An Investigation of Choking in Sport and the Moderating Influence of Physiological Stress

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Abstract

The aim of the study was to explore choking in sport and examine the moderating influence of physiological stress. Through a pragmatic mixed-methods approach, 40 novice golfers completed a low intensity (LI; 90% gas exchange threshold) and high intensity (HI; 100% V'O2max) exercise task, followed by a golf putting task under high (HP) and low pressure (HP). Performance scores were investigated using a two-way (2 x 2) pressure by intensity repeated measures ANOVA, and the difference between LP and HP performance scores of each participant (after LI and HI) was calculated to identify individuals who had choked. Six participants choked under pressure, and they each completed a semi-structured interview which explored their choking event and the perceived role of physiological stress. The study provided a further insight into the antecedents, mechanisms, consequences and moderators of choking, and found that the influence of physiological stress on choking in sport was insignificant.

Introduction

Choking in sport is a significant drop in performance standard that occurs under conditions of high perceived pressure and elevated anxiety (Hill, Hanton, Fleming, & Matthews, 2009; Mesagno & Mullane-Grant, 2010). It is caused by attentional disturbances, which are the result of self-focus and / or distraction (see Beilock & Gray, 2007; Hill, Hanton, Matthews, & Fleming, 2010a for a review). With regards to self-focus (i.e., Explicit Monitoring Hypothesis, Beilock & Carr, 2001; Consciousness Processing Hypothesis, Masters, 1992), raised anxiety levels will cause some athletes to direct their attention inwardly and reinvest their well-learned procedural motor skill. Thus, rather than process the skill automatically, the athlete consciously monitors and / or controls its explicit, technical aspects (Masters, 1992). As this places high demands on working memory, the skill is processed less efficiently and choking may occur as a result (see Jackson, Ashford, & Norsworthy, 2006). Conversely, choking through distraction is the consequence of the athlete processing task irrelevant anxiety-related thoughts (e.g., worries, fear and self-doubt) alongside task-relevant information required for performance (Eysenck & Calvo, 1992). Such dual-processing overloads working memory and the athlete can experience choking unless they respond with increased effort (Wilson, Smith, & Holmes, 2007).

Although self-focus is presented within the literature as the most likely explanation of choking, much of its supporting evidence has emerged from experimental studies in which conditions were manipulated to encourage the participant to self-focus (see Hill et al., 2010a). Indeed, more recent ecologically valid research has indicated that few athletes 'naturally' self-focus when exposed to competitive pressure (Oudejans, Kuijpers, Kooijman, & Bakker, 2011), and that distraction appears to be the most common mechanism of choking (e.g., Gucciardi, Longbottom, Jackson, & Dimmock, 2010; Hill, Hanton, Matthews, & Fleming, 2010b, Hill & Shaw, in press). However, it has been identified that a range of personal and situational variables may encourage an athlete's susceptibility to choke and influence the mechanism through which it occurs. These include: skill level (Beilock & Carr, 2001); public self-

consciousness; narcissism (Geukes, Mesagno, Hanrahan, & Kellman, 2012); trait reinvestment (Masters, Polman, & Hammond, 1993); fear of negative evaluation (Mesagno, Harvey, & Janelle, 2011); coping style (Wang, Marchant, & Morris, 2004); perfectionism (Gucciardi et al., 2010); task complexity (Williams, Vickers, & Rodrigues, 2002); team cohesion (Hill & Shaw, in press); and team status / history (Jordet, 2009; Jordet, Hartman, & Vuijk, 2012).

To date, the choking phenomenon has been explored almost exclusively through motor tasks or sports which place modest physiological stress on the athlete (e.g., golf, soccer penalty kick, basketball free throws, ten pin bowling, and baseball batting). This is a surprising limitation to the literature, when most competitive sports are psychologically and physiologically demanding. In their recent review, Knicker, Renshaw, Oldham and Cairns (2011) concluded that physiological stress and fatigue can influence athletic performance negatively through decreased muscle functioning. However, psychological processes such as decision making are often maintained or improved when the athlete is fatigued, due to compensatory mechanisms such as increased arousal. Nevertheless, it remains unclear whether physiological stress and fatigue can influence specifically the process of choking in sport.

Only Vickers and Williams (2007) have explored directly the influence of physiological stress on choking. They examined the shooting performances of ten elite biathletes under low and high pressure, after they had exercised at 55%, 70%, 85% and 100% of their maximum oxygen uptake. To ensure that choking episodes were identified correctly, participants were deemed to have choked if their performance deteriorated significantly under pressure (i.e., >40% in comparison to their low pressure score). The results indicated that a number of participants choked after exercising at 100% of their maximum oxygen uptake, which through the measurement of gaze (Quiet Eye, QE) was considered to be the result of failing to maintain focus on the target. It was inferred by the authors that the physiological demands of the exercise task had distracted the participants from the task, although this assumption was not verified through follow-up testing or interviews.

More recently, Hill and Shaw (in press) used a qualitative approach to explore the choking experiences of athletes who competed in team sports (i.e., soccer, rugby union, hockey and cricket). Whilst they had not intended to explore the impact of physiological stress on choking, their participants identified that the physical demands of their sport and their associated fatigue, had caused distraction and increased their vulnerability to choke. Although such findings offer support for Vickers and Williams (2007), Hill and Shaw relied on the participants' retrospective recall of the choking event, and perceptions of physiological stress and fatigue. Thus, without objective data it is unclear whether a choking episode rather than other forms of performance failure (e.g., underperformance, injury, and the opponents' good play) was being recalled. Moreover, it is difficult to ascertain the intensity and extent of the physiological demands experienced by the participants during their performance failure.

It appears that physiological stress may have the potential to influence choking in sport, although further exploration of this relationship is warranted. However, such research would benefit from employing objective methods to ensure that the choking episode is identified correctly, and that the intensity of physiological stress placed on the athlete is established accurately. Thereafter, it would be advantageous to adopt idiographic approaches to enable a detailed examination of the choking phenomenon, including the perceived impact of physiological stress.

Accordingly, this study will adopt a mixed-method research design to address the research aims. Objective measures will be employed to expose participants to set physiological workloads, and to identify participants who subsequently choke under pressure whilst completing a motor skill. Thereafter, qualitative methods will be utilized to explore fully the experiences of those who choked, and reflect on the moderating impact of physiological stress.

Method

Methodology

The study adopts a broadly pragmatic philosophy (Pierce, 1984), for it aims to provide practical solutions to applied research questions (Rorty, 1990). That is, it aims to explore the experience of choking in sport and determine the moderating impact of physiological stress in order to provide relevant information for practitioners working with athletes. The research question is the focal point of a pragmatic study and so the methods chosen are those which can answer the research question most effectively (Creswell, 2003). Accordingly, a mixed-methods design was employed within the current study, in which qualitative and quantitative data are valued, and both contribute to the study (Taskakkori & Teddlie, 1998).

Participants

40 students (23 male and17 female) from a university in the South West region of the United Kingdom were recruited for the study. All participants were aged between 19 and 22 years of age and played a range of team sports (soccer, rugby union, netball and hockey) regularly (trained > twice a week; > one competitive game during the season) at a competitive level for the university and / or local club. All participants were novice golfers.

Procedure

An email which provided the aim, purpose and nature of the study was sent to all students enrolled on a sport-related degree programme at the selected University. A student wishing to take part in the study, and who was a novice golfer, was recruited to the study.

An equivalent status mixed-method approach (see Giacobbi, Poczwardowski, & Hager, 2005) was adopted to address the research aims. That is, experimental quantitative approaches were used initially to expose participants to physiological and psychological stress, in order to identify choking episodes and establish whether a relationship between physiological stress and choking in sport existed. Thereafter, qualitative methods were employed to explore in detail the experience of participants who had choked, and determine the perceived moderating influence of physiological stress. As such, the study was divided into two distinct stages.

Stage one: physiological stress. Participants received an information sheet explaining the nature of the study and details of the experimental procedures. Once informed consent was obtained, participants' health status was assessed using a questionnaire aligned closely with Olds and Norton's (1999) interpretation of the American College of Sport Medicine's Guidelines for Exercise Testing and Prescription (ACSM, 1995). Based on the information provided, participants who were free from disease and regularly active were recruited for the study. Ethical approval for the health questionnaire and the experimental protocol was granted by the University's Research Ethics Committee.

The procedure followed that of Vickers and Williams (2007), in which participants were required to complete a task (golf putting) in low and high pressure conditions following either low intensity (LI) or high intensity (HI) exercise. However, rather than prescribing work rates relative to $V'O_{2max}$ alone, as was the case in Vickers and Williams (2007), the current study prescribed work rate relative to both the gas exchange threshold (GET) and $V'O_{2max}$. This approach is due to the overwhelming evidence that GET is a fundamental marker of exercise intensity, and that merely prescribing intensity according to $V'O_{2max}$ is inappropriate (e.g., Meyer, Gabriel, & Kindermann, 1999; Meyer, Lucia, Earnest, & Kindermann, 2005). As such, LI exercise was set at 90% GET, and HI was set at 100% $V'O_{2max}$. (GET was estimated using the V-slope technique, Beaver, Wasserman, & Whipp, 1986). A ramp test to exhaustion (with ramp rate set at $30W \cdot min^{-1}$) was used to determine GET and $V'O_{2max}$. The subsequent exercise task was performed on an electromagnetically-braked cycle ergometer (Excalibur Sport, Lode, Groningen, the Netherlands) set in cadence independent mode, with respiratory data measured using an Oxycon Pro (Carefusion, Houten, the Netherlands).

Stage one: motor skill task: Participants exercised at either LI or HI for 5 minutes and were immediately required to complete a putting task under low (LP) and high (HP) pressure conditions. The task consisted of putting to three targets that were three meters away, and 30 centimeters apart from each other. The participants completed two familiarization putts to each

target, and then putted once to each target in turn, until they had completed thirty putts. The distance from target of each putt was measured, and the total absolute error score (of the 30 putts) was calculated. The exercise and pressure conditions were counterbalanced and there was a minimum of one day's rest between trials.

Stage one: motor task pressure manipulation. During the LP condition, participants completed the putting task with one member of the research team present, who recorded the performance scores. Conversely, the HP condition was created in accordance with Mesagno, Harvey and Janelle (2011), who demonstrated that perceived pressure elevates when participants experience self-presentational concerns (i.e., the desire to convey a positive image to others and avoid negative evaluation, Leary, 1992). Thus, putting performance was video recorded, and participants were informed that the footage would be shown to other students at the university for the purpose of performance analysis. In addition, as perceived pressure is also increased through motivational monetary rewards (Beilock & Carr, 2001; Masters, 1992), participants were notified that the individual with the lowest absolute error score would receive £200.

To ascertain whether the pressure manipulation had been successful, participants completed the modified Competitive State Anxiety Inventory-2 (Jones & Swain, 1992) prior to both set of putts, which measures intensity and interpretation of cognitive anxiety, somatic anxiety and self-confidence. It was only necessary to utilize the intensity subscale during the present study however, in order to establish whether the participants' anxiety levels had risen from the LP to the HP condition. The intensity subscale consists of 27 items (9 for each subscale) and is rated on a four-point Likert scale that ranges from 1 (*not at all*) to 4 (*very much so*). Cognitive and somatic intensity were analyzed using separate two-way (2 x 2) pressure by intensity analyses of variance (ANOVA).

Stage one: analysis of performance scores. The putting performance scores were investigated using a two-way (2 x 2) pressure by intensity repeated measures ANOVA. Furthermore, the difference between the LP and HP performance scores of each participant (after

both LI and HI) was calculated to identify whether any individual had choked under pressure. In accordance with Vickers and Williams (2007) and the recent work of Hill and colleagues (Hill et al., 2009; Hill, et al., 2010ab; Hill & Shaw, in press), a performance that declined significantly under pressure (i.e., >40%) was considered a choke. The performance data from individuals who choked under pressure were also analyzed using a two-way pressure by intensity repeated measures ANOVA. Alpha was set at the 0.05 level.

Stage two: choking and the perceived influence of physiological stress. All participants who experienced choking under pressure during stage one of the study (after LI and / or HI), completed a semi-structured interview which lasted approximately 30 minutes. Following the procedure identified by Teddlie and Tashakkori (2009), the qualitative semi-structured interviews began with unstructured and informal questions to build rapport with the interviewee. Thereafter, the questions became directed increasingly towards addressing the research aims of the study, yet remained open ended and broad. This section of the interview examined the participants' perceived antecedents, mechanisms, consequences and moderators of their choking event. The interview concluded with highly structured questions that focused on the perceived influence of physiological stress on the choking process. As such, a holistic and detailed exploration of the choking experience was gained, whilst establishing specifically the perceived influence of physiological stress.

Stage two: analysis of qualitative data. The interview data were analyzed through content analysis, in which the meaning of data was revealed through a systematic classification process of identifying themes and patterns (Kondracki & Wellman, 2002; Krippendorf, 1980). More specifically, directed content analysis (see Potter & Levine-Donnerstein, 1999) was employed, which aims to extend the conceptual understanding of a phenomenon, whilst identifying and / or verifying relationships between pre-determined variables or concepts (Mayring, 2000). Such analytical processes were therefore used to provide a further understanding of the choking

experience, whilst also exploring the perceived relationship between physiological stress and choking.

The digitally recorded interviews were transcribed *verbatim* and the transcripts read several times by the lead author to ensure familiarity. Any relevant text was highlighted and grouped within the pre-determined overarching codes of: antecedents of choking; mechanisms of choking; consequence of choking; moderator of choking; and impact of physiological stress on choking. Subsequently, the text within each overarching code was organized and collated further into sub-categories, in order to construct an increasingly explicit representation of the choking experience.

Results

Pressure Manipulation

There was no significant interaction for somatic or cognitive anxiety ($p > 0.05$). There were significant pressure main effects for cognitive ($p < 0.01$, $F = 42.24$, $df = 1$) and somatic ($p < 0.01$, $F = 33.41$, $df = 1$) anxiety. No intensity main effect for cognitive anxiety ($p > 0.05$) was found, although there was a significant intensity main effect for somatic anxiety ($p < 0.01$, $F = 31.61$, $df = 1$). Therefore the pressure manipulation for the HP condition was effective (see Table 1 for summary data).

<Insert Table 1>

Interactive Influence of Physiological Stress and Psychological Pressure

There was no significant pressure by intensity performance interaction ($p > 0.05$), nor main effect for pressure ($p > 0.05$), or intensity ($p > 0.05$). Similarly, for the six participants deemed to have choked under pressure (>40% drop in performance), there was no significant pressure by intensity performance interaction ($p > 0.05$) or main effect for intensity ($p > 0.05$). There was a significant pressure main effect ($p < 0.01$, $F = 23.76$, $df = 1$) with worse performance during the high pressure condition. Thus, physiological stress had no impact on the putting performance

(under LP and HP conditions) of the non-chokers and chokers, and as expected, the performance of 'chokers' was significantly lower under HP (see Table 2 for summary data).

<Insert Table 2>

Perceived Antecedents, Mechanism, Consequences and Moderators of choking in sport

A summary of findings which emerged from the interviews are summarized in Table 3.

<Insert Table 3>

Perceived antecedents of choking in sport: All six of the interviewed participants identified *self-presentation concerns* as the primary antecedent of their choking episodes. In each case, they noted that the presence of a video camera created concerns regarding how they would be perceived by others. In turn this led to high levels of perceived pressure and anxiety which encouraged their choking. For example, Debbie suggested, "the video camera put a lot of pressure on me. I was aware that people would be watching me and looking at the way I was standing…I didn't like the thought of being critiqued. Similarly, Anna explained:

> I was thinking…'people will be watching this. I'm no good when people are viewing me'…I wanted to give up, because I was worried about making myself look stupid…I was embarrassed to be evaluated…I was fine when I wasn't being filmed.

Five of the 'chokers' identified that the *unfamiliarity* of the first testing day (regardless of whether it included the LI or HI exercise task) acted as a precursor to their choking episode, for it increased perceived pressure, cognitive anxiety (i.e., self- doubts and worry), and reduced the opportunity to prepare mentally for the pressurized situation. Sasha suggested:

> I didn't know what it [the testing] was going to be like, so I was worried I might not be able to do it. The second time…I knew what to expect…I knew what frame of mind I needed to be in…I practiced in my head what I was going to do…so I was calmer and performed better.

In addition, four of the participants stated that exposure to an *individual task* had been an antecedent to their choking episode. They explained that as they competed normally within team sport, they were less able to cope with a task that exposed them to observation and evaluation.

Betty explained, "I am a team player, and I enjoy playing with my team under pressure…But, I am not used to being singled out and looked at…and being watched so closely".

Finally, three participants perceived *negative psychological momentum* as an antecedent to their choking episode. That is, they began each high pressure putting task with positive expectations, yet once performance standards began to decline, and they realized their performance goal may not be achieved (e.g., winning the prize or improving on previous performance), they experienced intense negative cognitions and affect. Consequently performance declined further and the participants choked. Carol clarified this point further, "I was expecting to do well… to improve. But when I realized it was going badly, I panicked. I got more nervous, and more stressed…I then didn't feel I could do anything about it…It all got away from me".

The perceived mechanism of choking in sport: The six participants interviewed recognized their choking episodes were associated with intense *debilitative cognitive and somatic anxiety*. With regards to cognitive anxiety, Sasha suggested, "I was worried that I wasn't going to perform well enough, and I worried how I would perform compared to other people. I was so nervous that I couldn't do anything". Likewise, Edith noted, "I was really nervous because I was being filmed and there was prize money riding on this…I doubted myself and my thoughts became negative and more intense…I ended thinking I can't do this". Similarly, Anna explained how somatic anxiety had affected her performance, "I was shaky and nervous… the palms of my hands were sweating…my body was tense…so I was hitting it [golf ball] everywhere".

Moreover, all six participants perceived *distraction* to be the principal mechanism of choking. In one instance, the participant focused on the potential of failure and not achieving the intended outcome. However, for the most part, the distraction consisted of self-presentational concerns. Debbie suggested, "I was thinking about the camera and being watched. I was thinking about being watched more than I was on the task". Betty reflected, "I couldn't maintain my focus. I

thought about letting myself down in front of people…so I was focusing on that". Conversely, Edith identified that her self presentation concerns may have led to choking through *self-focus*:

> The anxiety made me worry about how I looked to others. I was concerned that they would be analyzing my stance and technique…so then I started to think about my stance and technique and how I was hitting the ball…all it did was cause me to massively over-shoot the putt.

The final mechanism of choking revealed by the interviews was *low perceived control*. Five participants indicated they felt unable to control their emotions or the execution of the skill during their choke. Debbie explored this finding further*:*

> I was anxious…I was struggling to get to grip…I couldn't regain control over myself…I was hitting the balls all over the place…I lost control of the task….and it just got worse…My performance was better [during the second test] simply because I managed to control myself.

Perceived consequences of choking in sport: One participant perceived the choking experience was likely to have a *positive influence* on their future sporting performance, "well, now I know that focusing on the technique makes me choke, I will learn from this, and it will help me cope with pressure in the future". However, five of the participants interviewed were concerned the choking episode may have a *negative impact*. For instance, Betty stated that, "If I find myself in another unfamiliar situation, then I do wonder if will cope after this experience [of choking]". Likewise Anna stated, "I do think it [the choke] could affect my future performances under pressure, as if this has happened once it could happen again. I will relate back to this, and think the same will happen again". The six participants interviewed, recognized they experienced intense *negative affects* as a consequence of choking. This predominantly included disappointment, anger, frustration and unhappiness, but was mainly short-lived.

Perceived moderator of choking in sport: The first moderator noted by four of the interviewed participants was *self-confidence*. They indicated that if they were confident before the putting task began, or were able to develop confidence by starting the task successfully, they

were able to maintain performance under high pressure. Conversely, if they experienced low confidence before or during the pressurized task, then the likelihood of choking increased. The second perceived moderator identified was *mental skills*. More specifically, approach-coping strategies that included imagery were considered to facilitate successful performance under pressure. Debbie stated:

> After I messed up in the first test, I practiced in my head what I was going to do…I imagined myself in the situation, coping with it, and putting better…I also tried to imagine how I felt under pressure in my normal sport and how I coped with that situation…to make me feel more comfortable. It worked well.

Whereas, avoidance-coping strategies (e.g., rushing through the task) were identified by three of the participants, as ineffective attempts to manage the perceived pressure and were suggested to encourage choking.

The final perceived moderator of choking was the *prospect of choking.* Although this was identified by only one participant, they argued it had a significant impact. Anna explained that her awareness of high profile cases of choking within golf had increased her vulnerability to choke, "golf is always in the news about choking…I was thinking to myself, 'I am doing this test in golf. If professionals choke, then so will I'. I know it sounds weird, but that influenced me massively…it was all I thinking about".

Perceived Influence of Physiological Stress on Choking in Sport

The qualitative data revealed a mixed picture with regards to the perceived impact of physiological stress on the participants choking episodes. Anna experienced choking after exercising at HI, and did recognize that high levels of arousal experienced post-exercise made it more difficult to focus on the putting task under pressure. Yet she perceived this had not impacted her performance or caused the choke. Betty also choked after completing the HI exercise condition but interestingly, suggested she had found it was easier to focus on the high pressure putting task afterwards:

> Maybe because there was more blood flowing through my body or something…I just felt things were easier. This impacted on me positively…In the end, I wasn't getting stressed because of the exercise or my fatigued. I choked because I was not winning and had that video camera pointing at me.

Similarly, Debbie choked under pressure after exercising at LI and HI, with Sasha choking after exercising at LI only. Thus, both perceived that the physiological stress and associated fatigue had not influenced their choking episodes.

As such, the remaining two 'chokers' were the only participants within the study to perceive that physiological stress had moderated their choking episodes. In both cases, it was through distraction from the task. Firstly, Carol noted that, "I was thinking…I had just done a high intensity cycle and I am tired…and so I found it harder to focus on what I should have. For me, it did encourage the choke". Likewise Edith reflected:

> The high intensity workout influenced my performance, as my heart was racing faster, my hands were clammy and I was more out of breath…I could hear my heart pounding in my ears. So I couldn't get control of myself. It was much harder to concentrate. This made it really hard for me to perform.

Discussion

The aim of the study was to explore the choking experience in detail, and examine specifically the moderating influence of physiological stress. Six participants choked whilst executing the motor skill under experimental HP conditions and through qualitative interviews identified a range of perceived antecedents, mechanisms, consequences and moderators to their choking event.

As expected, the introduction of the video camera and the potential of evaluation from significant others, increased the participants' self-presentational concerns. All participants identified that such concerns acted as the primary antecedent to their choking episode(s). Accordingly, this study offers further support for the self-presentation model of choking

(Mesagno, 2009), which proposes that certain athletes are highly motivated to portray a positive image of themselves to others and / or avoid negative evaluation. As this process can increase cognitive and somatic anxiety, it often leads to choking through self-monitoring techniques (i.e., self-focus) or distraction. Although self-presentation was manipulated artificially within the current study, the 'real life' sporting context has considerably more potential for exposing athletes to evaluation and judgment from others (Leary, 1992). Therefore, as the participants suffered self-presentation distress within the experimental condition, it is likely they would also experience similar concerns within the natural competitive sport environment.

Several 'chokers' noted that a precursor to their choking episode was the unfamiliarity of the first testing condition. In their study of elite golfers, Hill et al. (2010b) also identified that choking occurred when athletes are uncertain whether they can cope with an unfamiliar situation. Nevertheless, it would be advantageous for future experimental choking research to ensure participants are adequately familiarized with the testing environment, so that the psychological demands of consecutive testing stages are consistent.

The participants interviewed were all involved with competitive team sport, and so it was unsurprising that the execution of an individual task was found to impact their choking. The current study therefore, concurs with Hill and Shaw (in press), who established that team sport players were more likely to choke when performing an individual skill (e.g., penalty kick), as they are exposed to the attention and evaluation of 'others'. This will raise anxiety and increase the potential of choking through self-focus and / or distraction. Thus, with self-presentational concerns continuing to appear as a critical contributor to the choking process, it is advisable to ensure that athletes (particularly of team sport) learn mental skills that manage evaluation apprehension and encourage task-related focus (see Toering, Elferink-Gemser, Jordet, Jorna, Pepping, & Visscher, 2011).

An interesting recent development within the literature is the suggested relationship between psychological momentum (PM) and choking (see Hill & Shaw, in press). PM is defined as the

athlete's perception of progressing towards his / her goal (Vallerand, Colavecchio, & Pelletier, 1988) although to date, the literature remains equivocal with regards to its impact on athletic performance (e.g., Jones & Harwood, 2008). It is acknowledged however, that PM can alter cognitions, emotions and behaviors, depending on whether the individual is progressing towards (positive PM) or away (negative PM) from their goal (see Gernigon, Briki, & Eykens, 2010). Participants within the current study 'appeared' to experience negative PM prior to their choke. That is, they realized they were beginning to fail in their attempts to achieve their goal (e.g., performing well or winning the reward), were moving further away from their goal, and then experienced negative cognitions and emotions which were perceived to encourage choking. Thus, further research which examines the impact of negative PM on choking in sport is warranted.

The current study revealed that the participants' perceived mechanisms of choking were consistent with the extant literature (see Hill et al., 2010a for a review). Firstly, the choking episodes of all participants were associated with intense somatic and cognitive anxiety, and therefore the need for athletes to manage, control or re-appraise their anxiety remains a priority for those vulnerable to choking.

Secondly, the majority of participants choked through distraction. As novice golfers at the early stage of learning (Fitts & Posner, 1967), the participants were likely to have processed the explicit, technical aspects of the putting skill through working memory. Consequently, they would have less attentional capacity to process anxiety or self-presentation-related thoughts, and were therefore vulnerable to choke through distraction (e.g., Beilock & Carr, 2001; Beilock, Carr, MacMahon, & Starkes, 2002; Gray, 2004). However, one participant indicated they may have choked through self-focus by becoming increasingly self-aware of their technique. It is probable that the individual in question was more skilled than admitted, as their LP performance was amongst the best in the study. Therefore, as a skilled performer she may have processed the putting task-related information implicitly, becoming susceptible to self-focus (Gucciardi &

Dimmock, 2008; Jackson et al., 2006). It does remain a possibility however, that the individual possessed personality characteristics such as private self-consciousness (Wang, Marchant, Morris, & Gibbs, 2004) or dispositional reinvestment (Jackson, Ashford, & Norsworthy, 2006) which encouraged performance failure through an internal focus when performing under pressure. Such an interactive perspective in which sporting behaviors are predicted as a result of situational determinants and their activation of personality traits, has gained increased research attention recently. For example Geukes et al. (2012) indicated that a situation with high perceived pressure, can activate the trait of high narcissism, and may reduce the potential of choking behavior. This approach appears to have scope within choking research, as it would be advantageous to establish the situational factors and personality traits that interact to increase an athlete's susceptibility to choking, and determine the mechanism through which it occurs.

Thirdly, this study offers further evidence for the pivotal role of perceived control within the choking experience (Hill et al., 2010b; Otten, 2009), as most participants felt unable to control their emotions and / or the outcome of the task during the choke.

The study has reinforced the suggestion that choking events can have a negative effect on the performer (see Hill et al., 2010b; Hill, Hanton, Matthews, & Fleming, 2011). The participants experienced negative affect (e.g., frustration, unhappiness, disappointment), although it was mainly short-lived. Most of the participants were also concerned that their future pressurized sporting performances could be affected detrimentally as a result of this choking event. It has been demonstrated that individuals who reflect on their choking experienced negatively, continue to choke with increased regularity due to lowered self-confidence and reduced perceived control (Hill et al., 2010b; Hill et al., 2011). Whereas athletes who use the experience constructively to inform future performance, appear to maintain or even improve future performances under pressure (e.g., Gucciardi et al., 2010). Thus, it would be advantageous to ascertain whether certain athletes are predisposed to perceive choking events negatively and

therefore remain susceptible to the phenomenon. Additionally, it would be beneficial to examine further the role of reflective practice within the alleviation of choking in sport.

The participant's perceived that self-confidence and the use of mental skills moderated their choking experience. Both of which have been found to influence choking within previous choking studies (e.g., Baumeister et al., 1985; Hill et al., 2011). One participant identified that her awareness of high profile golfers who had choked under pressure, increased her likelihood of choking. It is difficult to explain why the knowledge of others choking affected her own self-belief system. Although it is clear that it led to expectations of failure which inevitably encouraged a performance decrement under pressure (e.g., Mckay, Lewthwaite, & Wulf, 2010) and choking (Hill et al., 201b).

As an aside, all six participants who choked were female, and therefore almost one third of the female sample experienced choking under pressure. Although the literature has demonstrated that male athletes choke under pressure (e.g., Mesagno et al., 2012; Hill et al., 2011), this study is the first to indicate that gender may moderate the likelihood of choking.

Finally, this study found little support for the moderating impact of physiological stress on choking in sport. The quantitative data found no interactive effect of physiological work load and performance under pressure for both the non-chokers and chokers. This supports the suggestion that psychological processes are often maintained or even improved when the athlete is fatigued after exposure to physiological stress (Brisswalter, Collardeau, & René, 2002). This may be due to exercise-induced arousal or increased motivation and self-efficacy after exercise (see Knicker et al., 2011) which can enhance task-related attention. Indeed, several participants within the current study recognized it had been easier to focus on the pressurized task after exercising intensively due to raised arousal levels.

However, this was not the case for all, with two participants suggesting that physiological stress had encouraged their choking episode as a result of distraction. This finding demonstrates the advantages of using a mixed-methods design, for the study was able to evidence that

physiological stress did not affect the majority. Yet it was able to identify that it may influence the choking process of a small number of participants. It is necessary to understand the general cognitive, emotional and behavioral patterns which underpin optimal and failed sporting performance. However, it is also necessary for applied researchers to adopt approaches that remain sensitive to individual differences, so that practitioners can be provided with the necessary information to intervene appropriately with their athletes. Thus, this study demonstrates that physiological stress is unlikely to affect pressurized motor performance or choking in sport. Whilst it also affords the awareness that for a small number of athletes, the physiological demands of their sport may become distracting. Hence, such athletes may benefit from psychological interventions such as biofeedback, which enhance focus through the perceived control over their heart rate and breathing frequency (see Moss & Wilson, 2012).

Conclusion and Summary

The study utilized a mixed-method design to provide further insight into the antecedents, mechanisms, consequences and moderators of choking in sport. Moreover, it has provided evidence that physiological stress does not have a significant impact on choking in sport, but may have the potential to encourage choking through distraction in a minority of cases. The study has utilized quantitative methods to enable an objective measurement of physiological stress on performance under pressure, and identify accurately participants who had choked. Thereafter, qualitative interviews were used to gain the detailed understanding of choking in sport and the perceived role of physiological stress.

However, the study possesses a number of limitations which require consideration. Firstly, the sample size was small, particularly for those who experienced choking. However, as found within other studies, choking in sport is infrequent and appears to be experienced by the few. It is necessary therefore, to develop quantitative methods that identify choking susceptible athletes efficiently and effectively, in order for researchers to explore the phenomenon through larger samples.

Secondly, participants within this study were novice golfers, and therefore the findings cannot be used to explain choking within skilled athletes for the process differs (see Beilock et al., 2002). In addition, it could be argued that the observed choke was merely a fluctuation in performance standard associated with novice athletes. However, during the interviews there was a clear indication that the psychological processes experienced by all participants during their performance failure, were consistent with choking under pressure (e.g., debilitative anxiety, low perceived control, low self-confidence, attentional disturbances). Therefore we are confident that the choking events were identified accurately.

Thirdly, the protocol utilized during the study to induce physiological stress was not sport-specific. Royal et al. (2006) has suggested that running or cycling protocols might create sensory states that differ to those experienced during 'real life' sporting performance. This may explain why the current study fails to offer support for Hill and Shaw (in press), who found that the physiological demands associated with playing team sport, had impacted choking. It would be appropriate therefore, to extend the current study by adopting more 'realistic' exercise tasks. Finally, as noted previously, the familiarization protocol adopted within the study appeared insufficient. Consequently, the perceived moderating role of unfamiliarity within choking in sport may be overstated, and related primarily to the experience of the participants within this study.

In summary, the study extends the choking literature by advancing our understanding of the choking phenomenon, and providing evidence that the impact of physiological stress on choking in sport is marginal.

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1 Table

2 *Table 1*. Cognitive and somatic anxiety data (LP and HP conditions).

3

	Cognitive	Somatic
Low intensity, low pressure	8 ± 2	9 ± 3
Low intensity, high pressure	10 ± 3	11 ± 4
High intensity, low pressure	9 ± 3	12 ± 5
High intensity, high pressure	11 ± 3	14 ± 4

Cognitive and somatic anxiety data from the CSAI-2 questionnaire (Mean ± SD).

Table

Table 2. Performance data for the ‘chokers’ in each condition

	Performance
Low intensity, low pressure	474.0 ± 162.3
Low intensity, high pressure	660.6 ± 235.2
High intensity, low pressure	358.7 ± 100.5
High intensity, high pressure	513.8 ± 168.1

Absolute error putting scores (mm). (Mean ± SD).

Table

Table 3: Summary of perceived antecedents, mechanism, consequences and moderators of choking in sport

Overarching Theme	Sub category
Antecedent of choking	Self-presentation concerns Unfamiliarity Individual task Negative psychological momentum
Mechanism of choking	Debilitative cognitive and somatic anxiety Distraction Self-focus Low perceived control
Consequence of choking	Positive influence Negative impact Negative affects
Moderator of choking	Self confidence Mental skills Prospect of choking