Reappraisal and Mindset Interventions on Pressurised Esport Performance

Article *in* Applied Psychology · April 2024

Reappraisal and Mindset Interventions on Pressurised Esport Performance

Sharpe, B. T.[1*], Leis, O.[2], Moore, L.[3], Sharpe, A.[1], Seymour, S.[1], Obine, E. A. C.[1] & Poulus, D.[4]

[1]Institute of Psychology, Business, and Human Sciences, University of Chichester, Chichester, UK

[2]Department of Sport Psychology, Faculty of Sport Science, Leipzig University, Leipzig, Germany

[3]Department for Health, Faculty of Humanities and Social Sciences, University of Bath, Bath, UK

[4]Physical Activity, Sport, and Exercise Research Theme, Faculty of Health, Southern Cross University, Australia.

Author Note

***Corresponding author:** Benjamin Sharpe, Institute of Psychology, Business, and Human Sciences, b.sharpe@chi.ac.uk. The authors hold no conflicts of interest associated with the publication of the following manuscript. No external funding supported development of this research. Full access to all data is available upon request. Ethical approval for the study protocol was awarded by the lead institution.

Abstract

This study investigated the impact of two low-resource interventions on esport competitors' responses to pressure, focusing primarily on state anxiety, challenge and threat appraisals, and action performance. In Experiment 1, a single-session arousal reappraisal intervention demonstrated a significant influence on high-pressure esports performance. Notably, it not only prompted a shift in appraisals from threat to challenge but also reduced cognitive and somatic anxiety, increased quiet eye durations, and heightened cognitive effort. In Experiment 2, a preliminary assessment of the Mindset-Reappraisal intervention was undertaken, demonstrating enhancements in esport action performance, including accelerated completion times and heightened shooting accuracy. This intervention cultivated a stress-enhancing mindset, lowered cognitive and somatic anxiety, fostered challenge appraisals, and underscores the practical efficacy of cost-effective interventions within the specific context of our performance task. Effective management of arousal levels and educating esports competitors on stress mindset implications may improve performance under pressure, offering valuable insights for esports performance psychology. These findings suggest opportunities for refining pressure-response strategies, paving the way for comprehensive approaches to optimize performance in competitive esports.

Keywords: Anxiety, Cognitive Appraisals, Arousal, Stress, Counter-Strike

Introduction

Esports athletes, much like traditional athletes, are frequently subjected to various sources of pressure, including performance stressors, team issues, and social media exposure (Leis et al., 2022; Poulus et al., 2022). Research in surgical, aviation, and sports fields (Brimmell et al., 2019; McGrath et al., 2011; Vine et al., 2015) has established that the impact of pressure can vary greatly and is influenced by various factors (see Hanton et al., 2008 for review). The extent to which athletes perceive pressure as either a challenge or a threat significantly affects their experience of anxiety-related cognitive and physiological symptoms. For example, an athlete who views a stressor as an enhancer (e.g., evaluating a situation as demanding, yet having the resources to cope) may experience improved performance, whereas someone who feels overwhelmed may experience pressure as a hindrance to performance (Gildea et al., 2007). As the esports industry continues to grow with increased player participation (Jenny et al., 2018), spectator interest (Hallmann & Giel, 2018), player challenges (Poulus et al., 2024), the study of esports performance is also gaining prominence (Sharpe et al., 2024). Given the critical role of stress management in ensuring performance (Lazarus, 2000) and previous research linking pressure to reduced performance among amateur and national-level esports athletes (Sharpe et al., 2024; Trotter et al., 2023), the present study aims to explore approaches for mitigating the way individuals view their arousal in a pressurised esport environment.

Arousal Reappraisal

One potential intervention to enhance performance under pressure may be through arousal reappraisal. Arousal reappraisal involves perceiving physiological arousal, such as an increased heart rate noticed through interoception (see Schulz & Vögele, 2015), as a facilitative tool rather than a debilitative response (Jamieson et al., 2013). This strategy allows individuals to reconceptualize pressure as a coping mechanism (i.e., encourages individuals to view their physiological reactions as an additional resource that can facilitate optimal performance; Jamieson et al., 2016) and has been found to stimulate a challenge state and improve performance (Jamieson et al., 2010, 2012, 2022). Moore et al. (2015) presented initial empirical support for the advantages of arousal reappraisal, as participants who performed a reappraisal intervention reported a more constructive interpretation of physiological arousal, performed better on a pressurized single-trial golf putting task, and displayed a more favourable but not a statistically significant cardiovascular response. Sammy et al. (2017), however, demonstrated that arousal reappraisal can lead to more facilitative cardiovascular responses, positive perceptions of resources, and self-confidence, promoting a more adaptive pressure response in pressurized motor performance situations (Sammy et al., 2017). Both authors noted several limitations that may enhance future investigations, such as additional measures of attention (e.g., pupil dilation) and justification for control interventions, and highlighted the need for further research in domains that require differing motor skills (e.g., esports). Related, more recent research has observed no statistically significant differences in cognitive or somatic anxiety between an arousal reappraisal and a control intervention during a computerised laboratory task (Ginty et al., 2022). The absence of significant findings is not unexpected, considering that arousal reappraisal is not specifically designed to alleviate anxiety. Instead, its primary aim is to prompt individuals to perceive pressure-induced increases in physiological arousal in a constructive manner (e.g., Goyer et al., 2022; Hangen et al., 2019). Nevertheless, the authors emphasize an approach termed 'stress optimization' to mitigate the negative outcomes associated with the presence of a highly pressurized context (refer to the next section for a detailed discussion).

Consequently, there are no studies examining the impact of arousal reappraisal on esports athletes operating within high-pressure environments, thus warranting further investigation. The potential insights gained from such research not only hold promise for enhancing esports performance but also carry the potential to offer broader applications by advocating for a positive reframing of stress perceptions within various pressurized contexts beyond the realm of (e)sports, such as in occupational settings. Particularly noteworthy is the acknowledgment that in the domain of esports, the detrimental consequences of recurrent exposure to stressors extend beyond immediate performance implications, as evidenced by their link to mental health issues (Birch et al., 2024; Smith et al., 2022). Therefore, a nuanced understanding of the interplay between stress and performance in esports becomes imperative for the development of tailored, evidence-based support interventions for athletes (Leis et al., 2021).

Stress Mindset

Research has indicated the approach of combining a reappraisal intervention with stress mindset tools (Jamieson et al., 2018). Specifically, stress mindsets are outlooks about how one perceives the experience of stress (i.e., stress is enhancing or debilitating in relation to performance). Given the intricate nature of stress, which can potentially yield both advantageous and debilitating consequences, stress mindsets function as simplifying frameworks that orient individuals toward a specific set of anticipations and motivations. These frameworks are designed to enhance the likelihood of individuals experiencing the beneficial effects of stress (Akinola et al., 2016; Crum et al., 2013, 2017, 2020). In fact, literature has underscored the metacognitive dimension of mindsets, observing that participants, when educated about the concept of a mindset and informed about research highlighting that these mindsets are not inherently true or false yet yield self-fulfilling outcomes, tend to adopt a more advantageous mindset (e.g., Baynard-Montague & James, 2023; Journault et al., 2024; Yeager et al., 2022). This inclination toward an adaptive mindset is driven by its pragmatic utility, irrespective of its complete factual accuracy (Crum et al., 2023). Furthermore, Crum et al. (2023) posit that individuals, upon recognizing the strong influence of mindsets, are more inclined to embrace adaptive mindsets due to their practical value, even if these mindsets are not entirely congruent with objective reality. Similarly, scholars emphasize the significance of presenting more neutral information, avoiding exclusive emphasis on a single notion such as 'stress is enhancing.' This approach is motivated by the inherent conflicts in the field's body of knowledge on stress-related matters and the potential ethical challenges that could arise from exclusively imparting participants with a biased subset of literature (see Jamieson et al., 2018; Crum et al., 2023). Consequently, instructing participants about mindsets before engaging in arousal reappraisal (for a comprehensive overview, refer to Jamieson et al., 2018) holds the potential to enhance their responses to pressure and foster improved performance outcomes (e.g., Mansell et al., 2023).

Influence of Pressure

The influence of pressure on performance is intricate, contingent upon various factors such as trait anxiety, self-confidence, and coping responses (Hanton et al., 2008). Its impact can manifest positively or negatively based on individuals' perceptions and evaluations of stressors (Gildea et al., 2007; Mendes et al., 2007; Seery, 2011; Seery et al., 2013). The Integrative Framework of Stress, Attention, and Visuomotor Performance, referred to as the Integrative Framework herein (Vine et al., 2016), elucidates how divergent responses to pressure influence attentional and visuomotor control, subsequently affecting motor skill performance. For instance, anxiety can disrupt attentional control and diminish performance (Wood & Wilson, 2010, 2011). In essence, the Integrative Framework posits that individuals consciously and subconsciously evaluate the demands of a stressful situation and their ability to cope. Those who perceive sufficient coping resources tend to view the situation as a challenge, while those perceiving a lack of resources interpret it as a threat. The Attention Control Theory (Eysenck et al., 2007) delineates challenge appraisals with a balanced influence of goal-directed and stimulus-driven systems, whereas threat appraisals exhibit an increased influence of the stimulus-driven system. Objective measures indicate that these appraisals impact gaze behaviour, particularly the duration of the quiet eye, which is the final visual fixation before executing a motor action within a 3° visual angle (Vickers & Williams, 2007). Notably, longer quiet eye durations correlate with challenging appraisals, while shorter durations signify threatening appraisals (Brimmell et al., 2019; Moore et al., 2013), reflecting changes in the allocation of cognitive resources. Studies consistently show that challenge and threat appraisals predict performance increase or decrease (Behnke et al., 2020; Trotman et al., 2018; M. J. Turner et al., 2021), continuing to be a subject of inquiry (Behnke & Kaczmarek, 2018; Hase et al., 2019). As an illustration, recent research explored the repercussions of psychological pressure on cognitive anxiety, challenge and threat assessments, gaze behaviour, cognitive exertion, and action performance in an esport task involving Counter-Strike competitors (Sharpe et al., 2024). Consistent with the Integrative Framework, participants in high-pressure conditions reported elevated anxiety, perceived threat, and suboptimal gaze behaviour, leading to inferior performance compared to low-pressure conditions, despite increased cognitive effort. It is worth noting that research highlights a scarcity of dedicated interventions mitigating psychological pressure's influence on perceptual-cognitive performance in authentic esport scenarios (Cottrell et al., 2019; Leis et al., 2023). Nevertheless, Sharpe et al. (2024), amongst others (Trotter et al., 2023), underscore the opportunity for empirical testing of interventions, given the discernible effects on action performance induced by pressure manipulations.

Experiment 1

Based on prior research in analogous tasks, an increased perception of pressure may result in heightened perceptions of cognitive anxiety, threat appraisal, decreased quiet eye durations, and ultimately a reduction in performance (e.g., Brimmell et al., 2019). Therefore, Experiment 1 aims to investigate the impact of a pressurised esports context on measures of state anxiety, challenge and threat appraisals, gaze behaviour, effort, and action performance after exposure to arousal reappraisal (i.e., encouraging increased arousal as beneficial). In line with the Integrative Framework (Vine et al., 2016), and informed by prior literature in esport (Sharpe et al., 2024), we posit that while a high-pressure scenario would elicit an increase in state anxiety, threat appraisal, shorter quiet eye durations, increased effort, and reduced action performance (i.e., poorer shooting accuracy), an arousal reappraisal intervention would enable performers to perceive a pressurised context as less threatening compared to the control intervention (as demonstrated by differences in challenge and threat appraisal scores; Moore et al., 2015). Consequently, we predict that the intervention would demonstrate statistically significant differences against the control intervention in action performance and gaze behaviours (Sammy et al., 2017).

Method

Pre-registration, Study Design, and Procedure

Prior to data collection, we pre-registered our method and aims with the Open Science Framework (see *blinded for review*[1]). The lead institution awarded ethical approval for the study protocol (2223_37), and all participants provided written informed consent. All study participants underwent the within-subject design: exposure to the arousal reappraisal intervention and the control intervention, before encountering a highly pressurized esport context. The presentation order of these conditions was counterbalanced to mitigate potential order effects. The two distinct experimental conditions were administered on alternate days, further counterbalanced to eliminate any sequence-related biases. Participants took part in the study over a span of two consecutive days. The order of which participants engaged in either intervention were randomly assigned via https://www.random.org/lists/. The duration of each data collection session was ~30 minutes (*M* = 32.50 minutes, *SD* = 6.57). All data collection took place during daytime hours (9 am-4 pm). Participants were asked to attend the session having not consumed caffeine-based drinks in the 24 hours prior to testing (see Sainz et al., 2020). Following the provision of verbal demographic information (such as age, gender, and domain-specific experience), participants were equipped with an eye tracker, as outlined in the Measures section. Subsequently, participants underwent a familiarization phase for the primary esport task, consisting of a single round. Following this, participants engaged in four rounds of the pressurized esport task, in accordance with the Measures section. The experimental environment was manipulated through verbal, pre-recorded instructions provided to participants, as detailed in the Manipulation section. Before commencing the task, participants were exposed to one of the two interventions, as specified in the Intervention Instructions section. Each round concluded after three minutes if not completed by the participant. Between each round, participants were granted a one-minute break to recalibrate the eye tracker,

[1] https://osf.io/w6be9/?view_only=008729261e1b43a4b4098384053cff74

ensuring accurate data acquisition. The room remained darkened from natural light so that illumination could be controlled and standardised (M Horizontal = 11.34, *SD* = 3.69 Lx; M Vertical = 42.09, *SD* = 6.11 Lx) across all testing (recorded through the LUX LIGHT APP).

Participants

A total of 44 Counter-Strike competitors volunteered to take part (M_{age} = 21.34, *SD* = 3.85), consisting of 39 males and 5 participants who preferred not to disclose their gender, from across seven competitive esport teams. Participants were recruited via word of mouth and snowball sampling. All participants held between 848 and 3392 hours of experience playing Counter-Strike ($M_{experience}$ = 2082.16 hours, *SD* = 838.70). Beyond competitive matchmaking, all participants had competed in more than one United Kingdom-based cross-university Counter-Strike tournament ($M_{tournaments}$ = 12.77, *SD* = 7.59). At the time of data collection, all participants had not competed above university-level. All participants reported a tournament success rate of 48% or above. All participants were currently active in university-level competition at the time of data collection, were right-handed, used their dominant hand to control the mouse, and played the game with the in-game weapon on the right side of the display. Each participant had normal or corrected vision and had no known psychiatric or neurological disorders. G*Power 3.1.9.4 software (Faul et al., 2007) was used to perform an a priori calculation of sample size based on the formula proposed by Faul et al. (2009). With a power (1-β) of .80, two-tailed α of .05, 44 participants were required using the effect size (*d* = .66) of prior literature (Moore et al., 2015), which supported the effectiveness of arousal reappraisal on performance. As with all psychological research (see Lakens, 2022), our sample size was constrained by the relatively limited availability of esport student competitors in the United Kingdom.

Measures

State Anxiety

As a manipulation check, we measured the intensity of cognitive and somatic anxiety using the Immediate Anxiety Measurement Scale (IAMS; Thomas et al., 2002). The IAMS provided a definition of both types of anxiety after which participants completed questions relating to measuring the intensity of that anxiety (e.g., '*To what extent are you experiencing cognitive anxiety right now*'). The IAMS refers to the term cognitive anxiety as '*the mental component of anxiety and may be characterized by thoughts such as concerns or worries about your upcoming task, for example, about the way you will perform or the importance of the* *event*'. Conversely, somatic anxiety pertains to *'your perception of your physical state and maybe characterised by symptoms such as physical nervousness, butterflies in the stomach, tense muscles, and increases in heart rate.'* The intensity of the anxiety experienced was rated on a 7-point Likert scale anchored from 1 ('*not at all'*) to 7 ('*extremely'*). Due to time constraints imposed on the research team, stemming from a request to minimize the duration of the experimental design, inquiries pertaining to directional perceptions were omitted from the questioning protocol (see Thomas et al., 2002 for discussion into the value of direction data).

Challenge and Threat Appraisal

Challenge and threat appraisals were assessed using two items adapted from the Cognitive Appraisal Ratio (Tomaka et al., 1993). Specifically, evaluated demands were assessed using the question, '*What is your expectation of the demands of the upcoming competition?*'. In addition, evaluated personal coping resources were measured by the question, '*What is your perceived ability to cope with the demands of the upcoming competition?*' Both items were rated using a 6-point Likert scale, with anchors ranging from 1 ('*not at all'*) to 6 ('*extremely'*). A Demand-Resource Evaluation Score (DRES) was calculated by subtracting demands from resources, with zero or a positive score indicating a challenge appraisal (i.e., coping resources match or exceed task demands) and a negative score reflecting a threat appraisal (i.e., task demands exceed coping resources; Brimmell et al., 2019).

Objective Pressure and Quiet Eye Duration

A head-mounted 50 Hz, four sensor, Tobii Pro Glasses 2 mobile eye tracker (www.tobii.com/) was used to record pupil dilation (i.e., pupillometry) and *Quiet Eye Duration*. Pupillometry (i.e., change in pupil dilation) was adopted as a neurobiological marker of objective psychological pressure (Burkhouse et al., 2014; Graur & Siegle, 2013) and a manipulation check for psychological pressure. Pupil diameter was recorded by the eye tracking device during the calibration process to represent a baseline measure of pupil size per participant. In-situ pupil diameter was recorded at the onset of shot initiation at a refresh rate of 30 hz and was used to represent cognitive effort (Sharpe et al., 2024). The peak pupil diameter per condition was used to calculate percentage change from baseline. Right eye dilation was used for all pupillometry analyses (Kahya et al., 2018; Moran, 2016; Runswick et al., 2021). A fixation was defined as a gaze that was maintained on a location within 1° of visual angle for at least 100 ms (Vickers, 2009). Quiet eye duration was defined as the average duration of the final fixation directed to a single location within 3° of visual angle (or less) for at least 100ms prior to the final movement (i.e., mouse click; Vickers, 1996; Vickers & Williams, 2007). Quiet eye duration was calculated every time a participant engaged with a target before being averaged across all rounds in each condition.

Action Performance

Action performance was measured through total time taken to complete a Counter-Strike time trial and percentage accuracy (i.e., hits vs. misses). In an esport context, action performance refers to the attributes (e.g., shooting accuracy) that may contribute to the outcome (e.g., win or loss; Sharpe et al., 2022). Participants completed one task (i.e., engage the appearing obstacles), while virtually travelling from the start to the end point of the map. For each trial, individuals followed the same scripted task. All task-related variables remained constant between participants. The performance measures recorded included time (overall time taken to complete the task, in seconds) and hit/miss percentage (through recording the average accuracy of all virtual shots fired, recorded as a percentage). Screen resolution (1280 x 960), including aspect ratio (16:10) and refresh rate (144 Hz), remained constant across all conditions. The task was presented on a BenQ MOBIUZ EX240N (24“) Gaming Monitor through a custom-built gaming computer (NVIDIA GeForce RTX 4070 Ti). All participants were equipped with a Logitech G213 gaming keyboard, Logitech G402 Hyperion Fury gaming mouse, a Logitech G840 gaming mouse pad (400mm x 900mm), and a Logitech G733 gaming headset. Player crosshair and in-game settings were standardised across all conditions.

High-Pressure Manipulation

The pressurised experimental manipulation was taken from a previous pre-registered study (Sharpe et al., 2024). Such manipulation, which was adapted from prior research (Moore et al., 2012), elicited pressure through verbal, pre-recorded instructions emphasizing the importance and difficulty of the task, comparison with others through a leader board, public observation via Twitch, and the possibility of post-task interviews for low performers. These manipulations were based on prior research indicating game-specific worry, performance expectations, and audience pressure as stressors experienced by esports competitors (Leis et al., 2022; Poulus et al., 2022; Smith et al., 2022). The instructions emphasized the high degree of difficulty and highlighted the excellent performance of prior participants. Instructions were repeated before each round. The instructions were provided through a pre-recorded video that lasted two minutes.

Intervention Instructions

The arousal reappraisal instructions, presented in written form, closely resembled those used by Moore et al. (2015) and Sammy et al. (2017), which was originally adapted from prior authors (Jamieson et al., 2012, 2013), and were as follows: *"In stressful situations, like esporting competitions, our bodies react in very specific ways. The increase in arousal you may feel during stressful situations is not harmful. In fact, recent research has shown that this response to stress can be beneficial and aid performance in stressful situations. Indeed, this response evolved because it helped our ancestors survive by delivering oxygen to where it was needed in the body to help address stressors. Therefore, before and during the upcoming counter strike task, we encourage you to reinterpret your bodily signals and any increases in arousal as beneficial and remind yourself that they could be helping you perform well."* The control instructions, also presented in written form, consisted of AI-generated facts about birds and was matched for the word count of the arousal reappraisal instructions. This was to ensure the participants had an equal duration of contact time with the instructions and experimenters per condition. The participants were informed that the task would potentially help reduce pressure-induced arousal. Specifically, the control instructions were: *"Birds are a class of vertebrates that are known for their feathers, wings, beaks, and ability to fly. They evolved from theropod dinosaurs over 150 million years ago, and today there are over 10,000 different species of birds found all around the world. While most birds are capable of flight, there are some species, such as ostriches and emus, that are flightless. Birds are also known for their complex social behaviour, communication, and intelligence. Some birds, such as parrots and crows, can use tools and solve complex problems. Additionally, many birds play a crucial role in many ecosystems, helping to pollinate plants and control pest populations."* The interventions were introduced immediately preceding the initial presentation of the high-pressure manipulation. This manipulation was administered prior to the commencement of the participant's engagement in the action performance task.

Statistical Analysis

Statistical analyses were completed in R Studio (RStudio Inc, v 0.99.903; R Core Team, 2017) using the R statistical package (v 4.2.1). Assumptions were screened with all variables meeting the criteria for normality (i.e., Skewness < 2 and Kurtosis < 4) and no outliers were identified. A series of paired samples t tests were conducted through the rstatix package (0.7.0) to examine any differences between the arousal reappraisal and control intervention in cognitive and somatic anxiety, challenge and threat appraisals, quiet eye duration, cognitive effort (i.e., pupillometry), and action performance (i.e., trial time and shooting accuracy). Alpha level (p) was set at 0.05, with Cohen's d used as effect sizes (Cohen, 1988).

Results

State Anxiety

Cognitive anxiety was significantly higher following the control intervention (*M* = 3.91, *SD* = 1.61) than the arousal reappraisal intervention (*M* = 3.07, *SD* = 1.25; $t(43) = 2.840$, $p = .007$, $d = 0.43$). Somatic anxiety was significantly higher in the control intervention (*M* = 2.86, *SD* = 0.66) than the arousal reappraisal intervention (*M* = 2.86, *SD* = 1.27; $t(43) = 2.417$, $p = .020$, $d = 0.36$).

Challenge and Threat Appraisals

Participants appraised the control intervention (*M* = -0.91, *SD* = 2.43) as significantly more of a threat than the arousal reappraisal intervention (*M* = 1.30, *SD* = 2.13; $t(43) = 4.752$, $p < .001$, $d = 0.72$).

Quiet Eye Duration

Quiet eye duration was significantly shorter in the control intervention (*M* = 495.66, *SD* = 141.33) than the arousal reappraisal intervention (*M* = 558.86, *SD* = 131.68; $t(43) = 2.250$, $p = .030$, $d = 0.34$).

Cognitive Effort

Pupillometry data from three participants was removed due to the eye tracking systems' failure to detect pupil diameter during baseline measurements or when establishing peak pupil dilation during one of the two intervention conditions. The arousal reappraisal intervention percentage change ($M_{difference}$ = 10%, *SD* = 5.47) was significantly lower than the control intervention ($M_{difference}$ = 14%, *SD* = 5.79; ($t(40) = 3.353$, $p = .002$, $d = 0.52$).

Action Performance

Trial time demonstrated no statistically significant differences between the control intervention (*M* = 62.88 s, *SD* = 12.29) and arousal reappraisal intervention (*M* = 58.37 s, *SD* = 15.10; $t(43) = 1.625$, $p = .111$, $d = 0.25$). Participants shooting accuracy was less effective in the control intervention (*M* = 66%, *SD* = 10.33) than the arousal reappraisal intervention (*M* = 72%, *SD* = 10.40; $t(43) = 3.384$, $p = .001$, $d = 0.51$).

Discussion

Experiment 1 sought to analyse the impact of a single session arousal reappraisal intervention (relative to a control intervention), administered immediately preceding a highly pressurised esport task. This investigation encompassed state anxiety levels, assessments of perceived threat, and objective effort. In parallel, our inquiry delved into potential alterations induced by the intervention on certain performance-related variables, including quiet eye durations, time trial performance, and shot accuracy. Results indicated the arousal reappraisal intervention seemingly prevented the typical effects that occur when esport competitors perform under elevated pressure (i.e., elevation in state anxiety, threat appraisals, disruptions in attentional control, and detriments to performance). Given the primary intervention was not an anxiety-reduction technique, and instead a means to change the way individuals view arousal in high-pressure situations, it was unexpected that we observed a reduction in cognitive and somatic anxiety levels. Irrespective, the arousal reappraisal intervention did prompt shifts in threat appraisals toward challenge appraisals, increased shooting accuracy, and contributed to an increase in participant effort (as demonstrated by a reduction in the percentage change of pupil diameter from baseline). These findings align with prior investigations exploring the efficacy of arousal reappraisal strategies in the context of cognitive performance (Jamieson et al., 2010, 2013). Findings are discussed in further detail in the General Discussion.

Experiment 2

This pilot study evaluated the impact of a high-pressure esports context on state anxiety, challenge and threat appraisals, gaze behaviour, effort, and action performance before and after exposure to a stress mindset educational video, structured arousal-focused exercise, and arousal reappraisal (jointly termed Mindset-Reappraisal Intervention). We used a stress mindset measure as a manipulation check to confirm the primary intervention elicited the desired outcome (i.e., stress-is-enhancing mindset; Crum et al., 2013). It was predicted that the intervention would enable performers to exhibit an overall stress-is-enhancing mindset, more favourable perceptions of cognitive and somatic anxiety, an appraisal away from threat and towards a challenge, and improved action performance (i.e., time trail performance and shooting accuracy). It is expected that this pilot will inform a future study of greater scale, contingent upon the identification of discernible trends in effectiveness and practical feasibility.

Method

Study Design and Procedure

Participants were provided with an information sheet outlining the study's purpose and their ethical rights, including confidentiality, anonymity, and the right to withdraw. Following written informed consent, a pre-experimental design was used where participants were exposed to the pressurised performance task before and after receiving the Mindset-Reappraisal intervention. No control group and/or control condition was provided due to researcher constraints (i.e., time and funding). Data collection was carried out over a single day. The duration of each data collection session was ~45 minutes (M = 44.57 minutes, SD = 8.53 minutes). All data collection took place during daytime hours (10am-4:45pm). Participants were asked to attend the session having not consumed caffeine-based drinks in the 24 hours prior to testing (see Sainz et al., 2020). After verbally providing demographic information (e.g., age, gender, domain-specific experience), participants completed a familiarization of the esport task. All participants in the study were exposed to a high-pressure condition, elicited as per Experiment 1 (i.e., emphasizing task difficulty, competitive leader boards, public observation, and the possibility of post-task interviews). Participants completed eight rounds of the task, with four rounds of the task pre-intervention and four rounds of the task post-intervention, and a 30-minute break in between. A break was introduced to reduce the likelihood of a vigilance decrement negatively influencing task performance (Hunter & Wu, 2016; Ross et al., 2014). Each round concluded after three minutes if not completed by the participant. While illumination was not recorded, the same room was used as per experiment 1.

Participants

A different set of participants volunteered to be part of experiment 2 (M_{age} = 20.40 years, SD = 1.65 years) consisting of seven males, two females, and one who preferred not to disclose their gender. To recruit a different set of participants for this experiment, esport players from any level (i.e., hobbyist players to esport competitors) were recruited via word of mouth. While data relating to competitive level was not collected, all participants reported between 557 and 2307 hours of experience playing Counter-Strike ($M_{experience}$ = 1249.70 hours, SD = 943.43 hours). At the time of data collection, all participants had not competed at a level above university-level. All participants were right-handed, used their dominant hand to control the mouse, and played the game with the in-game weapon on the right side of the display. Each participant had normal or corrected vision and had no known psychiatric or neurological disorders. Given this experiment was deemed a pilot and considering limitations in terms of resources (Lakens, 2022), we opted for a sample size of 10 participants rather than recruiting based on an a priori sample size calculation.

Measures

Measures of state anxiety, challenge and threat appraisals, and action performance were identical to Experiment 1. Additional measures are described in detail below. Unfortunately, resource constraints prevented the collection of eye tracking data (i.e., pupillometry and quiet eye duration).

Stress Mindset Measure

Stress mindset was assessed using the Stress Mindset Measure (SMM; Crum et al., 2013). Specifically, participants rated how strongly they agreed with six items (e.g., "*experiencing stress enhances my performance and productivity"*) on a 5-point Likert scale anchored between 0 ('s*trongly disagree'*) and 4 ('*strongly agree'*). The perceived stress mindset of participants was operationalized by computing the mean of all responses, following appropriate reverse coding of negative items, with higher scores reflecting a 'stress-is-enhancing' as opposed to a 'stress-is-debilitating' mindset (Crum et al., 2013). Questions relating to learning were removed as the adopted intervention did not incorporate such topics (i.e., Questions 2 and 5). Such a tool has been adopted previously with appropriate reliability (α = .87; Crum et al., 2017).

Manipulation

The high-pressure manipulation (which followed immediately after the intervention) was identical to Experiment 1.

Mindset-Appraisal Intervention

Stress Mindset Educational Video

Adopted from previous research (e.g., Crum et al., 2013), the stress mindset educational video consisted of watching four back-to-back educational videos related to the enhancing and debilitating nature of stress in the context of health and performance (https://mbl.stanford.edu/rethink-stress-intervention-videos). These videos collectively took

10 minutes and 30 seconds to watch. More specifically, these instructional recordings delivered impartial information elucidating the nature of stress, elucidating its multifaceted impact on performance, health, and overall well-being.

Structured Exercise and Arousal Reappraisal Instructions

After the educational segment, participants were engaged in a structured exercise encompassing reading and subsequent question-and-answer components, spanning 10 minutes. The content of this exercise consisted of encapsulated summaries extracted from scientific literature addressing the adaptive advantages associated with heightened physiological arousal resultant from stress induction (for instance, augmented heart rate and increased respiratory rate). The overarching objective of this exercise was to foster a perspective shift, facilitating the participants' perception of stress as a utilitarian resource or tool capable of enhancing their performance outcomes during high-pressure situations. The materials utilized for this exercise were adapted from the work of Jamieson et al. (2016). The previously noted stress mindset educational videos, and more recent iterations (Crum et al., 2013, 2017; Jamieson et al., 2018), as well as the exercise task (Jamieson et al., 2012, 2013, 2016), have demonstrated their efficacy in reshaping cognitive frameworks concerning stress-triggered physiological arousal towards mindsets conducive to performance enhancement. Finally, participants read-aloud the arousal reappraisal instructions presented in Experiment 1.

Statistical Analysis

In line with Experiment 1, statistical analyses were completed in R Studio. All assumptions were screened, with all variables meeting criteria for normality, no outliers identified, and no missing data noted. A series of paired sample *t*-tests were conducted through the rstatix package (0.7.0) to examine any differences between pre-and post-intervention in SMM, state anxiety, challenge and threat appraisals, and action performance (see Table 1). Alpha level (p) was set at 0.05, with Cohen's *d* was used to present effect sizes (Cohen, 1988).

Results

Table 1 demonstrates the differences between pre- and post-intervention in stress mindset, challenge and threat appraisals, cognitive anxiety, somatic anxiety, time-trial time, and shooting accuracy. The raw data, probability density, and summary statistics of the variables of interest are illustrated in Figure 1.

Table 1

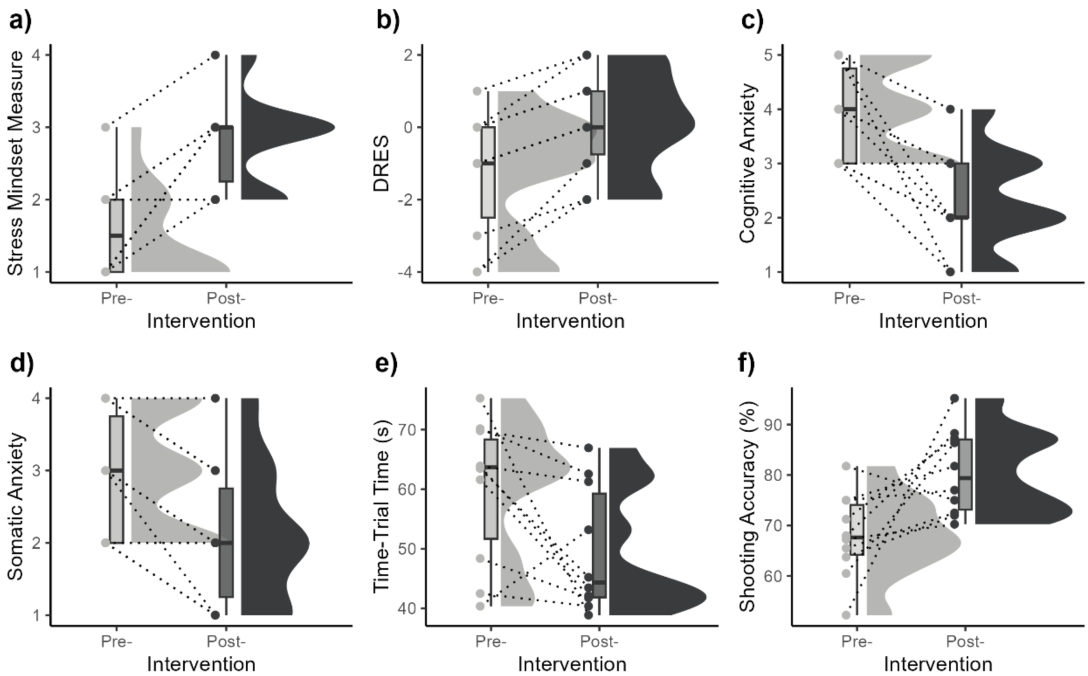
Pre- and Post-Intervention Comparisons of Variables of Interest

	Pre-Intervention		***Post- Intervention***		***t***	***d***
	M	***SD***	***M***	***SD***		
SMM	1.60	0.70	2.80	0.63	-4.81	1.52***
DRES	-1.30	1.77	0.10	1.45	-6.33	2.00***
CA	3.90	0.88	2.30	0.95	4.31	1.36**
SA	2.90	0.88	2.10	0.99	4.00	1.27**
Time	59.92	12.04	49.56	10.50	2.41	0.76*
Accuracy	68.03	8.35	80.56	8.44	-2.78	0.88*

Note: * < .05, ** < .01, *** < .001; DRES = challenge and threat appraisal; CA = cognitive anxiety; SA = somatic anxiety; SMM = stress mindset measure.

Figure 1

Illustration of raw data, probability density, and summary statistics through boxplots



Discussion

Experiment 2 sought to extend the findings of Experiment 1 by investigating an extension to the single session intervention, titled Mindset-Reappraisal. This preliminary investigation recorded participant cognitive and somatic anxiety, challenge and threat appraisals, stress mindsets, and action performance (i.e., time trial performance and shot accuracy) to determine the impact of the intervention in a high-pressure context. Results indicated that following the intervention, participants reported a more stress-is-enhancing mindset, exhibited reduced cognitive and somatic anxiety, appraised the task as more of a challenge (vs. a threat), and displayed better action performance (i.e., faster completion times and greater shooting accuracy). We discuss the findings of both experiments in more depth below.

General Discussion

The primary aim of this study was to explore interventions for mitigating the adverse effects of high psychological pressure on esport action performance. In Experiment 1, we aimed to comprehend the impact of an arousal reappraisal intervention in comparison to a control intervention. We assessed variables including state anxiety, challenge and threat appraisal, gaze behaviour, effort, and action performance (i.e., time-trial time, shot accuracy). In Experiment 2, we conducted a pilot study into the influence of a high-pressure environment before and after participants were exposed to a comprehensive intervention, referred to as the Mindset-Reappraisal Intervention, which consisted of a stress mindset educational video, structured arousal-focused exercise, and the original arousal reappraisal intervention. In summary, we revealed novel and significant findings, establishing that arousal reappraisal within an esports context can mitigate some of the negative impacts associated with a highly pressurized environment. The redirection of participants' perception of arousal towards a challenge appraisal and a stress-is-enhancing mindset not only led to enhanced esports action performance compared to control interventions but also resulted in a reduction of immediate cognitive and somatic anxiety (see Figure 1). Notably, the latter outcome is noteworthy given that neither variant of the selected interventions was specifically designed to address anxiety directly. We are optimistic that these findings will contribute significantly to the existing body of knowledge in the perceptions of arousal (and anxiety).

In Experiment 1, quiet eye durations revealed statistically significant difference for the intervention. The average duration of the quiet eye significantly decreased following the control intervention in comparison to the arousal reappraisal intervention. The observed shorter durations during the control intervention may signify a reallocation of cognitive resources away from the goal-directed system (as per the ACT; Eysenck et al., 2007). This reallocation potentially results in reduced total time available for the detection of task-relevant information, consequently impacting the timing and accuracy of the athlete's motor response, such as a mouse click. The decline in quiet eye duration aligns with consistent findings in various traditional sporting domains as documented in prior research (Giancamilli et al., 2022; Moeinirad et al., 2020; Vincze et al., 2022). Our research implies that even for subtle movements, such as mouse control, the motor system demonstrates significantly improved accuracy when provided with better and more timely visual information. These findings underscore the importance of optimizing visual information processing in enhancing motor performance, emphasizing its relevance across various athletic domains. Findings certainly push for future research to extend the relative strength of arousal reappraisal interventions by combining additional approaches that may enable individuals to experience more favourable stress responses, such as transcranial direct current stimulation (e.g., Brunoni et al., 2013; Remue et al., 2016) or like the approach adopted in Experiment 2 with educational components.

The arousal reappraisal intervention did not yield a statistically significant difference in time trial performance, whereas notable differences were observed following the Mindset-Reappraisal intervention. However, it is important to highlight that, in both experiments, the introduction of either primary intervention resulted in a significant positive impact on state anxiety levels. This finding is particularly noteworthy due to the origins of somatic and cognitive anxiety symptoms can be elicited by different antecedents, as well as their association with different performance outcomes (Mellalieu et al., 2004; C. M. Turner & Barrett, 2003; White & Farrell, 2001). This phenomenon aligns with the framework of Attentional Control Theory, which suggests that anxiety might not necessarily impede performance if it prompts the implementation of compensatory mechanisms, such as heightened effort (Eysenck et al., 2007). Interestingly, our analysis of pupil dilation data corroborated this notion by revealing a more pronounced alteration in pupil dilation from baseline among participants subjected to the arousal reappraisal intervention, in contrast to the control intervention. This could imply that individuals adopted compensatory strategies, perhaps taken from the intervention itself, to safeguard against performance decline induced by the high-pressure environment. Further, the Integrative Framework may explain why no statistically significant differences were observed in time trial performance during experiment 1. The framework postulates that heightened investment might not necessarily enable participants to sustain or elevate their performance, as the exerted effort may predominantly contribute to the initial evaluation rather than serve as a response to anxiety (Vine et al., 2016). Conversely, our observations also noted significant differences in shooting accuracy which may tentatively fall in line with prior literature indicating that effort mediates the decline in performance in some pressurised contexts (Cooke et al., 2010, 2011). Nevertheless, despite these considerations, it remains a compelling area for future inquiry to investigate whether the arousal reappraisal intervention not only fosters more favourable stress responses but also potentially stimulates greater participant effort.

Unlike time trial performance, arousal reappraisal did demonstrate a notable performance advantage beyond the control intervention in Experiment 1 for percentage shooting accuracy. Given that arousal reappraisal is hypothesized to enhance sympathetic-adrenomedullary activation and bolster oxygenated blood flow to cerebral and muscular domains (Jamieson et al., 2013; Moore et al., 2015), and the percentage of accuracy stands as a proxy for the precise execution of fine motor skills (i.e., mouse control), such findings were anticipated. Findings are encouraging, given accuracy has been noted as a key determinant of Counter-Strike action performance amongst a series of technical expert panels (see Sharpe et al., 2024), while time trial performance may not translate directly into the competitive nature of the esport. In fact, time trial performance may require keyboard proficiency (i.e., efficient character movement) and an understanding of map knowledge (i.e., where to move next), processing speed, and planning ability – and so generalisability must be approached with caution. Arousal reappraisal facilitating the sustainment of accuracy under high pressure demonstrates a notable advantage of a low-resource intervention that may benefit the competitive esport landscape.

Preliminary findings from Experiment 2 appear to align with prior discussions noting how reappraisal and mindset interventions can be collectively utilised to optimise stress responses and facilitate performance in certain contexts (Crum et al., 2013, 2017; see Jamieson et al., 2018 for review); however, given the nature of the exploration, such discussions remain tentative. The Mindset-Reappraisal intervention demonstrated an ability to redirect participants' environmental assessments toward a perspective that prioritizes challenge-oriented states and a stress-enhancing mindset (see Figure 1). This collective shift in mindset potentially underscores the practical efficacy of cost-effective interventions within the specific context of our performance task (see Journault et al., 2024 for discussion). While it would be assumed to be favourable to maintain the use of ‘stress reduction’ interventions, our findings, at the very least, provide some additional support for those who wish to use such interventions at a single time point and may stimulate discussions about integrating interventions within esports. However, it is important to note that Experiment 2 warrants a degree of caution regarding our interpretation of findings (e.g., Baynard-Montague & James, 2023; Yeager et al., 2022). This cautionary note stems from the lack of a control group and primary intent of the investigation, which was designed as a preliminary exploration to establish a foundation for a more comprehensive randomized control trial (see Poulus et al., 2023 for similar design). Additionally, it is crucial to acknowledge that Experiment 2 comprised predominantly male participants within a similar age range, and the study did not inquire into the diversity of their backgrounds, including whether individuals with disabilities were represented. It is plausible that a different population may exhibit distinct outcomes, underscoring the need for further research encompassing diverse demographics (see Goyer et al., 2022; Hangen et al., 2019; Journault et al., 2024 for discussion). For example, in light of previous studies indicating potential gender-specific effects of arousal reappraisal (Hangen et al., 2019), replicating these findings and/or exploring alternative approaches that benefit female competitors would be an invaluable contribution to the field.

Limitations and Future Directions

The practical implementation of a low-resource intervention demands deeper exploration within the domain of esports, particularly in Counter-Strike. Such interventions hold the potential to foster challenge-oriented mental states, mitigate anxiety, enhance effort exertion, and facilitate a sustained or enhanced level of performance when confronted with high-pressure situations. Furthermore, there is a noteworthy consideration in redirecting the mindset of competitors towards the notion that stress can be enhancing. This shift in mindset may significantly enhance the perceived value of such interventions in relation to individual assessments of high-pressure situations and their consequential performance outcomes in specific contexts. It is important to acknowledge that our study took place in a controlled laboratory environment and aimed to simulate high-pressure situations. However, we must clarify that our research cannot fully replicate the complex stressors experienced by competitors during actual esports tournaments, particularly when they are part of a team (see Leis & Lautenbach, 2020 for discussion). Our study did create a certain level of pressure that influenced player performance, and so our findings can only suggest, with some caution, that similar outcomes might be observed in tournament conditions after implementing the interventions we studied. Despite the inherent challenges of conducting research in ecologically valid environments such as tournament conditions, we encourage researchers to make this step. Similarly, considering the array of arousal reappraisal and stress mindset variants accessible, this study chose to utilize the available versions due to their online availability and researcher constraints. However, we do not assert that these variants are the exclusive methods to induce such effects. Instead, we recommend that future researchers investigate alternative interventions to incorporate, aiming to enhance favourable outcomes.

Future research endeavours should also aim to investigate whether the benefits observed in interventions, such as the one examined in this study, extend to outcomes beyond the immediate high-pressure esports' environment. This includes exploring effects on everyday functioning (e.g., Griffith & Sharpe, 2024) and considering the potential impact on mental health (Birch et al., 2024), given the acknowledgment that long-term exposure to stressors may be linked to mental ill health (Smith et al., 2022). Expanding the focus beyond exclusive consideration of performance outcomes is essential for ensuring player longevity and sustainability. Additionally, such investigations may offer valuable insights that benefit competitors even after they discontinue their engagement in esports altogether. We encourage future researchers to investigate the duration of the retention period linked to arousal reappraisal among esports competitors, as well as whether repeated exposure to such techniques is necessary to sustain their advantageous effects.

Conclusion

In Experiment 1, we observed that a single-session arousal reappraisal intervention exerted a noteworthy influence on high-pressure esports performance. This intervention not only effectively reduced state anxiety but also led to a shift in appraisals from threat to challenge, benefitted attentional control and shooting accuracy, and manifested a decrease in pupil dilation reflecting participant effort compared to the control intervention. In Experiment 2, we offered a preliminary evaluation of a Mindset-Reappraisal intervention, which also resulted in improvements in esport performance under pressure (i.e., faster completion times and greater shooting accuracy). This comprehensive intervention fostered a mindset that views stress as enhancing, lowered cognitive and somatic anxiety, and prompted challenge appraisals. Effective management of arousal levels and educating competitors on the impact of stress mindsets may empower individuals to adeptly navigate high-pressure situations and thereby enhance their performance. Consequently, this research provides valuable insights into the realm of esports performance psychology, shedding light on the potential of interventions such as arousal reappraisal and stress mindset strategies to aid performance under pressure. Future studies can build on these findings to further refine and expand strategies for optimizing performance and responses to pressure in competitive esports environments.

References

Akinola, M., Fridman, I., Mor, S., Morris, M. W., & Crum, A. J. (2016). Adaptive Appraisals of Anxiety Moderate the Association between Cortisol Reactivity and Performance in Salary Negotiations. *PLOS ONE*, *11*(12), e0167977. https://doi.org/10.1371/journal.pone.0167977

Baynard-Montague, J., & James, L. E. (2023). A stress mindset manipulation can affect speakers' articulation rate. *Anxiety, Stress, & Coping*, *36*(5), 543–554. https://doi.org/10.1080/10615806.2023.2179621

Behnke, M., & Kaczmarek, L. D. (2018). Successful performance and cardiovascular markers of challenge and threat: A meta-analysis. *International Journal of Psychophysiology*, *130*, 73–79. https://doi.org/10.1016/j.ijpsycho.2018.04.007

Behnke, M., Kosakowski, M., & Kaczmarek, L. D. (2020). Social challenge and threat predict performance and cardiovascular responses during competitive video gaming. *Psychology of Sport and Exercise*, *46*, 101584. https://doi.org/10.1016/j.psychsport.2019.101584

Birch, P. D. J., Smith, M. J., Arumuham, A., de Gortari A. O, & Sharpe, B. T. (2024). The prevalence of mental ill health in elite Counter-Strike athletes. *Journal of Electronic Gaming and Esports*.

Brimmell, J., Parker, J., Wilson, M. R., Vine, S. J., & Moore, L. J. (2019). Challenge and threat states, performance, and attentional control during a pressurized soccer penalty task. *Sport, Exercise, and Performance Psychology*, *8*(1), 63–79. https://doi.org/10.1037/spy0000147

Brunoni, A. R., Ferrucci, R., Bortolomasi, M., Scelzo, E., Boggio, P. S., Fregni, F., Dell'Osso, B., Giacopuzzi, M., Altamura, A. C., & Priori, A. (2013). Interactions between transcranial direct current stimulation (tDCS) and pharmacological interventions in the Major Depressive Episode: Findings from a naturalistic study. *European Psychiatry*, *28*(6), 356–361. https://doi.org/10.1016/j.eurpsy.2012.09.001

Burkhouse, K. L., Siegle, G. J., & Gibb, B. E. (2014). Pupillary reactivity to emotional stimuli in children of depressed and anxious mothers. *Journal of Child Psychology and Psychiatry*, *55*(9), 1009–1016. https://doi.org/10.1111/jcpp.12225

Cooke, A., Kavussanu, M., McIntyre, D., Boardley, I. D., & Ring, C. (2011). Effects of competitive pressure on expert performance: Underlying psychological, physiological, and kinematic mechanisms. *Psychophysiology*, *48*(8), 1146–1156. https://doi.org/10.1111/j.1469-8986.2011.01175.x

Cooke, A., Kavussanu, M., McIntyre, D., & Ring, C. (2010). Psychological, muscular and kinematic factors mediate performance under pressure. *Psychophysiology*. https://doi.org/10.1111/j.1469-8986.2010.01021.x

Cottrell, C., McMillen, N., & Harris, B. S. (2019). Sport psychology in a virtual world: Considerations for practitioners working in eSports. *Journal of Sport Psychology in Action*, *10*(2), 73–81. https://doi.org/10.1080/21520704.2018.1518280

Crum, A. J., Akinola, M., Martin, A., & Fath, S. (2017). The role of stress mindset in shaping cognitive, emotional, and physiological responses to challenging and threatening stress. *Anxiety, Stress, & Coping*, *30*(4), 379–395. https://doi.org/10.1080/10615806.2016.1275585

Crum, A. J., Jamieson, J. P., & Akinola, M. (2020). Optimizing stress: An integrated intervention for regulating stress responses. *Emotion*, *20*(1), 120–125. https://doi.org/10.1037/emo0000670

Crum, A. J., Salovey, P., & Achor, S. (2013). Rethinking stress: The role of mindsets in determining the stress response. *Journal of Personality and Social Psychology*, *104*(4), 716–733. https://doi.org/10.1037/a0031201

Crum, A. J., Santoro, E., Handley-Miner, I., Smith, E. N., Evans, K., Moraveji, N., Achor, S., & Salovey, P. (2023). Evaluation of the "rethink stress" mindset intervention: A metacognitive approach to changing mindsets. *Journal of Experimental Psychology: General*, *152*(9), 2603–2622. https://doi.org/10.1037/xge0001396

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion*, *7*(2), 336–353. https://doi.org/10.1037/1528-3542.7.2.336

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4). https://doi.org/10.3758/BRM.41.4.1149

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Giancamilli, F., Galli, F., Chirico, A., Fegatelli, D., Mallia, L., Palombi, T., & Lucidi, F. (2022). High-Pressure Game Conditions Affect Quiet Eye Depending on the Player's Expertise: Evidence from the Basketball Three-Point Shot. *Brain Sciences*, *12*(2), 286. https://doi.org/10.3390/brainsci12020286

Gildea, K. M., Schneider, T. R., & Shebilske, W. L. (2007). Stress Appraisals and Training Performance on a Complex Laboratory Task. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *49*(4), 745–758. https://doi.org/10.1518/001872007X215818

Ginty, A. T., Oosterhoff, B. J., Young, D. A., & Williams, S. E. (2022). Effects of arousal reappraisal on the anxiety responses to stress: Breaking the cycle of negative arousal intensity and arousal interpretation. *British Journal of Psychology*, *113*(1), 131–152. https://doi.org/10.1111/bjop.12528

Goyer, J. P., Akinola, M., Grunberg, R., & Crum, A. J. (2022). Thriving under pressure: The effects of stress-related wise interventions on affect, sleep, and exam performance for college students from disadvantaged backgrounds. *Emotion*, *22*(8), 1755–1772. https://doi.org/10.1037/emo0001026

Graur, S., & Siegle, G. (2013). Pupillary Motility: Bringing Neuroscience to the Psychiatry Clinic of the Future. *Current Neurology and Neuroscience Reports*, *13*(8), 365. https://doi.org/10.1007/s11910-013-0365-0

Griffith, O. J., & Sharpe, B. T. (2024). Investigating Psychological Disparities Across Gamers: A Genre-Based Study. *Journal of Electronic Gaming and Esports*.

Hallmann, K., & Giel, T. (2018). eSports – Competitive sports or recreational activity? *Sport Management Review*, *21*(1), 14–20. https://doi.org/10.1016/j.smr.2017.07.011

Hangen, E. J., Elliot, A. J., & Jamieson, J. P. (2019). Stress reappraisal during a mathematics competition: testing effects on cardiovascular approach-oriented states and exploring the moderating role of gender. *Anxiety, Stress, & Coping*, *32*(1), 95–108. https://doi.org/10.1080/10615806.2018.1530049

Hanton, S., Neil, R., & Mellalieu, S. D. (2008). Recent developments in competitive anxiety direction and competition stress research. *International Review of Sport and Exercise Psychology*, *1*(1), 45–57. https://doi.org/10.1080/17509840701827445

Hase, A., O'Brien, J., Moore, L. J., & Freeman, P. (2019). The relationship between challenge and threat states and performance: A systematic review. *Sport, Exercise, and Performance Psychology*, *8*(2), 123–144. https://doi.org/10.1037/spy0000132

Hunter, E. M., & Wu, C. (2016). Give me a better break: Choosing workday break activities to maximize resource recovery. *Journal of Applied Psychology*, *101*(2), 302–311. https://doi.org/10.1037/apl0000045

Jamieson, J. P., Black, A. E., Pelaia, L. E., Gravelding, H., Gordils, J., & Reis, H. T. (2022). Reappraising stress arousal improves affective, neuroendocrine, and academic performance outcomes in community college classrooms. *Journal of Experimental Psychology: General*, *151*(1), 197–212. https://doi.org/10.1037/xge0000893

Jamieson, J. P., Crum, A. J., Goyer, J. P., Marotta, M. E., & Akinola, M. (2018). Optimizing stress responses with reappraisal and mindset interventions: an integrated model. *Anxiety, Stress, & Coping*, *31*(3), 245–261. https://doi.org/10.1080/10615806.2018.1442615

Jamieson, J. P., Mendes, W. B., Blackstock, E., & Schmader, T. (2010). Turning the knots in your stomach into bows: Reappraising arousal improves performance on the GRE. *Journal of Experimental Social Psychology*, *46*(1), 208–212. https://doi.org/10.1016/j.jesp.2009.08.015

Jamieson, J. P., Mendes, W. B., & Nock, M. K. (2013). Improving Acute Stress Responses. *Current Directions in Psychological Science*, *22*(1), 51–56. https://doi.org/10.1177/0963721412461500

Jamieson, J. P., Nock, M. K., & Mendes, W. B. (2012). Mind over matter: Reappraising arousal improves cardiovascular and cognitive responses to stress. *Journal of Experimental Psychology: General*, *141*(3), 417–422. https://doi.org/10.1037/a0025719

Jamieson, J. P., Peters, B. J., Greenwood, E. J., & Altose, A. J. (2016). Reappraising Stress Arousal Improves Performance and Reduces Evaluation Anxiety in Classroom Exam

Situations. *Social Psychological and Personality Science*, *7*(6), 579–587. https://doi.org/10.1177/1948550616644656

Jenny, S. E., Keiper, M. C., Taylor, B. J., Williams, D. P., Gawrysiak, J., Manning, R. D., & Tutka, P. M. (2018). eSports Venues: A New Sport Business Opportunity. *Journal of Applied Sport Management*, *10*(1), 34–49. https://doi.org/10.18666/JASM-2018-V10-I1-8469

Journault, A.-A., Cernik, R., Charbonneau, S., Sauvageau, C., Giguère, C.-É., Jamieson, J. P., Plante, I., Geoffrion, S., & Lupien, S. J. (2024). Learning to embrace one's stress: the selective effects of short videos on youth's stress mindsets. *Anxiety, Stress, & Coping*, *37*(1), 29–44. https://doi.org/10.1080/10615806.2023.2234309

Kahya, M., Moon, S., Lyons, K. E., Pahwa, R., Akinwuntan, A. E., & Devos, H. (2018). Pupillary Response to Cognitive Demand in Parkinson's Disease: A Pilot Study. *Frontiers in Aging Neuroscience*, *10*. https://doi.org/10.3389/fnagi.2018.00090

Lakens, D. (2022). Sample Size Justification. *Collabra: Psychology*, *8*(1). https://doi.org/10.1525/collabra.33267

Lazarus, R. S. (2000). How emotions influence performance in competitive sports. *The Sport Psychologist*, *14*(3), 229–252.

Leis, O., & Lautenbach, F. (2020). Psychological and physiological stress in non-competitive and competitive esports settings: A systematic review. *Psychology of Sport and Exercise*, *51*, 101738. https://doi.org/10.1016/j.psychsport.2020.101738

Leis, O., Lautenbach, F., Birch, P. D., & Elbe, A. M. (2022). Stressors, associated responses, and coping strategies in professional esports players: A qualitative study. *International Journal of Esports*, *3*(3).

Leis, O., Raue, C., Dreiskämper, D., & Lautenbach, F. (2021). To be or not to be (e)sports? That is not the question! Why and how sport and exercise psychology could research esports. *German Journal of Exercise and Sport Research*, *51*(2), 241–247. https://doi.org/10.1007/s12662-021-00715-9

Leis, O., Watson, M., Swettenham, L., Pedraza-Ramirez, I., & Lautenbach, F. (2023). Stress Management Strategies in Esports: An Exploratory Online Survey on Applied Practice. *Journal of Electronic Gaming and Esports*, *1*(1). https://doi.org/10.1123/jege.2023-0002

Mansell, P., Sparks, K., Wright, J., Roe, L., Carrington, S., Lock, J., & Slater, M. (2023). "Mindset: performing under pressure" – a multimodal cognitive-behavioural intervention to enhance the well-being and performance of young athletes. *Journal of Applied Sport Psychology*, 1–20. https://doi.org/10.1080/10413200.2023.2296900

McGrath, J. S., Moore, L., Wilson, M. R., Freeman, P., & Vine, S. (2011). 'Challenge' and 'threat' states in surgery: implications for surgical performance and training. *BJU International*, *108*(6), 795–796. https://doi.org/10.1111/j.1464-410X.2011.10558.x

Mellalieu, S. D., Hanton, S., & O'Brien, M. (2004). Intensity and direction of competitive anxiety as a function of sport type and experience. *Scandinavian Journal of Medicine* *and Science in Sports*, *14*(5), 326–334. https://doi.org/10.1111/j.1600-0838.2004.00389.x

Mendes, W. B., Blascovich, J., Hunter, S. B., Lickel, B., & Jost, J. T. (2007). Threatened by the unexpected: Physiological responses during social interactions with expectancy-violating partners. *Journal of Personality and Social Psychology*, *92*(4), 698–716. https://doi.org/10.1037/0022-3514.92.4.698

Moeinirad, S., Abdoli, B., Farsi, A., & Ahmadi, N. (2020). The Role of Quiet Eye Duration and Its Components in a Complex Far-Aiming Task. *Journal of Motor Learning and Development*, *8*(3), 516–527. https://doi.org/10.1123/jmld.2019-0048

Moore, L. J., Vine, S. J., Freeman, P., & Wilson, M. R. (2013). Quiet eye training promotes challenge appraisals and aids performance under elevated anxiety. *International Journal of Sport and Exercise Psychology*, *11*(2), 169–183. https://doi.org/10.1080/1612197X.2013.773688

Moore, L. J., Vine, S. J., Wilson, M. R., & Freeman, P. (2015). Reappraising Threat: How to Optimize Performance Under Pressure. *Journal of Sport and Exercise Psychology*, *37*(3), 339–343. https://doi.org/10.1123/jsep.2014-0186

Moran, T. P. (2016). Anxiety and working memory capacity: A meta-analysis and narrative review. *Psychological Bulletin*, *142*(8), 831–864. https://doi.org/10.1037/bul0000051

Poulus, D. R., Bennett, K. JM., Swann, C., Moyle, G. M., & Polman, R. CJ. (2023). The influence of an esports-adapted coping effectiveness training (E-CET) on resilience, mental health, and subjective performance among elite league of Legends players: A pilot study. *Psychology of Sport and Exercise*, *69*, 102510. https://doi.org/10.1016/j.psychsport.2023.102510

Poulus, D. R., Coulter, T., Trotter, M., & Polman, R. (2022). Perceived stressors experienced by competitive esports athletes. *International Journal of Esports*, *3*(3).

Poulus, D. R., Sargeant, J., Zarate, D., Griffiths, M. D., & Stavropoulos, V. (2024). Burnout, resilience, and coping among esports players: A network analysis approach. *Computers in Human Behavior*, *153*, 108139. https://doi.org/10.1016/j.chb.2024.108139

Remue, J., Vanderhasselt, M.-A., Baeken, C., Rossi, V., Tullo, J., & De Raedt, R. (2016). The effect of a single HF-rTMS session over the left DLPFC on the physiological stress response as measured by heart rate variability. *Neuropsychology*, *30*(6), 756–766. https://doi.org/10.1037/neu0000255

Ross, H. A., Russell, P. N., & Helton, W. S. (2014). Effects of breaks and goal switches on the vigilance decrement. *Experimental Brain Research*, *232*(6), 1729–1737. https://doi.org/10.1007/s00221-014-3865-5

Runswick, O. R., Jewiss, M., Sharpe, B. T., & North, J. S. (2021). Context Affects Quiet Eye Duration and Motor Performance Independent of Cognitive Effort. *Journal of Sport & Exercise Psychology*, *43*(2), 191–197. https://doi.org/10.1123/jsep.2020-0026

Sainz, I., Collado-Mateo, D., & Coso, J. Del. (2020). Effect of acute caffeine intake on hit accuracy and reaction time in professional e-sports players. *Physiology & Behavior*, *224*, 113031. https://doi.org/10.1016/j.physbeh.2020.113031

Sammy, N., Anstiss, P. A., Moore, L. J., Freeman, P., Wilson, M. R., & Vine, S. J. (2017). The effects of arousal reappraisal on stress responses, performance and attention. *Anxiety, Stress, & Coping*, *30*(6), 619–629. https://doi.org/10.1080/10615806.2017.1330952

Schulz, A., & Vögele, C. (2015). Interoception and stress. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2015.00993

Seery, M. D. (2011). Challenge or threat? Cardiovascular indexes of resilience and vulnerability to potential stress in humans. *Neuroscience & Biobehavioral Reviews*, *35*(7), 1603–1610. https://doi.org/10.1016/j.neubiorev.2011.03.003

Seery, M. D., Leo, R. J., Lupien, S. P., Kondrak, C. L., & Almonte, J. L. (2013). An Upside to Adversity? *Psychological Science*, *24*(7), 1181–1189. https://doi.org/10.1177/0956797612469210

Sharpe, B. T., Besombes, N., Welsh, M. R., & Birch, P. D. J. (2022). Indexing Esport Performance. *Journal of Electronic Gaming and Esports*, *1*(1). https://doi.org/10.1123/jege.2022-0017

Sharpe, B. T., Obine, E. A. C., Birch, P. D. J., Pocock, C., & Moore, L. J. (2024). Performance Breakdown Under Pressure Among Esports Competitors. *Sport, Exercise, and Performance Psychology*, *13*(1), 89–109. https://doi.org/10.1037/spy0000337

Smith, M., Sharpe, B., Arumuham, A., & Birch, P. (2022). Examining the Predictors of Mental Ill Health in Esport Competitors. *Healthcare*, *10*(4), 626. https://doi.org/10.3390/healthcare10040626

Thomas, O., Hanton, S., & Jones, G. (2002). An alternative approach to short-form self report assessment of competitive anxiety. *International Journal of Sport Psychology*, *33*, 325–336.

Tomaka, J., Blascovich, J., Kelsey, R. M., & Leitten, C. L. (1993). Subjective, physiological, and behavioral effects of threat and challenge appraisal. *Journal of Personality and Social Psychology*, *65*(2), 248–260. https://doi.org/10.1037/0022-3514.65.2.248

Trotman, G. P., Williams, S. E., Quinton, M. L., & Veldhuijzen van Zanten, J. J. C. S. (2018). Challenge and threat states: examining cardiovascular, cognitive and affective responses to two distinct laboratory stress tasks. *International Journal of Psychophysiology*, *126*, 42–51. https://doi.org/10.1016/j.ijpsycho.2018.02.004

Trotter, M. G., Obine, E. A., & Sharpe, B. T. (2023). Self-Regulation, Stress Appraisals, and Esport Action Performance. *Front. Psychol. Performance Science*, *14*.

Turner, C. M., & Barrett, P. M. (2003). Does age play a role in structure of anxiety and depression in children and youths? An investigation of the tripartite model in three age cohorts. *Journal of Consulting and Clinical Psychology*, *71*(4), 826–833. https://doi.org/10.1037/0022-006X.71.4.826

Turner, M. J., Massie, R., Slater, M. J., & Braithwaite, E. (2021). Do challenge and threat evaluations predict netball performance and selection at trials in youth netball players? *Sport, Exercise, and Performance Psychology*, *10*(1), 71–87. https://doi.org/10.1037/spy0000248

Vickers, J. N. (1996). Visual control when aiming at a far target. *Journal of Experimental Psychology: Human Perception and Performance*, *22*(2), 342–354. https://doi.org/10.1037/0096-1523.22.2.342

Vickers, J. N. (2009). *Advances in coupling perception and action: the quiet eye as a bidirectional link between gaze, attention, and action* (pp. 279–288). https://doi.org/10.1016/S0079-6123(09)01322-3

Vickers, J. N., & Williams, A. M. (2007). Performing Under Pressure: The Effects of Physiological Arousal, Cognitive Anxiety, and Gaze Control in Biathlon. *Journal of Motor Behavior*, *39*(5), 381–394. https://doi.org/10.3200/JMBR.39.5.381-394

Vincze, A., Jurchis, R., & Iliescu, D. (2022). The dynamics of Quiet Eye under stress in elite table tennis performance. *International Journal of Sport and Exercise Psychology*, 1–17. https://doi.org/10.1080/1612197X.2022.2078853

Vine, S. J., Moore, L. J., & Wilson, M. R. (2016). An Integrative Framework of Stress, Attention, and Visuomotor Performance. *Frontiers in Psychology*, *7*. https://doi.org/10.3389/fpsyg.2016.01671

Vine, S. J., Uiga, L., Lavric, A., Moore, L. J., Tsaneva-Atanasova, K., & Wilson, M. R. (2015). Individual reactions to stress predict performance during a critical aviation incident. *Anxiety, Stress, & Coping*, *28*(4), 467–477. https://doi.org/10.1080/10615806.2014.986722

White, K. S., & Farrell, A. D. (2001). Structure of anxiety symptoms in urban children: Competing factor models of Revised Children's Manifest Anxiety Scale. *Journal of Consulting and Clinical Psychology*, *69*(2), 333–337. https://doi.org/10.1037/0022-006X.69.2.333

Wood, G., & Wilson, M. R. (2010). A moving goalkeeper distracts penalty takers and impairs shooting accuracy. *Journal of Sports Sciences*, *28*(9), 937–946. https://doi.org/10.1080/02640414.2010.495995

Wood, G., & Wilson, M. R. (2011). Quiet-eye training for soccer penalty kicks. *Cognitive Processing*, *12*(3), 257–266. https://doi.org/10.1007/s10339-011-0393-0

Yeager, D. S., Bryan, C. J., Gross, J. J., Murray, J. S., Krettek Cobb, D., H. F. Santos, P., Gravelding, H., Johnson, M., & Jamieson, J. P. (2022). A synergistic mindsets intervention protects adolescents from stress. *Nature*, *607*(7919), 512–520. https://doi.org/10.1038/s41586-022-04907-7