, or experienced in
4 situations or tasks that are not aligned to its action tendency, this is likely to result in
5 disruptive thought processing and hinder performance (e.g., Lazarus, 2000). Second, anger
6 could be directed towards self-blame that may result in internal cognitions such as berating
7 oneself (e.g., “I am annoyed with myself”), or directed to the blame of others (e.g., an
8 opponent following provocation) that could result in disruptive focus towards irrelevant
9 external information; thus, cognitions not captured by the TOQS. It is for future research to
10 verify such explanations.

11 **Pleasant Emotions and Cognitive Interference**

12 Excitement negatively predicted cognitive interference in both studies. Specifically,
13 pre-performance and in-game excitement was associated with reduced frequency of irrelevant
14 thoughts and thoughts of escape, and pre-performance excitement was also associated with
15 reduced frequency of performance worries. These findings support propositions based on the
16 motivational dimensional model (Gable & Harmon-Jones, 2010) and are akin to previous
17 research that has also shown excitement to be negatively associated with thoughts of escape
18 and concentration disruption in youth athletes (McCarthy et al., 2013). Interesting, the
19 negative relationship between in-game excitement and task irrelevant thoughts in Study 2 was
20 moderated by an interaction between reappraisal and [pre-performance](#) confidence.
21 Specifically, the negative relationship between excitement and task irrelevant thoughts was
22 more pronounced for individuals high in reappraisal and low in confidence. This may be
23 explained by reappraisal facilitating more positive thought processing when athletes are low
24 in confidence that may elicit more intense feelings of excitement. Conceptually, excitement is
25 thought to arise when a person has a positive expectation in their ability to cope and reach a

Emotion and Cognitive Interference

1 goal(s) or complete a task in challenging situations (Jones, 1995). Therefore, if an athlete is
2 able to reappraise events during performance more positively they may be able to counteract
3 the low confidence by enhancing excitement. In other words, excitement may promote self-
4 belief in the ability to reach a goal or overcome challenging circumstances in the absence of
5 confidence and thereby reduce irrelevant information processing. These findings are aligned
6 to research that highlights the benefits of reappraising anxiety as excitement across a range of
7 pressure inducing tasks, such as public speaking (Brooks, 2014).

8 In-game happiness was a positive predictor of cognitive interference, particularly in
9 the form of task irrelevant thoughts. These findings are partially supported by previous
10 research showing that the link between happiness and concentration disruption was in a
11 positive direction (Allen et al., 2013). However, other studies tend to find happiness is
12 negligibly associated with cognitive interference and concentration disruption (e.g.,
13 McCarthy et al., 2013). The positive relationship between in-game happiness and task
14 irrelevant thoughts was also moderated by an interaction between [pre-performance](#)
15 confidence and in-game reappraisal whereby this relationship was more pronounced for
16 players' low in both reappraisal and confidence. This suggests that experiencing happiness
17 during performance may be disruptive to attention when athletes are low in confidence and
18 less likely to reappraise the emotion. Moreover, a moderating effect of confidence on the
19 relationship between happiness and thoughts of escape was also noted whereby happiness
20 was more strongly associated with more frequent thoughts of escape for individuals' low in
21 confidence. These findings can be explained in light of the motivational–dimensional model
22 (Gable & Harmon-Jones, 2010). Specifically, positive emotions lower in approach motivation
23 such as happiness may broaden attentional focus, which could result in irrelevant information
24 being processed. Accordingly, when athletes do not reappraise happiness to facilitate a more

Emotion and Cognitive Interference

1 conducive emotional state and when low in confidence, this may result in attention becoming
2 more blasé and drawn away from the task.

3 In Study 1, pre-performance happiness was not associated with cognitive interference.
4 These findings are consistent with previous research investigating pre-performance emotions
5 on cognitive interference and concentration disruption in youth athletes (McCarthy et al.,
6 2013). A possible reason why in-game happiness could potentially be more disruptive to
7 thought processing than pre-performance emotions is that happiness before performance may
8 also be helpful to preserve energy and attentional resources (e.g., Gable & Harmon-Jones,
9 2010) prior to competition whereas if experienced during performance, and not controlled,
10 may directly result in irrelevant thought processing. Future research should consider re-
11 addressing the role of pre-performance vs. in-game happiness on attention and performance.

12 It is worth noting that based on the interactions for pleasant emotions (see Figure 1),
13 most frequently reported irrelevant thoughts were in players reporting low excitement and
14 confidence, and high reappraisal use, or when in athletes reporting low confidence and
15 reappraisal use, and high happiness. The potential reason for this is that confidence and
16 excitement may be associated with less frequent irrelevant thoughts, however if athletes use
17 reappraisal to experience more positive emotion in the form of happiness rather than
18 excitement, or do not reappraise happiness when experienced, it is possible that this is
19 associated with more frequent irrelevant thoughts. In other words, these findings suggest it
20 may be more facilitative for athletes who use reappraisal to experience excitement rather than
21 happiness. It is for further research to confirm these suggestions.

22 **Applied Implications**

23 The findings presented in this paper imply that athletes may benefit from forms of
24 emotion control training (e.g., reframing, cognitive restructuring) (see Jones, 2003).
25 Strategies to reduce experiences of dejection, and regulate the intensity of anxiety and

Emotion and Cognitive Interference

1 happiness during performance may help reduce the likelihood of interfering thoughts during
2 competition. Alternatively, strategies that can help athletes reappraise experiences or
3 symptoms of anxiety into feelings of excitement should help concentration. Brooks (2014)
4 recently showed that reappraisal of anxiety provoking situations as exciting through self-
5 statements such as “I am excited” or “get excited” was more beneficial for performance than
6 “trying to relax or stay calm”.

7 Pre-performance confidence and in-game reappraisal use were found to moderate
8 some of the relationships between in-game emotions and cognitive interference, specifically
9 for dejection and happiness. Accordingly, athletes would benefit from applying appropriate
10 confidence building approaches (e.g., self-talk, imagery) prior to performance and developing
11 their ability to reappraise emotions during performance by learning to effectively apply
12 cognitive behavioural strategies.

13 **Limitations and Future Research Directions**

14 Although this research has provided some novel findings there are of course some
15 limitations that should be considered. Performance was not assessed in the two studies, so we
16 assume that cognitive interference had a negative effect on performance outcome. Both
17 studies were cross-sectional, so the causal direction of relationships cannot be determined.
18 Similar to previous studies of emotion (e.g., Dewar & Kavussanu, 2011; McCarthy et al.,
19 2013; Vast et al., 2010), participants were asked to reflect on emotions across specified points
20 or periods of time (i.e., 10 minutes before the latest match or during the latest match,
21 respectively). As emotions are transient and likely to fluctuate, we cannot say with any
22 certainty that specific intensities of emotions, or combinations of emotions, temporarily
23 aligned to occurrences of cognitive interference. We also measured pre-performance
24 confidence in both studies to control the temporal sequencing of confidence as a moderator of
25 the relationships between emotions and cognitive interference. Though confidence may not

Emotion and Cognitive Interference

1 be expected to be as transient as emotions, it is of course possible that confidence could
2 fluctuate during a match (e.g., Vealey, 2001). Experimental investigation would afford the
3 more direct examination of the effects of confidence, emotion inductions, and emotion
4 regulation strategies on attentional processes, and in turn, their impact on sport-specific
5 performance.

6 Self-report allows researchers to measure participants' subjective experience of
7 emotions and assess attentional processing in real-world contexts without impacting on
8 participant performance preparation by completing the measures after, rather than just before
9 or during performance. Moreover, research has supported that emotions in sport can be
10 reliably recalled in time periods up to a month (e.g., Arnold & Fletcher, 2015). That said, it is
11 possible that results were impacted by recall bias. To advance research in the field, multi-
12 measure approaches to the assessment of emotion (e.g., observations of facial expression,
13 psychophysiological indices of emotion) and attention (e.g., EEG, active recall from
14 observations) as part of experimental or longitudinal research designs should be considered.

15 Apart from one previous study that investigated the moderating role of age on the
16 emotion-concentration relationship in youth athletes, to our knowledge, this is the only other
17 research that has investigated potential moderators of this relationship, and the first in adult
18 sport performers. Given the complexity of how some emotions may influence concentration,
19 it is unlikely that our test of potential moderators was exhaustive. Appraising emotion-
20 concentration relationships through other theoretical lenses (e.g., Jones, Meijen, McCarthy, &
21 Sheffield, 2009) could identify other potential moderators to trial. Finally, this study focused
22 on cognitive interference and did not examine other potentially disruptive thought patterns
23 including external distractions or thoughts directed towards conscious processing of
24 movements. Given that emotions, particularly anxiety, have been argued to play a role on
25 such attentional processes (e.g., Eysenck et al., 2007; Masters & Maxwell, 2008), researchers

Emotion and Cognitive Interference

1 may wish to further explore how an array of emotions can influence other forms of disruptive
2 thoughts not captured by cognitive interference.

3 **Conclusion**

4 To conclude, this research demonstrated that emotions can play a role in cognitive
5 interference in sport. Specifically, anxiety, dejection and, to an extent, happiness were
6 positive predictors, and excitement a negative predictor, of aspects of cognitive interference.
7 Moreover, reappraisal and confidence moderated some relationships between in-game
8 emotions and cognitive interference. These findings provide a range of applied implications
9 in terms of highlighting how pre-performance and in-game emotions are associated with
10 interfering thoughts. Finally, such research underscores the importance of investigating how
11 emotions can influence attention during sport performance, as well as the need to consider
12 variables that moderate these relationships.

13

References

- 1
2 Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting*
3 *interactions*. Newbury Park, London: Sage.
- 4 Allen, M. S, Jones, M., McCarthy, P., Sheehan-Mansfield, & Sheffield, D. (2013). Emotions
5 correlate with perceived mental effort and concentration disruption in adult sport performers.
6 *European Journal of Sport Science, 13*, 697-706. doi:10.1080/174613391.2013.771381
- 7 Arnold, R., & Fletcher, D. (2015). Confirmatory factor analysis of the sport emotion
8 questionnaire in organizational environments. *Journal of Sports Sciences, 33*, 169-179.
9 doi:10.1080/02640414.2014.955520
- 10 Balk, Y. A., Adriaanse, M. A., De Ridder, D. T., & Evers, C. (2013). Coping under pressure:
11 employing emotion regulation strategies to enhance performance under pressure. *Journal*
12 *of Sport & Exercise Psychology, 35*, 408-418. doi:10.1123/jsep.35.4.408
- 13 Bolger, N. (1990). Coping as a personality process: a prospective study. *Journal of*
14 *Personality & Social Psychology, 59*, 525-537. doi:10.1037/0022-3514.59.3.525
- 15 Brooks, A. W. (2014). Get excited: reappraising pre-performance anxiety as excitement.
16 *Journal of Experimental Psychology: General, 143*, 1144-1158. doi:10.1037/a0035325
- 17 Campo, M., Mellalieu, S., Ferrand, C., Mertinent, G., & Rosnet, E. (2012). Emotions in team
18 contact sports: a systematic review. *The Sport Psychologist, 26*, 62-97. doi:10.1123/tsp.26.1.62
- 19 Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/ correlation*
20 *analysis for the behavioral sciences*. Mahwah., NJ Lawrence Erlbaum Associates.
- 21 Cox, R. H., Martens, M. P., & Russell, W. D. (2003). Measuring anxiety in athletics: the revised
22 competitive state anxiety inventory-2. *Journal of Sport & Exercise Psychology, 25*, 519-533.
23 doi:10.1123.jsep.25.4.519
- 24 Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika,*
25 *22*, 297-334. doi:10.1007/BF02310555

Emotion and Cognitive Interference

- 1 Derekshan, N., & Eysenck, M.W. (2010). Introduction to the special issue: emotional states,
2 attention, and working memory. *Cognition & Emotion*, *24*, 189-199. doi:10.1080/026999-
3 30903412120
- 4 Dewar, A. J., & Kavussanu, M. (2011). Achievement goals and emotions in golf: The
5 mediating and moderating role of perceived performance. *Psychology of Sport & Exercise*,
6 *12*, 525-532. doi:10.1016/j.psychsport.2011.05.005
- 7 Eysenck, M., & Calvo, M. (1992). Anxiety and performance: the processing efficiency
8 theory. *Cognition & Emotion*, *6*, 409-434. doi:10.1080/02699939208409696
- 9 Eysenck, M. W., Derakshan, N., Santos, R. & Calvo, M. G. (2007). Anxiety and cognitive
10 performance: attentional control theory. *Emotion*, *7*, 336-353. doi:10.1037/15283542.7.2.336
- 11 Feltz, D. (1988). Self-confidence and sports performance. *Exercise & Sport Sciences*
12 *Reviews*, *16*, 423-457. doi:10.1249/00003677-198800160-00016
- 13 Fredrickson, B.L. (2001). The role of positive emotions in positive psychology: The broaden
14 and- build theory of positive emotions. *American Psychologist*, *56*, 218-226.
15 doi:10.1037/0003-066X.56.3.218
- 16 Frijda, N.H. (1994). Emotions are functional, most of the time. In P. Ekman & R.J. Davidson
17 (Eds.), *The nature of emotion* (pp. 112-122). Oxford, England: Oxford Univ. Press.
- 18 Gable, P. A., & Harmon-Jones, E. (2010). The motivational dimensional model of affect:
19 implications for breath of attention, memory and cognitive categorisation. *Cognition &*
20 *Emotion*, *24*, 322-337. doi:10.1080/02699930903378305
- 21 Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes:
22 Implications for affect, relationships, and well-being. *Journal of Personality and Social*
23 *Psychology*, *85*, 348-362. doi:10.1037/0022-3514.85.2.348

Emotion and Cognitive Interference

- 1 Hanton, S., Mellalieu, S. D., & Hall, R. (2004). Self-confidence and anxiety interpretation: a
2 qualitative investigation. *Psychology of Sport & Exercise*, 5, 477-495. doi:10.1016/S1469-
3 0292(03)00040-2
- 4 Hatzigeorgiadis, A., & Biddle, S. J. (2000). Assessing cognitive interference in sport:
5 development of the thought occurrence questionnaire for Sport. *Anxiety, Stress & Coping*,
6 13, 65-86. doi:10.1080/106158000082448334
- 7 Isberg, L. (2000). *Anger, aggressive behavior, and athletic performance*. In Y. L. Hanin
8 (Ed.), *Emotions in sport* (pp. 113-133). Champaign, IL: Human Kinetics.
- 9 Jokela, M., & Hanin, Y. (1999). Does the individual zones of optimal functioning model
10 discriminate between successful and less successful athletes? A meta-analysis. *Journal of*
11 *Sports Sciences*, 17, 873-887. doi:10.1080/026404199365434
- 12 Jones, G. (1995). More than just a game: Research developments and issues in competitive
13 anxiety in sport. *British Journal of Psychology*, 86, 449-478. doi:10.1111/j.2044-
14 8295.1995.tb02565.x
- 15 Jones, M.V. (2003). Controlling emotions in sport. *The Sport Psychologist*, 17, 471-486.
- 16 Jones, M. V., Lane, A. M., Bray, S. R., Uphill, M., & Catlin, J. (2005). Development and
17 validation of the sport emotion questionnaire. *Journal of Sport and Exercise Psychology*,
18 27, 407-431. doi:10.1123/jsep.27.4.407
- 19 Jones, M., Meijen, C., McCarthy, P. J., Sheffield, D. (2009). A theory of challenge of threat
20 states in athletes. *International Review of Sport & Exercise Psychology*, 2, 161-180.
21 doi:10.1080/17509840902829331
- 22 Lane, A. M., & Terry, P. C. (2000). The nature of mood: development of a conceptual mode
23 with a focus on depression. *Journal of Applied Sport Psychology*, 12, 16-33.
24 doi:10.1080/10413200008404211

Emotion and Cognitive Interference

- 1 Lazarus, R. S. (2000). How emotions influence performance in competitive sports. *The Sport*
2 *Psychologist, 14*, 229-252. doi:10.1123/tsp.14.3.229
- 3 Masters, R., & Maxwell, J. (2008). The theory of reinvestment. *International Review of Sport*
4 *& Exercise Psychology, 1*, 160-183. doi:10.1080/17509840802287218
- 5 McCarthy, P. J., Allen, M. S., & Jones, M. V. (2013). Emotions, cognitive interference, and
6 concentration disruption in youth sport. *Journal of Sports Sciences, 31*, 505-515.
7 doi:10.1080/02640414.2012.738303
- 8 Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D.
9 (2000). The unity and diversity of executive functions and their contributions to complex
10 “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49–100.
- 11 Murray, N., & Janelle, C. (2003). Anxiety and performance: A visual search examination of
12 the Processing Efficiency Theory. *Journal of Sport & Exercise Psychology, 25*, 171-187.
- 13 Neil, R., Mellalieu, S. D., & Hanton, S. (2006). Psychological skills usage and the
14 competitive anxiety response as a function of skill level in rugby union. *Journal of Sports*
15 *Science & Medicine, 5*, 415-423.
- 16 Osborne, J. W., & Overbay, A. (2004). The power of outliers (and why researchers should
17 always check for them). *Practical Assessment, Research & Evaluation, 9*.
- 18 Rathschlag, M., & Memmert, D. (2013). The influence of self-generated emotions on
19 physical performance: an investigation of happiness, anger, anxiety, and sadness. *Journal*
20 *of Sport & Exercise Psychology, 35*, 197-210. doi:10.1123/jsep.35.2.197
- 21 Richards, J. M., & Gross, J. J. (2000). Emotion regulation and memory: the cognitive costs of
22 keeping one’s cool. *Journal of Personality & Social Psychology, 79*, 410-424.
23 doi:10.1037/0022-3514.79.3.410

Emotion and Cognitive Interference

- 1 Robazza, C., & Bortoli, L. (2007). Perceived impact of anger and anxiety on sport
2 performance in rugby players. *Psychology of Sport & Exercise*, 8, 875-896.
3 doi:10.1016/j.psychsport.2006.07.005
- 4 Sarason, I. G., Sarason, B. S., & Pierce, G. R. (1990). Anxiety, cognitive interference, and
5 performance: Communication, cognition and anxiety. *Journal of Social Behaviour and*
6 *Personality*, 5, 1-18.
- 7 Schmid, A. & Peper, E. (1998). Strategies for Training Concentration. In J. M. Williams
8 (ed.), *Applied Sport Psychology: Personal Growth to Peak Performance* (pp. 316-328).
9 Mountain View, CA: Mayfield.
- 10 Spielberger, C. D. (1966). *Theory and research on anxiety*. In C. D. Spielberger (Ed.),
11 *Anxiety and behavior* (pp. 3-20). New York: Academic press.
- 12 Stanger, N., Kavussanu, M., McIntyre, D., & Ring, C. (2016). Empathy inhibits aggression in
13 competition: the role of provocation, emotion and gender. *Journal of Sport & Exercise*
14 *Psychology*, 38, 4-14. doi:10.1123/jsep.2014-0332
- 15 Uphill, M., Groom, R., & Jones, M. (2014). The influence of in-game emotions on basketball
16 performance. *European Journal of Sport Science*, 14, 76-83. doi:10.1080/17461391.2012.729088
- 17 Uphill, M., Lane, A. M., & Jones, M.V. (2012). Emotion regulation questionnaire for use with
18 athletes. *Psychology of Sport & Exercise*, 13, 761-770. doi:10.1016/j.psychsport.2012.05.001
- 19 Vealey, R. S. (2001). Understanding and enhancing self-confidence in athletes. In R. N. Singer, H.
20 A. Hausenblas, C. M. Janelle (Eds). *Handbook of sport psychology*. Wiley: New York.
- 21 Vast, R. L., Young, R. L., & Thomas, P. R. (2010). Emotions in sport: perceived effects on
22 attention, concentration, and performance. *Australian Psychologist*, 45, 132-140.
23 doi:10.1080/00050060903261538
- 24 Wilson, M., Vine, S., & Wood , G. (2009). The influence of anxiety on visual attentional control
25 in basketball free throw shooting. *Journal of Sport & Exercise Psychology*, 31, 152-168.

Emotion and Cognitive Interference

- 1 Woodman, T., Davis, P. A., Hardy, L., Callow, N., Glasscock, I., & Yuill-Proctor, J. (2009).
- 2 Emotions and sport performance: an exploration of happiness, hope, and anger. *Journal of*
- 3 *Sport & Exercise Psychology*, *31*, 169-188. doi:10.1123/jsep.31.2.169
- 4 Woodman, T., & Hardy, L. (2003). The relative impact of cognitive anxiety and self-
- 5 confidence upon sports performance: A meta-analysis. *Journal of Sports Sciences*, *21*, 443-
- 6 457. doi:10.1080/0264041031000101809
- 7 Young, P. R. (2012). The effect of attentional interference on a rock climbing task: A pilot
- 8 study. *Pamukkale Journal of Sport Sciences*, *3*, 10-19.

Table 1. Descriptive Statistics, correlations and internal consistency for Study 1 (N=105)

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	9	10
1. Anxiety	1.56	0.87	(.84)								
2. Excitement	2.83	0.68	.17	(.72)							
3. Happiness	2.27	0.86	.05	.63**	(.82)						
4. Performance worries	2.74	0.97	.39**	-.13	-.01	(.74)					
5. Irrelevant thoughts	2.09	1.13	.19	-.14	.01	.47**	(.88)				
6. Thoughts of escape	1.45	0.61	.16	-.25*	-.09	.59**	.57**	(.83)			
7. Cog. Interference	2.09	0.74	.31**	-.21*	-.04	.84**	.83**	.82**	(.89)		
8. Reappraisal	4.16	1.05	-.01	.13	-.01	-.03	-.15	-.02	-.08	(.84)	
9. Confidence	2.59	0.74	-.05	.43***	.24*	-.25**	-.08	-.30**	-.24*	.20*	(.87)

Note: Emotions and self-confidence were measured on a 1-5 scale, and cognitive interference and reappraisal were measured on a 1-7 scale. * $p < .05$, ** $p < .01$, *** $p < .001$.

Emotion and Cognitive Interference

Table 2. Regression analyses for pre-performance emotions on cognitive interference in Study 1 ($N = 105$).

Emotion	Performance worries		Irrelevant thoughts		Thoughts of escape		Cognitive interference (total)	
	<i>b</i> (se)	β	<i>b</i> (se)	β	<i>b</i> (se)	β	<i>b</i> (se)	β
Step 1								
Anxiety	.48 (0.10)	.44***	0.30 (0.13)	.23*	0.15 (0.07)	.21*	0.31 (0.08)	.37***
Excitement	-.44 (0.17)	-.31**	-0.49 (0.21)	-.29*	-0.33 (0.11)	-.37**	-0.43 (0.13)	-.39**
Happiness	.18 (0.13)	.16	0.24 (0.16)	.18	0.10 (0.09)	.14	0.16 (0.10)	.18
Step 2								
Reappraisal	.04 (0.08)	.04	-0.12(0.11)	-.12	0.03 (0.06)	.06	-0.00 (0.07)	-.00
Confidence	-24 (0.13)	-.18	0.05(0.17)	.04	-0.17 (0.09)	-.28*	-0.13 (0.10)	-.13

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Emotion and Cognitive Interference

Table 3. Descriptive Statistics, correlations and internal consistency for Study 2 ($N=164$)

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10
1. Anxiety	2.00	0.67	(.78)									
2. Anger	1.81	0.61	.23**	(.68)								
3. Dejection	1.62	0.48	.28**	.56**	(.66)							
4. Excitement	3.24	0.74	.24**	-.05	-.21**	(.68)						
5. Happiness	3.28	0.78	.12	-.23**	-.29**	.56**	(.76)					
6. Performance worries	2.71	0.80	.29**	.19*	.31**	-.03	.07	(.63)				
7. Irrelevant thoughts	1.86	0.81	.09	-.03	.01	-.08	.14	.35**	(.80)			
8. Thoughts of escape	1.45	0.48	.22**	.25**	.39**	-.17*	-.10	.34**	.53**	(.71)		
9. Cognitive interference	2.02	0.54	.27**	.17*	.29**	-.10	.07	.79**	.80**	.73**	(.81)	
10. Reappraisal	4.17	1.09	.11	.09	.03	.13	.19*	-.03	.12	-.02	.04	(.85)
11. Self confidence	3.14	0.78	-.14	-.10	-.10	.36***	.22**	-.10	-.07	-.13	-.10	.00

Note: Emotions and self-confidence were measured on a 1-5 scale, and cognitive interference and reappraisal were measured on a 1-7 scale. * $p < .05$,

** $p < .01$

Emotion and Cognitive Interference

Table 4. Regression analyses for in-game emotions on cognitive interference in Study 2 ($N = 164$).

	Performance worries		Irrelevant thoughts		Thoughts of escape		Cognitive interference (total)	
	<i>b</i> (se)	<i>B</i>	<i>b</i> (se)	β	<i>b</i> (se)	β	<i>b</i> (se)	β
Step 1								
Anxiety	.26 (0.10)	.22**	0.15 (0.10)	.12	0.11 (0.06)	.16*	0.18 (0.06)	.22**
Anger	.03 (0.12)	.03	-0.01(0.13)	-.01	0.04 (0.07)	.05	0.03 (0.08)	.03
Dejection	.45 (0.16)	.27**	-0.00 (0.17)	-.00	0.31 (0.09)	.31**	0.26 (0.10)	.24*
Excitement (Excite)	-.14 (0.10)	-.13	-0.29 (0.11)	-.26**	-0.12 (0.06)	-.19*	-0.18 (0.07)	-.25**
Happiness (Happ)	.20 (0.09)	.20*	0.28 (0.10)	.27**	0.06 (0.06)	.09	0.17 (0.06)	.25**
Step 2								
Self Confidence (Conf)	-.05 (0.08)	-.05	-0.02(0.09)	-.01	-0.02 (0.05)	-.03	-0.03 (0.06)	-.04
Reappraisal	-.07 (0.06)	-.09	0.07 (0.11)	.08	-0.00 (0.03)	-.01	-0.01 (0.04)	-.01
Step 3								
Conf*Happiness					-0.25 (0.08)	-.34**		
Reappraisal*Dejection					-.37 (0.10)	-.39***		
Step 4								
Reappraisal*Conf*Excite			-0.44 (0.16)	-.36**				
Reappraisal*Conf*Happ			0.26 (0.12)	.33*				

Note. Only significant interactions for regression steps that were also significant are reported in the table. * $p < .05$, ** $p < .01$, *** $p < .001$

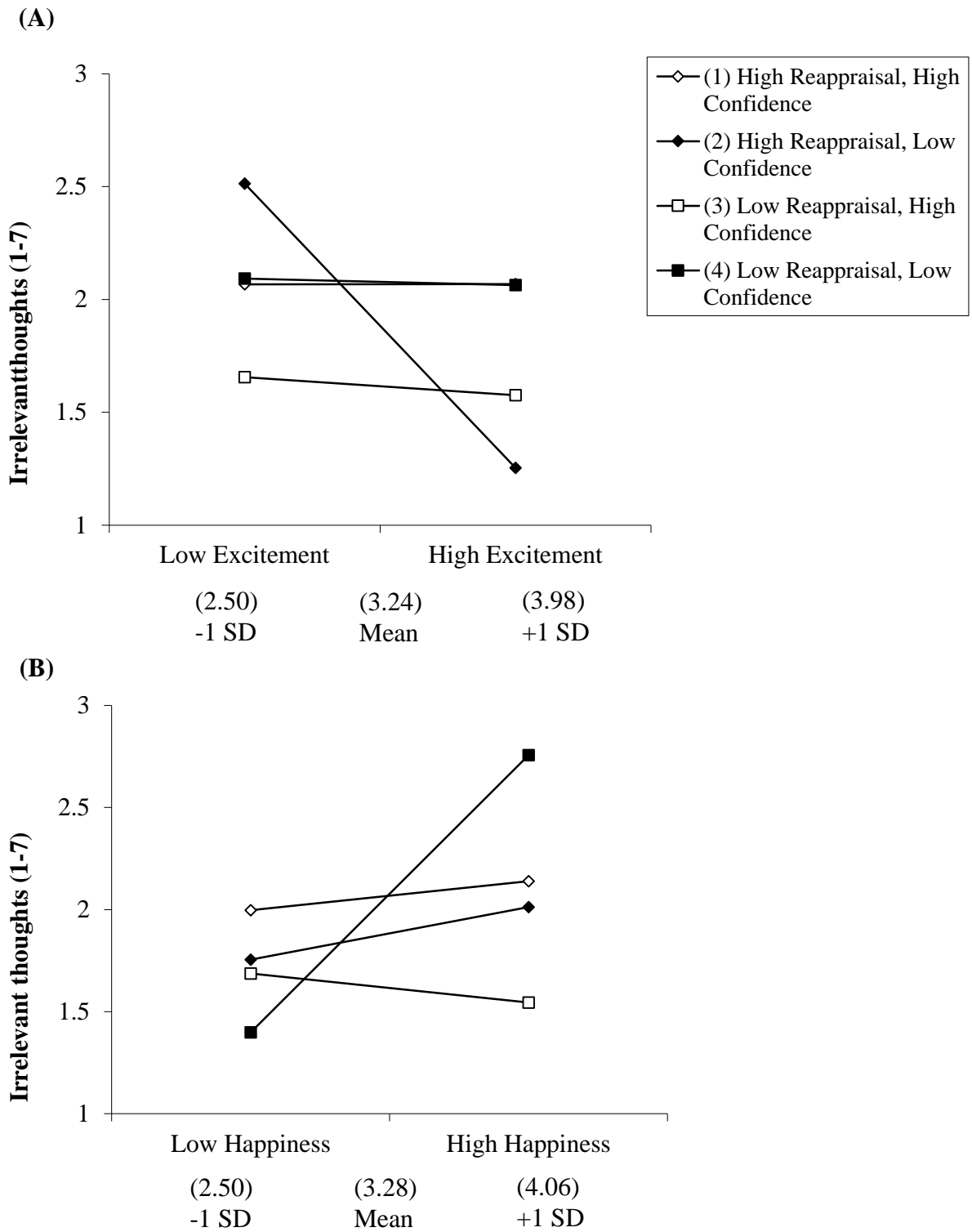


Figure 1. The moderating effect of reappraisal and confidence on the relationship between a) in-game excitement and task irrelevant thoughts (Panel A) and b) in-game happiness and task irrelevant thoughts (Panel B) in Study 2.