**Optimizing Esports Performance Using a Synergistic Mindsets Intervention**

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# Abstract

Affective responses during stressful high-stakes situations can play an important role in shaping performance outcomes. For example, feeling shaky and nervous at a job interview can undermine performance, whereas feeling pumped and excited during a sporting competition can optimize performance. These observations suggest that affect regulation – the way people influence their affective responses – might play a key role in determining high-stakes performance outcomes. To test this hypothesis, we propose to adapt a newly developed synergistic mindsets intervention (Yeager et al., 2022) to high-stakes situations. This adaptation is motivated by the idea that (1) mindsets both about situations and one’s response to situations can be shaped to maximize challenge versus threat responding, and (2) challenge versus threat affective responses will be associated with enhanced performance outcomes. Our particular focus is esports, a context that permits the measurement of affective response – affective experience and real-time cardiovascular responses - and well-defined performance outcomes. After a baseline performance task, we will randomly assign gamers (N = 250) either to a synergistic mindsets intervention or to a control condition in which they will learn brain facts. After two weeks of daily gaming, players will compete in a cash-prize tournament. We will measure affective experiences before the matches and cardiovascular responses before and throughout the matches. Compared to the control condition, we hypothesize that synergistic mindset gamers will show greater challenge affective responses and superior performance outcomes. If these predictions are supported, we will seek to extend this work to other contexts.

***Keywords:*** Affect, Biopsychosocial, Stress Appraisals, Reappraisal, Challenge and Threat, Mindset.

# Optimizing Esports Performance Using a Synergistic Mindsets Intervention

Stressful, high-stakes performance situations are common in people’s lives, including school and university exams, public speaking, job interviews, and sports competitions, to name some. These performance situations present acute task demands that require engagement– or orienting to demands–and instrumental responding to address (Blascovich, 1992; Blascovich & Mendes, 2010; Jamieson et al., 2018). While some individuals thrive in such stressful performance settings to attain goals, learn new skills, or innovate outside their comfort zones, others wilt under pressure and fail to achieve their goals and stagnate. Findings from different research traditions indicate that two critical factors that shape how people perform in acutely stressful performance contexts are (1) how they evaluate—or *appraise*—certain aspects of the situations, and (2) how they appraise their affective responses to those situations (Blascovich, 2008; Crum et al., 2013, 2017; Hase et al., 2019; Jamieson et al., 2013, 2018; Meijen et al., 2020; Yeager et al., 2022).

People tend to perform worse than might be expected when they appraise the situation (e.g., performance) as a threat - a belief that situational demands (e.g., controllability, social expectations, and required effort) exceed a person's resources (e.g., skills, knowledge, and abilities; see Hase et al., 2019, for a review). People also tend to perform worse than might be expected when they evaluate their physiological responses to the situation (e.g., sweaty hands) as harmful and hindering optimal performance (Jamieson et al., 2018). The disadvantage of having these negative appraisals of either one’s situation and/or one’s responses to the situation (as opposed to more positive ones) has been shown in various performance contexts, including math tasks (Chalabaev et al., 2012; Jamieson et al., 2016; Schneider, 2004), surgery (Vine et al., 2013), flight simulation (Vine et al., 2015), darts, (Moore et al., 2018), golf (Moore et al., 2013, 2015), gaming (Gildea et al., 2007), and esports (Behnke, Gross, et al., 2022). Understanding *how* these appraisals influence performance is a critical research goal that will assist in creating interventions to optimize individuals’ performance across a wide range of high-stakes situations.

**How Appraisals Influence Performance**

One possible mechanism by which appraisals of one’s situation and/or one’s responses to the situation can either harm or optimize performance outcomes is through the activation of one of two kinds of affective response: threat or challenge (Yeager et al., 2022; Figure 1). When people have negative performance-related appraisals (e.g., the performance situation is perceived as harmful and uncontrollable), they tend to respond to the performance situation with the threat affective response (Blascovich & Mendes, 2010). Threat/challenge affective responses are operationalized via two loosely coupled responses: cardiovascular responses and affective self-reports. Threat affective response is associated with maladaptive cardiovascular responses, characterized by decreased cardiovascular efficiency – decreased blood flow throughout the body (i.e., decreased cardiac output and increased total peripheral resistance) - harming cardiovascular mobilization required for successful performance (Blascovich, 2008; Seery, 2011). Cardiac output (CO) represents the volume of blood pumped through the cardiovascular system over time – usually 1 minute (e.g., Jamieson et al., 2012). Decreases in CO index less cardiac efficiency and accompany avoidance-oriented threat states as less oxygenated blood is being delivered to the brain compared to states with higher levels of CO such as challenge. Total peripheral resistance (TPR) assesses overall vascular resistance. Increases in TPR suggest a reduction of blood flow to peripheral sites (i.e., concentrating blood in the core), and accompany threat states as the organisms prepare for damage or social defeat. Furthermore, threat responses are associated with increased negative affective experience and decreased positive affective experience - the affective profile that can be maladaptive (Yeager et al., 2022) and that fits the worst emotional state for performance reported by athletes, namely feeling downhearted, sluggish, and highly anxious (Lane et al., 2016). Consistent with this idea, experiencing negative emotions such as anxiety and embarrassment is related to unsuccessful performance (Uphill et al., 2014; Vast et al., 2010; Woodman & Hardy, 2003).

In contrast, when people have positive performance-related appraisals (e.g., the performance situation is perceived as helpful and controllable), they tend to respond to the performance situation with the challenge affective response (Blascovich & Mendes, 2010). Challenge affective response is characterized by vasodilation (i.e., reduced TPR) and increased blood flow throughout the body, which provides efficient energy expenditure and oxygenated blood to the brain and peripheral sites (Behnke & Kaczmarek, 2018; Blascovich, 2008; Seery, 2011). A previous meta-analysis shows that stronger challenge - rather than threat - cardiovascular response is related to better performance across multiple contexts (e.g., sports, education, and cognitive tasks; Behnke & Kaczmarek, 2018). Furthermore, challenge responses are associated with increased positive affective experience and decreased negative affective experience (Yeager et al., 2022). This affective profile fits the ideal emotional state for performance reported by athletes, namely the mix of feeling happy, calm, and energetic (Lane et al., 2016). Consistent with this idea, researchers have found that upregulating positive emotions facilitates cycling performance (Beedie et al., 2012), eliciting enthusiasm and amusement promotes better esports performance (Behnke, Gross, et al., 2022), and eliciting happiness promotes better sprint performance (Rathschlag & Memmert, 2015), strength performance, and vertical jumping performance (Rathschlag & Memmert, 2013), and that experiencing positive emotions such as excitement and happiness is related to successful performance (Uphill et al., 2014; Vast et al., 2010).

One note on terminology may be useful here. Although affective responses - stress responses and emotions - are often viewed as separate phenomena, they both involve appraisals and whole-body reactions to psychologically relevant situations (Blascovich, 2008; Epel et al., 2018; Gross, 2015; Lazarus, 1993; Troy et al., 2022). We refer to affective responses and affect regulation - an umbrella term encompassing both coping and emotion regulation, among others (Troy et al., 2022) – as we believe they are the key to optimizing performance.

**Sculpting Appraisals Using Reappraisal**

If appraisals of one’s situation and one’s physiological responses to that situation determine threat vs. challenge affective responses (Blascovich, 2008; Seery, 2011; Yeager et al., 2022), and if these affective responses help to determine performance outcomes, one obvious target for intervention is changing the negative appraisals of situation and response. The affect regulation studies in the performance domain that focused on intentionally changing the appraisals – a process known as reappraisal – can be divided into two groups, one, studies focusing on reappraisals of the situations (Behnke et al., 2020; Moore et al., 2012, 2013; Seery et al., 2009; Turner et al., 2014), and second, studies focusing on reappraisals of individuals’ responses to the situations (Beltzer et al., 2014; Brooks, 2014; Griffin & Howard, 2021; Gurera & Isaacowitz, 2022; Jamieson et al., 2012; Moore et al., 2015; Oveis et al., 2020; Sammy et al., 2017).

The first group of studies mainly focused on situation reappraisals, including viewing the situation as an opportunity to gain financial benefits with no negative consequences (Behnke et al., 2020; Seery et al., 2009), as a performance in which participants are doing very well (Behnke et al., 2020), as a challenge to be met and overcome (Behnke et al., 2020; Moore et al., 2012, 2013), as similar to previous performances (Turner et al., 2014), as a situation that lacks complications (Turner et al., 2014), and as a context, in which previous participants performed well (Behnke et al., 2020; Moore et al., 2012, 2013). Findings to date suggest that situation reappraisal is useful in shaping the challenge vs. threat cardiovascular responses (Moore et al., 2012, 2013; Seery et al., 2009; Turner et al., 2014). The studies have also provided initial evidence that situation reappraisals can help optimize performance outcomes, including motor (Moore et al., 2012, 2013; Turner et al., 2014) and cognitive tasks (Chalabaev et al., 2009; Scheepers, 2009; Scheepers et al., 2012).

The second group of reappraisal studies mainly focused on individuals’ response reappraisals, including bodily sensations (e.g., arousal) and physiological responses (Crum et al., 2013, 2017; Jamieson et al., 2010, 2013, 2018). An example of an intervention focusing on people’s responses is the stress-can-be-enhancing vs. debilitating mindsets intervention (Crum et al., 2013, 2017; Jamieson et al., 2018). The stress-can-be-enhancing intervention is based on the belief that psychophysiological stress responses (e.g., fast-beating heart or sweaty hands) are normal body reactions that mobilize energetic resources to provide optimal support for future actions. In that way, the body provides more blood with oxygen and energetic substances to the brain and the muscles (Jamieson et al., 2013). Response reappraisal shifts the affective response, leading to greater challenge cardiovascular responses (Beltzer et al., 2014; Brooks, 2014; Gurera & Isaacowitz, 2022; Jamieson et al., 2013; Oveis et al., 2020; Sammy et al., 2017), more positive affect (Jentsch & Wolf, 2020), and a more positive view of one’s physiological arousal and anxiety (Ginty et al., 2022). Response reappraisal has also been found to enhance performance across a wide variety of domains like motor tasks (Balk et al., 2013; Moore et al., 2015), academic exams (Brady et al., 2018), math (Brooks, 2014; Jamieson et al., 2022; John-Henderson et al., 2015), artistic performance (Brooks, 2014), and public speaking (Beltzer et al., 2014; Brooks, 2014).

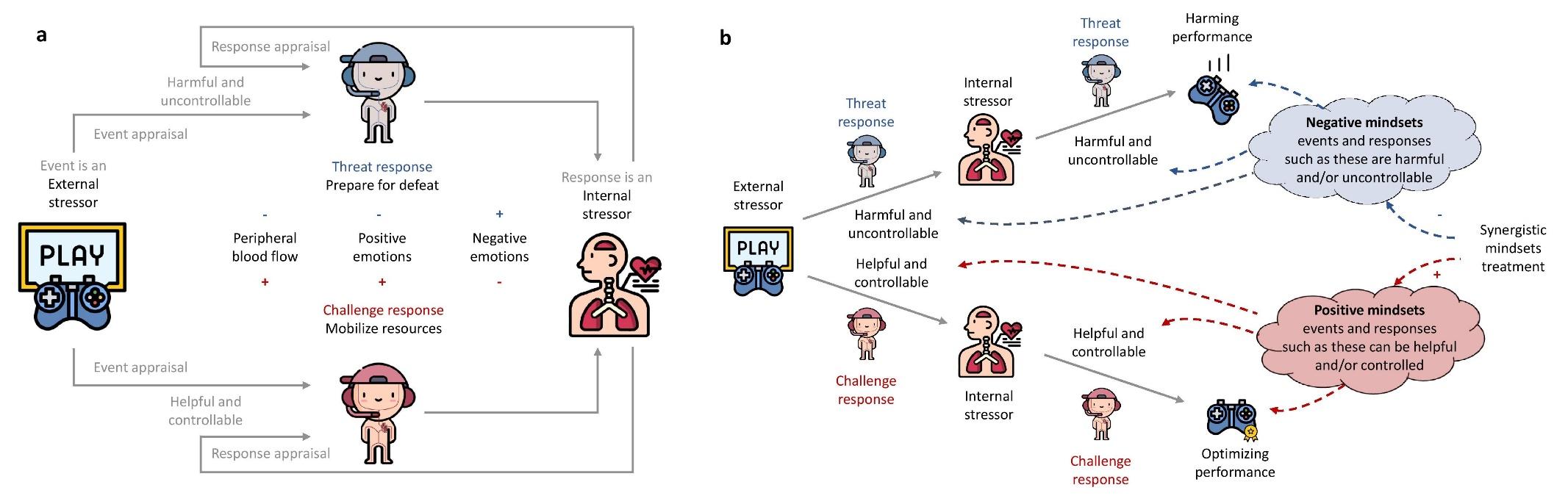
Although promising, the studies using reappraisal interventions (vs. control conditions) show that effect sizes are modest and heterogenous for both affective response (ranging from *d* = .06 to *d* = .81; Griffin & Howard, 2021; Jamieson et al., 2012) and for performance (ranging from *d* = -.12 to *d* = .93; Hangen et al., 2019; Moore et al., 2015; *d* = .10 in esports performance; Behnke et al., 2020). Furthermore, sometimes the effects are mixed, including non-significant effects of reappraisal intervention (e.g., Griffin & Howard, 2021; Hangen et al., 2019; Jamieson et al., 2012; Oveis et al., 2020), mixed results for the same instructions and golf performance in different studies (*d* = .93, Moore et al., 2015; *d* = .00, Sammy et al., 2017), or significant results for a cardiovascular response, but not for affective experience (Jamieson et al., 2012; Turner et al., 2014). These observations motivated us to use a novel double-barrelled approach called the *synergistic mindsets intervention* that targets *both* situational and bodily reappraisals to achieve the best results (Yeager et al., 2022).

**Optimizing Performance with the Synergistic Mindsets Intervention**

Mindsets are constellations of beliefs, which are temporally stable appraisals (Dweck, 2006). Recently, a new synergistic mindsets intervention has been proposed (Yeager et al., 2022). The synergistic mindsets intervention draws on the cumulative benefits of interventions related to reappraising situations (e.g., growth mindsets interventions; Dweck & Yeager, 2019; Yeager & Dweck, 2020) and responses to the situations (e.g., stress-can-be-enhancing interventions; Jamieson et al., 2013, 2018). The synergistic mindsets intervention focuses on reappraising the performance situation as an opportunity to grow, show individuals' capabilities, flourish, and strengthen the brain; and on reappraising the bodily responses usually associated with stress as natural responses that provides optimal support for future actions (Figure 1).

Another note on terminology may be useful. The synergistic mindsets intervention employed here builds on reappraisal interventions. The difference between targeted reappraisal interventions and more broadly focused mindset interventions lies in the scope of their impact, with the mindset intervention targeting general-level temporally stable beliefs and reappraisal interventions targeting situation-specific appraisals (Yeager et al., 2022). We have chosen this focus because a) we believe that if it is possible to use reappraisal to change general beliefs (e.g., sweaty hands in various high-stakes situations are a normal bodily response), this should lead people to have challenge versus threat affective responses across many different contexts (see Figure 1), b) targeted reappraisal interventions may exhibit “transfer problems” (Kassai et al., 2019), whereby they may not generalize beyond the context in which the reappraisal is applied.

In six studies (total *N* = 4,291), the synergistic mindsets interventions facilitated adolescents' stress-related cognitions to anticipated and experienced timed assignments, cardiovascular reactivity to a stressful task, daily cortisol levels, psychological well-being, academic success, and anxiety symptoms during the 2020 COVID-19 lockdowns (Yeager et al., 2022). More importantly, these studies indicated that a synergistic approach that combines both reappraisals-based approaches provides better support than the interventions focusing on the isolated reappraisals approach (Yeager et al., 2022). This premise is important for real-life applications where researchers strive to use and validate the best possible strategies while minimizing the costs of testing different available options (e.g., full factorial study designs).



*Note.* This model is an adaptation of the model presented by Yeager et al. (2022) to one high-stakes performance situation, namely esports. First, gamers appraise high-stakes performance events, which leads to differences in affective responses (panel a). The events are appraised as either harmful and uncontrollable or more helpful and controllable, leading to a threat or a challenge affective response. Challenge responses are characterized by increased peripheral blood flow (red depiction), increased positive emotions, and decreased negative emotions, whereas threat responses are characterized by decreased peripheral flow (blue depiction), decreased positive emotions, and increased negative emotions. Next, games also appraise their responses to the performance situation, and this constitutes an internal stressor. As was the case with the external events, their responses can also be appraised as harmful and uncontrollable or more helpful and controllable, leading to a self-reinforcing feedback cycle resulting in challenge or threat affective responses. By reappraising the ongoing events and their responses to these events, people can develop mindsets and shift their appraisals and affective responses (panel b). As events unfold, the challenge affective response should optimize their performance, whereas the threat affective response should harm their performance.

**Figure 1**

*Impact of (a) appraisals and (b) reappraisals associated with the Synergistic Mindsets Intervention during high-stakes performance situations. Figure adapted from Yeager et al., 2022.*

Although previous studies in the affect regulation literature (including initial studies on synergistic mindsets intervention) have many strengths, they also have some limitations that we aim to address in the present study. Previous studies usually focused on either emotional (e.g., Giuliani et al., 2008; Mauss et al., 2007; Rompilla et al., 2021) or stress responses (e.g., Behnke et al., 2020; Moore et al., 2012, 2013; Seery et al., 2009) rather than integrating them as affective responses. In both traditions (stress and emotions), interventions have focused on reappraising situations (e.g., Behnke et al., 2020; Moore et al., 2012, 2013; Seery et al., 2009; Turner et al., 2014) or the responses to the situations (e.g., Beltzer et al., 2014; Brooks, 2014; Jamieson et al., 2012; Moore et al., 2015), rather than focusing on both aspects of the performance. Studies generally have used brief and focal (i.e., single appraisal-oriented) reappraisal interventions rather than broader mindset-oriented interventions. Although these limitations were addressed by the initial studies on synergistic mindsets intervention (Yeager et al., 2022), they had different limitations that bear noting, including a lack of multi-stage performance under controlled conditions with continuous real-time monitoring of physiological responses at multiple levels concurrently with performance. Thus, in testing optimal approaches for performers, we will adapt and validate synergistic mindsets intervention in real-world performance and will examine its further potential in optimizing performers’ actions and affective responses.

**Present Study**

The present research aims to test the impact of a synergistic mindsets intervention in a high-stakes competitive interaction. In particular, we propose to focus on esports, a relatively novel social phenomenon and the fastest-growing area in sports, in which well-trained individuals – gamers – compete using video games. In esports, gamers compete in the seated position in front of the screen, which provides an excellent opportunity to examine affective responses, namely affective experience and real-time cardiovascular responses related to performance in laboratory settings (Behnke, Gross, et al., 2022; Behnke et al., 2020). Thus, using esports will allow us to examine high-stakes performance with continuous real-time monitoring of cardiovascular responses at multiple levels concurrently and will answer the initial study authors' call for new large-scale trials in diverse populations and contexts (Yeager et al., 2022).

We will organize a large-scale study built around a real-life esports competition (Behnke et al., 2020; Behnke, Gross, et al., 2022). We will conduct a three-stage experiment in which we will introduce an intervention that will be learned during a laboratory session and self-practiced in daily training. In Stage 1 of the experiment (laboratory session 1) - after a baseline performance match - half of the gamers will be randomly assigned to synergistic mindsets intervention. The other participants will be assigned to a previously tested control intervention focused on learning about the brain (Yeager et al., 2022). Next, participants will be asked to apply the knowledge provided to them during the intervention in training performance matches. In Stage 2, we will track the daily training progress for gamers' affect experience and performance for two weeks. In Stage 3, gamers will be asked to compete in a cash-prize esports tournament (laboratory session 2). We will measure gamers' functioning in the laboratory sessions with continuous, non-invasive measurements of affective responses (Stages 1 & 3). Finally, we will explore the long-term effects of the synergistic mindset intervention with the 1-month follow-up.

We aim to test the causal effect of the synergistic mindset intervention, but we also designed the study in a way that will allow us to examine the mechanism through which the causal effects operate. We will examine whether gamers in the synergistic mindsets intervention group will show greater challenge affective responses and superior performance than gamers in the control condition. Specifically, whether synergistic mindset gamers view their performance more positively and less negatively (research questions 1a & b), respond to performance with stronger challenge cardiovascular response (research question 2), and perform better (research question 3). The optimization potential of synergistic mindsets intervention will be supported if synergistic mindset gamers 1) experience more positive and less negative affective experiences before the performance (hypothesis 1a & 1b; the Design Table provides further detail about this and each subsequent hypothesis); 2) display greater challenge cardiovascular response before the performance (hypothesis 2); 3) achieve better outcomes in the tournament performances (hypothesis 3) than gamers in the control group. We also expect that affective response (i.e., affective experiences and cardiovascular challenge response) will mediate the effects of synergistic mindsets intervention on performance levels (hypotheses 4a, 4b & 5). In sum, our study will provide a unique combination of internal and external validity levels (i.e., using a controlled experiment & real-world outcome), a robust assessment of affective and physiological dynamics, and a robust theoretically motivated intervention.

# Methods

### **Participants**

### We will invite adult, Polish-speaking male players of one of the most popular esports games: Counter-Strike: Global Offensive (CS: GO), who play at least six hours per week. Based on our experience in studying esports players, this criterion should allow us to collect the targeted sample, limiting it to experienced gamers (Behnke et al., 2020; Behnke, Gross, et al., 2022). Furthermore, we will recruit adult players because CS: GO is recommended only for +18 players (PEGI, 2023). We will recruit Polish-speaking players as the study will be run in Poland. We will recruit only male players due to their predominance (76%) among first-person shooter gamers (Statista, 2023). Including non-Polish and non-male participants would entail producing and testing different group-specific research materials. Furthermore, gender and language might become confounding factors to the study, which we would not be able to test adequately due to the expected small number of eligible participants from these groups. We will recruit gamers from the general population via a Facebook advertisement targeted at CS: GO gamers and mailing lists among university students in Poznan. In recruitment, potential participants will be informed about the opportunity to participate in scientific research examining the psychological factors influencing esport performance. They will be informed that the research will involve participating in the esports tournament with the main prize of 2500 PLN (c.a. $600) and that each participant will receive a 400 PLN (c.a. $100) shopping voucher. Participants will provide informed consent.

**Sampling Plan**

***Expected Effect Sizes***

Since the initial study on synergistic mindsets intervention (Yeager et al., 2022) did not test all associations included in our statistical model, we also considered other affect regulation studies to estimate the expected effect sizes. We used Cohen's *d* and Pearson's correlation *r* as effect size measures. In two cases (Moore et al., 2015; Sammy et al., 2017), we calculated Cohen's *d* from the results reported in the original study (Lakens, 2013).

**Synergistic Mindsets & Performance.** We found two studies examining the effects of similar interventions based on stress reappraisal in the sport performance domain: golf (Moore et al., 2015) and darts (Sammy et al., 2017). Previous reappraisal interventions found medium to large effect sizes (*d* = 0.70, Moore et al., 2015; *d* = 0.66, Sammy et al., 2017) for the effects of reappraisal on performance.

Furthermore, we calculated the smallest effect size of interest to interpret the effect sizes regarding the statistical significance and practical significance (Anvari & Lakens, 2021). We decided that the smallest effect size of interest for performance outcome in our study should mimic the difference between the rivals ranked three places apart in the tournament table. Based on the data from our previous study, where we measured esports performance (Behnke et al., 2020), we calculated the effect size for the difference (e.g., the difference between 1st and 4th place, or 7th and 10th place). We found a very small effect size (*d* = 0.07, 95%CI [-.24, .38]) for rivals ranked three places apart. Thus, the smallest effect size of interest for performance outcome in our study would be *d* = 0.07.

### For the associations between performance level and synergistic mindsets intervention, both types of effect sizes seem impractical for our project's power analysis. The effect sizes in the literature are surprisingly large, as affect reappraisals usually have smaller effects on affective experience (Wang et al., 2021; Webb et al., 2012) than the observed effects on the performance, which seems a-priori unlikely, given that the effect on performance is theoretically expected to be mediated by the effect on the affective experience. Thus, we are skeptical that the expectations based on effect sizes in the literature that affect reappraisal should have stronger effects on the performance levels than on the affective experience are realistic.

### In contrast, aiming to achieve power for finding the smallest effect size of interest would require huge resources, and although designing a study to detect or reject the smallest effect size of interest would be most informative, given the substantial uncertainty in the presence of effects and their size, we believe a first important step is to examine the presence or absence of effects in a more realistic range. In the result of weighting between what can be done and what is expected, we used a more conservative effect size than the expected effect size based on published findings. We designed the study to be able to detect the effects for the association between the intervention and performance outcomes of *d* = 0.45. Thus, our approach would be able to really improve the accuracy of effect sizes in the sports performance field, which is valuable even though tiny effects in sports might matter, those are too costly to detect now.

**Synergistic Mindsets & Affective Experience.** We used one meta-analysis (Webb et al., 2012) and one recent large-scale study (Wang et al., 2021) to estimate the possible effect sizes. Meta-analysis shows that reappraisal has an average effect size of *d* = 0.45, 95% CI = [0.35, 0.56] in changing affective experience relative to passive control conditions (i.e., no instruction, instructions to experience naturally, instructions to not regulate in a specific manner, or instructions to enhance or maintain the focal emotion). A recent large-scale study found similar effects of reappraisal interventions (vs. controls) on positive affective experience *d* = 0.59 and on negative affective experience *d* = 0.39 (Wang et al., 2021).

Based on the previous study, we estimated the smallest effect size of interest of reappraisal interventions on the increase of positive affective experience of Δ*dz*= 0.47 and decrease of negative affective experience of Δ*dz* = 0.32 (Anvari & Lakens, 2021).

**Synergistic Mindsets & Cardiovascular Challenge/Threat Responses.** We found three studies examining the effect of similar interventions based on stress reappraisal that measured physiological challenge/threat cardiovascular responses in the performance domain (Moore et al., 2015; Sammy et al., 2017; Yeager et al., 2022). Previous reappraisal interventions showed medium to large effect sizes (*d* = 0.44, Moore et al., 2015; *d* = 0.90, Sammy et al., 2017; *d* = 0.44 – 0.79, Yeager et al., 2022) for the effects of reappraisal intervention of challenge/threat cardiovascular responses. We did not calculate the smallest effect size of interest for cardiovascular changes because we were unable to conceptualize the practically interesting change of cardiovascular measures.

**Affective Experience & Performance.** The published correlation coefficients for associations between performance and experienced emotions and stress are inconclusive, namely *r* =.14 for anxiety (Turner et al., 2012), *r* =.10 for excitement (Turner et al., 2012), *r* =.10 for happiness (Turner et al., 2012), *r* =-.09 for anxiety (Turner et al., 2013), *r* = -.18 for excitement (Turner et al., 2013), *r* = -.19 for happiness (Turner et al., 2013), *r* = .15 for positive affective experience (Doron & Martinent, 2021), *r* = -.14 for negative affective experience (Doron & Martinent, 2021). The effects are stronger for associations between performance satisfaction and positive affective experience (*r* = .31; Nicholls et al., 2012; and *r* = .52; Britton et al., 2019) and negative affective experience (*r* = -.24; Nicholls et al., 2012; *r* = -.36, Britton et al., 2019). But they do not account for the objective performance results. Thus, to calculate the expected effect size, we used unpublished data from our previous project that closely resembled a gaming tournament situation where we measured affective experience before and during gaming performance (Behnke et al., 2020) and found small effect sizes for the associations between affective experience and performance levels (*r* = .15; *d* = 0.30 for positive affective experience and *r* = -.15; *d* = -0.30 for negative affect).

**Cardiovascular Challenge/Threat Responses & Performance.** Based on the meta-analysis, we expect small effect sizes for the effects of cardiovascular responses on performance levels (*r* = .10 - .14; *d* = 0.20 – 0.28; Behnke & Kaczmarek, 2018).

### ***Sample Size Determination***

### We calculated the required sample sizes for our study with the Monte Carlo simulations using Mplus 8.0 (Muthén & Muthen, 2012). To determine the sample size, we considered expected effect sizes and the smallest effect size of interest (Lakens, 2022). To run the power analysis for the structural equation model, we transformed Cohen’s *d* into Pearson's correlation *r* with an effect size converter (Escal, 2022). In the simulation model, we used the following correlation coefficients: affect regulation group on performance *r* = .22 (based on conservative effect sizes in the literature), on positive affective experience *r* = .22, on negative affective experience *r* = -.22 (based on effect sizes in the literature; Wang et al., 2021; Webb et al., 2012), and on challenge/threat cardiovascular response *r* = .22 (based on effect sizes in the literature; Moore et al., 2015; Sammy et al., 2017; Yeager et al., 2022), positive affective experience on performance *r* = .15; negative affective experience on performance *r* = -.15 (based on analysis of unpublished data from; Behnke et al., 2020); challenge/threat cardiovascular response on performance *r* = .10 (based on effect sizes in the literature; Behnke & Kaczmarek, 2018). We used values of .50 for factor loadings for the positive and negative affect. We based our assumptions on the previous studies, which observed the factor loadings ranging from .53 to .79 for positive affective experience and from .47 to .65 for negative affective experience (Conte et al., 2020; Galanakis et al., 2016).

### We found that for two-level mediational models (for a repeated measures design), detecting expected small-to-medium effect sizes with a power of at least .95 and α = 0.05 would require a sample size of 2000 cases - 250 participants, each playing eight matches.

### Figure S1 and Table S1 present the power estimation for different sampling strategies.

### Type 1 and Type 2 errors are weighed equally. This stems from the balance between the costs and benefits of the synergetic mindset intervention. The computerized intervention is relatively cheap; thus, a Type 1 error is not costly. The potential benefits for gamers if synergistic mindsets intervention optimizes the performance is relatively large. Thus, rather than using the default 1:4 ratio between Type 1 and Type 2 errors (α = .05, β = .20, power .80), we used a 1:1 ratio (Maier & Lakens, 2022).

### We also calculated the power for the model fit index of RMSEA (Preacher & Coffman, 2006). We found that our model (α = .05; *df* = 37; sample size = 2000; Null RMSEA = .01; Alt. RMSEA = .05) will have a power of 1.00 to detect RMSEA of .05. We included the code for the power analysis in the supplementary materials.

### In anticipation of potential data loss, additional participants will be recruited (up to *N* = 300), expecting 10-20% of the sample to be reduced due to physiological recording problems and voluntary attrition. We expect a reduction in the sample based on our experience with similar projects (Behnke et al., 2020; Behnke, Gross, et al., 2022). Based on these power calculations, we secured funding for 300 participants. Thus, data collection will terminate after 300 participants are enrolled and provide data. The Monte Carlo simulation script is available in *Supplementary Materials*. Furthermore, the sensitivity analysis showed that our sample will allow us to detect the effect sizes of *d* = 0.42 with α = 0.05 and β = 0.95 for the difference between the two independent groups for the secondary variables (e.g., negative mindsets).

### **Exclusion**

### We will use participants’ preparation standards (e.g., refraining from physical exercise and intake of medications and caffeine for two hours before testing) and exclusion criteria (e.g., significant cardiovascular health problems or diagnosed mental disorders) used in psychophysiological studies (e.g., Shiota & Levenson, 2012). Furthermore, we will ask participants to reschedule if they experience illness or a major adverse life event.

### We will also exclude participants identified as careless responders. We will identify the participant as a careless responder if he: a) selects other answers than "Strongly agree" for the item: “Please select "Strongly agree" for this item to show that you are paying attention.”; b) answers the whole baseline questionnaire faster than 3 minutes (2 s for an item; Huang et al. 2012, and some extra time for reading the scales description); c) answers the whole baseline questionnaire with a string of identical responses greater than 40 items (half the length of the total scale; Curran, 2016); d) answers to the last item of the baseline questionnaires – “In your honest opinion, should we use your data in our analyses in this study” – “No, I responded carelessly” (Meade & Craig, 2012).

### We will exclude participants who meet diagnostic thresholds for problematic gaming. To screen participants, we will use the Gaming Disorder Test (GDT; Pontes et al., 2021; see Supplementary Materials for details), a validated psychometric test (Cudo et al., 2022; Karhulahti et al., 2021) developed to assess gaming disorder defined in the International Classification of Diseases (ICD-11; World Health Organization, 2018). The GDT will be a part of the online study registration. Any participants who meet the criteria for gaming disorder (i.e., endorsement of all four diagnostic criteria as assessed by each GDT item: marking '4: *Often'* or '5: *Very often*'; Pontes et al., 2021) will be evaluated by a clinical psychologist (retained as a consultant on the project). Participants who are judged to have a diagnosis of gaming disorder will be excluded from participation.

### Although participants will be scheduled on the same day for laboratory sessions 1 and 2, two weeks apart, we expect some participants will not be able to visit the lab on the scheduled day. We do not plan to exclude participants for whom Stage 2 will be longer than 14 days, as the amount of esports training will be self-decided by the gamers. We plan to add esports training time as the moderator in the exploratory analysis, where we will test the robustness of our findings.

# Ethics information

The Bioethical Committee of Poznan University of Medical Sciences (802/22) approved the study. Each participant will provide written informed consent. Gamers will receive a 400 PLN (approx. $100) shopping voucher for completing the study. Winners of esports tournaments will receive 2500, 1500, and 1000 PLN for taking first, second, and third places (approx. 600, 360, and 240 USD).

# Procedure

Each participant will visit the laboratory twice and be tested individually (Figure 2). During the first laboratory visit, we will collect baseline and training measures (Stage 1). Participants will be randomly assigned to receive synergistic mindsets intervention focused on using reappraisal to think more productively both about the performance situation and their responses to this situation (or will learn about the brain in the control condition). They will continue using reappraisal for two weeks and report their daily adherence and progress (Stage 2). During the second laboratory visit, participants will compete in the esports tournament (Stage 3). Finally, we will explore the long-term effects of the synergistic mindset intervention with the 1-month follow-up, where participants will answer the same questionnaires set as at the beginning of Stages 1 & 3.

***Stage 1***

During the first laboratory visit, after arriving at the lab, participants will be instructed on what they will be doing during the study. They will provide informed consent, in which they will be able to choose what data they want to make publicly available. Next, the researcher will apply psychophysiological sensors, and participants will fill in the baseline questionnaires, including measures of situational affect regulation, affective experience, negative prior mindsets, well-being and ill-being, alexithymia, and emotion beliefs (for details, see Measures and *Supplementary Materials*). The order of the baseline questionnaires will be randomized to minimize the order effects. All instructions will be presented, and responses will be collected via two PCs with 23-in. screens (one for gaming and the second for experimental software). Once the participant has finished filling in the questionnaires and the experimenter has switched on all the equipment and software, the experimenter will leave the room, and the experiment will begin.

The experiment will start with a 5-min physiological baseline (for the full descriptions of physiological measures, see Measures), during which we will ask gamers to sit quietly. After baseline measures, gamers will be asked to play the first match - baseline performance (without manipulations). The baseline performance format will resemble a future tournament. After the match, participants will be randomly assigned to two conditions: synergistic mindsets intervention or the control group. Participants will be randomly assigned to the two experimental groups using a random number generator (www.randomlists.com/) (the randomization scheme is presented in Table S2). Both groups will complete the self-administered 20-30 minutes intervention.

The interventions will be presented as part of an upcoming training program for young gamers to prepare them for the demands of competitive esports. Thus, as part of the study, we ask participants to help us test one of the modules of the psychological training program for the future generation of gamers. We will inform the players that we are testing different modules that we plan to use in the training program, but before including them, we have to test which program elements are beneficial to gamers and that, due to logistics, we will present them only one of the modules (related to stress and emotions or related to the brain). After the interventions, participants will be asked to evaluate the presented modules. Blinding will be maintained by emphasizing to participants that each module was created to help them develop new powerful psychological skills and prepare them to accomplish their goals. Although the experimenters will not have information about the intervention assignment before the study, they will gain it from the displayed study instructions during the sessions.

Next, gamers will be asked to apply the gained knowledge during esports training performance (two matches). The training performance format will also resemble a future tournament. At the end of Stage 1, gamers will be instructed on how to report daily measures. Participants in the synergistic mindsets condition will be instructed to make an additional effort in learned affect regulation strategy during gaming as often as possible in the coming two weeks. Participants in the control group will also be encouraged to apply the information they have learned to daily gaming.

**Synergistic Mindset Intervention.** In the synergistic mindsets condition, participants will learn about building the synergistic mindsets – reappraisal-based intervention for affect regulation. We adapted the synergistic mindsets intervention (Yeager et al., 2022) previously used in the educational context to the esports performance context. The intervention is based on the two active ingredients.

The first ingredient aims to change the appraisals of the performance situation. It introduces the idea that stressful and unpleasant performance situations might be, in fact, an opportunity to show one's capabilities and flourish, where one can manage how one feels. As with all challenging situations, first, gamers need to overcome many struggles, and they eventually get better with practice. Gamers will be asked to embrace challenges so they can grow skills and learn how to regulate stress and emotions. The intervention makes a case for the possibility to grow and flourish in performance based on neuroscientific information about the brain's potential to develop more efficient (i.e., "stronger") connections when people face difficult challenges and keep trying until they get better. To illustrate this better, we will use the analogy of muscles getting stronger with training (Aronson et al., 2002). The intervention aims to overcome the fixed mindset beliefs that often present intellectual ability as a fixed personal characteristic that cannot be changed (Dweck & Yeager, 2019). A fixed mindset belief leads to negative appraisals about controllability, efforts, causes of failures, and desired goals (Dweck & Yeager, 2019; Yeager & Dweck, 2020). Similarly, we believe a fixed mindset about performance situations could lead to negative consequences.

Second, the intervention targets appraisals related to bodily responses to performance. Our intervention will explain that when people engage in performance, they may experience body reactions such as a racing heart and sweaty palms – usually appraised as a harmful stress response. The intervention will lead people to perceive those body signals as information that the body is naturally preparing to provide optimal support for future actions and might be associated with positive emotions like excitement (Crum et al., 2013, 2017; Jamieson et al., 2018). In that way, the body provides more blood with oxygen and energetic substances to the brain and the muscles (Jamieson et al., 2013). Thus, the physiological response is proposed to be helpful for gamers. These appraisals align with a stress-can-be-enhancing mindset (Crum et al., 2013, 2017) in which stressors and stress responses are no longer valued as only “bad for me” but perceived as being potentially “good for me.”

In the synergistic mindset intervention, the two elements will be presented synergistically, building on each other to form a coherent whole. People will learn that by reappraising different stressors – situations and responses to those situations – they can build an affective response, which can optimize their performance (Figure 1). In the intervention, we will not only inform the participants about scientific findings about mindsets, but we will also guide participants on how to regulate affective responses using reappraisal. The reappraisal will be presented as trying to change how one thinks and adopt a new approach to the performance situation and response to the situation (McRea et al., 2012). We will encourage gamers to share their experiences about stress and emotions felt while gaming and already used regulation strategies. Participants will also hear stories from other players who share their stories of using reappraisal in gaming. Participants will be encouraged to share what they learned during the intervention as advice for someone else in a similar gaming situation, modeled after the "saying-is-believing" writing exercise (Aronson, 1999). The detailed intervention instructions are presented in *Supplementary Materials*.

**Control Intervention.** Participants in the control condition will learn basic scientific information about brain functioning. The intervention will also be a 20–30-minute self-administered activity designed to be visually like the synergistic mindset intervention group. The content will be modeled after the control condition used in prior large-scale growth mindset experiments (Yeager et al., 2019, 2022) and created with the design-thinking method (Yeager et al., 2016). The module resembles a psycho-educational talk about the foundations of how the body and mind work which is usually one of the first parts of mental training programs for athletes when the term 'physiological arousal' is introduced (Behnke et al., 2019; Röthlin et al., 2016). Next, to mirror the activity in the synergistic mindsets group, gamers will be encouraged to share their feedback and read stories from other gamers that helped us adapt the interventions. Information in the control condition will not make any claims about mindsets, affect regulation skills, or appraisals of the performance situation and responses to it.

**Gaming Performance.** Participants will play Counter-Strike: Global Offensive (CS: GO). In this multiplayer team-based first-person shooter game, two teams compete in simulated military combat. CS: GO is the leading game in the esports team-play category. It is also a popular leisure activity that engages up to 1.1 million daily active gamers worldwide (Steam & Game Stats, 2022). In CS: GO, gamers compete online against other gamers or offline against computer-controlled characters. To standardize conditions across participants, each participant will compete in a deathmatch mode on the Dust II map against computer-controlled avatars (bots) set at the maximum difficulty level (expert) without random weapons. Thus, our performance is a human-computer interaction situation (not human-human interaction). The game system will calculate each match score by multiplying the points for eliminating each enemy bot by the weapon difficulty level. Higher scores indicate better performance (Behnke et al., 2020). All gaming matches will consist of prematch baseline measurements (2 minutes), gaming (2 minutes), and recovery (2 minutes) (Figure 2). Throughout all match phases, we will collect cardiovascular data. The participants will report their affective experience and demands and resources evaluations before each match.

***Stage 2***

Between laboratory sessions, gamers will be asked to play CS: GO as frequently as they typically do. On days on which they choose to play CS: GO, we will ask participants to select one of their gaming sessions that day to play in performance mode, as they would in a tournament. Participants will be asked to play a single daily match in a mode resembling a future tournament, including a 2-minute waiting period and affective self-reports before the match – daily performance (Figure 2). After the match, participants will be asked to report match scores. At the end of the day, participants will be asked to report their daily positive and negative affective experiences and how much time they played during the day.

During the first week of Stage 2, participants in the synergistic mindset intervention will be asked before the match to use reappraisal to regulate their affective response. During the second week, they will not receive such information. We manipulate this to observe whether gamers will learn and use reappraisals in daily gaming without being asked directly. Furthermore, the synergistic mindsets group will report the adherence and progress in scheduled affect regulation training. As in a similar study (Ng & Diener, 2013), for each daily entry, participants will report the affective gaming situations in which they applied the reappraisal to ensure compliance with affect regulation instructions. The instructions will be: "List some of the gaming situations that elicited strong emotions or stress and the way you used Rethinking to make the situation beneficial to you.” This question can be treated as a reminder or booster of the synergistic mindset intervention, as gamers will be asked daily to describe the situation in which they applied the knowledge learned during the intervention. Gamers in the control group will be asked to: "List some of the gaming situations that happened to you today.”

As the frequency and optimal dose are essential for the effectiveness of interventions (Lyubomirsky & Layous, 2013), we will ask participants to train daily. Yet, participants will be informed that they can adjust how often, how long to practice and at what difficulty level to their personal preferences. This is important to minimize the risk of boomerang effects or unintended counter-reactions.

Graphical user interface, application

Description automatically generated

*Note.* The red frames represent a procedure for all performances (to simplify the figure, we depicted it in detail only for baseline performance), namely prematch physiology, affective experience, Counter Strike: Global Offensive match, and recovery. Baseline and post-intervention questionnaires include negative prior mindsets, positive and negative affective experiences, affect regulation strategies, well-being, ill-being, alexithymia, and emotion belief measures. Affective self-report includes affective experience and demands and resources evaluation. Emotion recall tasks include recalling and describing situations from the tournament that elicited positive and negative affective experiences and evaluating them using affective experience, situational appraisals and affect regulation strategies measures. One month after Stage 3 (not depicted), participants will be asked to fill in follow-up questionnaires, the same set as the baseline and post-intervention questionnaires.

**Figure 2**

*Project and Match Procedures*

***Stage 3***

During Laboratory Session 2 (participants will be scheduled on the same day as Laboratory Session 1, two weeks apart), participants will compete in the esport tournament. The session will begin like Stage 1, with a physiological hook-up, a set of questionnaires, and a 5-min physiological baseline. Next, participants will play eight tournament matches – tournament performance. After the tournament, participants will be asked to report the negative appraisals and complete an emotion recall task. Finally, participants will evaluate how they perceived the study using intervention evaluation measures. Upon completion, participants will be debriefed, screened for suspicion, and offered 400 PLN (approx. $100) vouchers. Winners will receive 2500, 1500, and 1000 PLN for taking first, second, and third places (approx. 600, 360, and 240 USD).

**Emotion Recall Task.** Participants will be asked to recall, describe, and evaluate two tournament situations, one that elicited positive emotions and one that elicited negative emotions. Participants will be asked to evaluate the situations on the dimensions of positive and negative affective experience, appraisals, and affect regulation strategies.

**Measures**

We will collect four types of measures in this project. First, we will collect measures for manipulation checks, description, and exploration of potential outcomes of the synergistic mindsets intervention, including intervention evaluation, situational affect regulation, demands and resources evaluations, negative appraisals, situational appraisals, and demographics. We treat them as secondary because we did not include them in the power analysis, and we may not have enough statistical power to infer about the effects of synergistic mindset intervention on them. Second, we will collect primary measures related to the main research questions that were used in power analysis for the sample size determination, namely affective experience, challenge/threat cardiovascular responses, and performance outcomes. Third, we will collect measures that can serve as possible moderators of the effects of synergistic mindset intervention, including negative prior mindsets, self-esteem, interoception abilities, and gaming experience. Fourth, we will collect measures outside the scope of this report (e.g., video recordings of participants and their gameplay, leg movements, well-being, and ill-being). The measures outside this report’s scope and unrelated to the research questions are presented in detail in *Supplementary Materials*. All data and materials will be made openly available on the Open Science Framework (OSF) website.

***Manipulation Check Measures***

### **Intervention Evaluation.** We will measure the intervention acceptability with the 7-item Program Feedback Scale (PFS; Schleider et al., 2020). The PFS includes items such as “ I enjoyed the program.” Furthermore, we will measure the motivation to apply the information included in the interventions and the belief in the effectiveness of the affect regulatory information included in the interventions (Wang et al., 2021). We will ask about the motivation to use information included in the interventions with the item: “I will try my hardest to apply information included in the program.” Belief in the effectiveness of information included in the interventions will be measured with the item “I believe that using the information included in the program will facilitate my gaming performance.” Participants will answer on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). We will use our Polish translation of the scale. The scale has been used in intervention-based studies (e.g., Dobias et al., 2021; Schleider et al., 2019, 2020) and showed good internal consistency (Cronbach's α = 0.88; Schleider et al., 2020).

**Situational Affect Regulation.** We will measure situational affect regulation using items from the Regulation of Emotion Systems Survey – Ecological Momentary Assessment (RESS-EMA; Medland et al., 2020). The RESS-EMA captures emotion regulation strategy use, including distraction, reappraisal, rumination, suppression, engagement, and the relaxation subscales. We will use six items of the RESS-EMA: " I took deep breaths." (Relaxation); "I expressed my feelings.", (Engagement), " I continually thought about what was bothering me." (Rumination), "I thought of other ways to interpret the situation." (Reappraisal), "I engaged in activities to distract myself." (Distraction), "I made an effort to hide my feelings." (Suppression). Participants will answer on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). We will use our Polish translation of the scale. The scale has been used in the affective research (e.g., De France & Hollenstein, 2017, 2019; Medland et al., 2020; Wylie et al., 2022) and showed good internal consistency (subscales Cronbach's α levels ranging from 0.88 through 0.94; De France & Hollenstein, 2017).

**Situational Appraisals.** We will measure gamers’ appraisals related to emotional situations using a 10-item Appraisal Scale (Uusberg et al., 2023). The Appraisal Scale captures dimensions representing five core appraisals, namely, relevance for goals and motives, congruence with goals and motives, accountability, outlook certainty, and coping potential. The Appraisal scale includes items such as “… I had a sense that this situation mattered to me” (Relevance), “… I had a sense that this situation was potentially desirable for me” (Congruence), “… I had a sense that I was responsible for this situation” (Accountability), “… I had a sense that I did not know how this situation was going to turn out” (Outlook certainty), “… I had a sense that I could change this situation for the better” (Coping potential). Participants will answer on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The data for the scale showed XXX internal consistency (Cronbach's α = 0.XXX to .XXX). We will use our Polish translation of the scale. The scale has been used only in the initial study (Uusberg et al., 2023), and showed acceptable internal consistency (intra-class correlations for each appraisal item ranged from .28 to .87 (*M* = .61, *SD* = .19) with seven items above 0.6 indicating moderately reliability; Uusberg et al., 2023).

**Negative Appraisals.** We will measure gamers’ appraisals related to the tournament using four items related to demands and resources (Yeager et al., 2022). Participants will rate their agreement or disagreement with the statements, including “Today’s tournament felt like a negative threat to me.”; “Today’s tournament felt like a positive challenge to me.”,” I felt like my body’s stress responses helped my performance in today's tournament.”, “I felt like my body’s stress responses hurt my performance in today's tournament.” Participants will answer on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The data for the scale showed XXX internal consistency (Cronbach's α = 0.XXX). The ratings will be averaged (and reversed for positive items) to provide a situational appraisal index, with higher values corresponding to more negative appraisals. We will use our Polish translation of the items. The items were used in initial synergistic mindsets study (Yeager et al., 2022).

**Demands and Resources Evaluations.** We will measure cognitive appraisals of situational demands and personal resources using an appraisal ratio approach (Moore et al., 2012, 2013, 2014; Tomaka et al., 1993; Yeager et al., 2022 ). One item will assess task demands (“How demanding do you expect the CS: GO match to be?”), and another item will assess personal resources (“How able are you to cope with the demands of the CS: GO match?”). The scale will range from 1 (*not at all)* to 7 (*extremely*). A ratio will be calculated by subtracting demands from resources (range: -5 to +5), with a more positive value reflecting a challenge state and a more negative value reflecting a threat state (Moore et al., 2013, 2014). We will use our Polish translation of the items.

Thus, instead, a demand resource evaluation score was calculated

**Demographics.**Participants will report their performance level (the highest level of competition: recreational, local, national, international), professional level (esport as full-time job, part-time job, no-income activity), duration of weekly playing (in hours for a typical week), experience and in-game ranking and measured as the highest rank achieved in the last 12 months. Before Stage 3, we will ask gamers how many hours they played during the last two weeks. Furthermore, participants will report their age, BMI, and education.

***Primary Measures***

**Affective Experience.**To measure emotions and stress, we will ask participants how they feel at the end of the prematch baseline. We will use a single-item rating scale from the modified Differential Emotions Scale on how much emotions and stress they feel right now (Fredrickson, 2013). For positive affect, we will measure four items: amusement, excitement, joy, and pride. For negative affect, we will measure four items: anger, fear, overwhelm, and stress. Before the matches, the scales range from 1 (*strongly disagree*) to 7 (*strongly agree*) (All response options will be labeled, and numbers will not be displayed to participants for clarity) (details for all scoring rules are described in the Data Preprocessing section). The data for the scales showed XXX internal consistency (Cronbach's α = 0.XXX to .XXX). We will use our Polish translation of the items. Similar measures were used in the previous studies and showed high internal reliability, ranging from Cronbach's α = 0.82 to 0.94 (e.g., Cohn et al., 2009; Fredrickson et al., 2003; 2017; Wang et al., 2021).

**Challenge/Threat Cardiovascular Response.**We will collect cardiac biosignals using Vrije Universiteit Ambulatory Monitoring System (VU-AMS, the Netherlands). VU-AMS includes impedance cardiography (ICG) and electrocardiography (ECG) that allows recording the cardiac action continuously and noninvasively. Following psychophysiological guidelines (Sherwood et al., 1990; van Lien et al., 2015), we will use pre-gelled AgCl electrodes (Kendall Abro, H98SG) placed in a standard Lead II configuration for ECG and a four-spot electrode array for ICG. The recordings will be processed using the VU-AMS Data, Analysis & Management Software (VU-DAMS 3.0). After detecting B, C, X, and R points in the ECG and ICG, we will visually check and adjust all points markers when necessary to correct erroneous placements. Then, we will calculate pre-ejection period (PEP, the period from initiating ventricular depolarization to opening of the aortic valve and ejection of blood reported in milliseconds) and cardiac output (CO, the amount of blood pumped by the heart per minute reported in liters) CO is calculated by first estimating stroke volume - the amount of blood ejected during each beat - and multiplying that by heart rate.

We will collect cardiovascular biosignals using Finometer MIDI (Finapres Medical Systems, Netherlands). Finometrer MIDI uses the volume-clamp method with finger cuﬀs to record finger arterial pressure waveforms. It allows us to estimate systolic blood pressure (SBP), diastolic blood pressure (DBP), and total peripheral resistance (TPR, a measure of the total vascular resistance reported in mmHg·min/L).

Responses along the cardiovascular challenge/threat dimension will be operationalized as PEP, HR, CO, and TPR responses. Shorter PEP reflects sympathetic activation (Seery, 2011). Shorter PEP and higher HR are characteristic of task engagement and physiological readiness for a motivated performance and are considered a prerequisite for interpreting CO and TPR as physiological indicators of psychological challenge and threat (Blascovich, 2008). This initial cardiovascular response leads to challenge- or threat-specific reactions. Challenge cardiovascular response is characterized by greater cardiac efficiency (i.e., increased CO) with lower vascular resistance (i.e., decreased TPR) than threat cardiovascular response that inhibits beneficial physiological mobilization (Seery, 2011). TPR is a primary measure of challenge/threat cardiovascular response and measures of the resistance to blood flow in the circulatory system (Blascovich, 2008; Yeager et al., 2022). The TPR is determined by the resistance of the arterial and venous vessels, as well as by any changes in the diameter of the vessels due to vasoconstriction or vasodilation. It affects the amount of blood flow and the pressure at which it flows through the body. Due to the technical limitations - participants in our study will use both hands during the game - we will collect PEP, HR, and CO but not TPR during the esports matches.

**Performance.** We will use the match score as the primary performance level indicator. The Counter-Strike: Global Offensive game system calculates each match score by multiplying the points for eliminating each enemy bot by the weapon difficulty level. A higher score indicates better performance. Daily reports will ask gamers to report the match score simulating the laboratory gaming tournament. Furthermore, we will collect secondary performance measures, including the number of kills, kills’ assists, and deaths.

***Moderators***

**Negative** P**rior** M**indsets**. We will assess gamers' fixed and stress mindsets with the 3-item Growth Mindset Scale (GMS; Dweck, 2006; Polish adaptation - Kanafa-Chmielewska & Bartosz, 2018) and 3-items from Stress Mindset Measure (SMM; Crum et al., 2013; Polish adaptation - Mierzejewska-Floreani et al., 2022). The GMS includes items such as "Your intelligence is something about you that you can't change very much,” and SMM includes items such as "The overall effect of stress on my life is negative.” Participants will answer on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The scales showed XXX internal consistency (GMS Cronbach's α = 0.XXX, and SMM Cronbach's α = 0.XXX). We will use a Polish translation of the scales. These measures have been used in affective studies (e.g., Crum et al., 2013, 2017; Klussman et al., 2021; Haimovitz & Dweck, 2016; Yeager et al., 2022) and showed good internal consistency for GMS (Cronbach's, α = 0.9; Haimovitz & Dweck, 2016, between 0.70 and 0.85; Yeager et al., 2022), and for SMM (Cronbach’s alpha = 0.80; Crum et al., 2013; Cronbach's α = 0.91; Mierzejewska-Floreani et al., 2022).

**Self-esteem.** We will measure gamers’ self-esteem with the Single-Item Self-Esteem Scale (Robins et al., 2001). Gamers will rate their agreement or disagreement with the statement “I have high self-esteem.” on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). We will use our Polish translation of the item. This measure has been used in previous affective studies (e.g., Marengo et al., 2021; Panzeri et al., 2021; Rodgers et al., 2020).

**Interoception.** We will measure gamers’ interoception abilities with the 18-item Body Awareness Questionnaire (BAQ; Shields et al., 1989). Gamers will rate their agreement or disagreement with the statements, including  “I notice distinct body reactions when I am fatigued.“, on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The data for the scale showed XXX internal consistency (Cronbach's α = 0.XXX). We will use a Polish translation of the scale (Brytek-Matera & Kozieł, 2015). This scale has been used in the affective studies (e.g., Crucianelli et al., 2022; Zamariola et al., 2018) and showed good internal consistency (Cronbach's α = 0.80, Brytek-Matera & Kozieł, 2015; Cronbach's α = 0.82, Shields et al., 1989; Zamariola et al., 2018).

**Gaming Experience.** We will use the total time spent playing the CS: GO that is counted CS: GO game system (Steam Library; Valve Corp., USA) as the gaming experience indicator. Before Stage 1, we will ask gamers to report the total hours played. Gamers reported CS: GO gaming experience from XX to XXX h (M = XXX h, SD = XXX) (Steam Library; Valve Corp., SA). Participants will also report the duration of playing against bots (in hours for a typical week).

***Response Quality Checks***

We will have a single “directed query” attention check (Abbey & Meloy, 2017). In questionnaire sets, the Emotion Beliefs scale will contain an additional item: “Please select "Strongly agree" for this item to show that you are paying attention.” We will also have a single attention and effort check (Meade & Craig, 2012). At the end of the questionnaire sets, we will ask participants: “In your honest opinion, should we use your data in our analyses in this study?”.

**Analysis Plan**

Researchers will be blind to the group allocation while running data preprocessing and analysis.

***Data Preprocessing***

**Affective Data Reduction.** As the primary measure of positive and negative affective experience, we plan to create latent factors. Since negative and positive emotions are separable (Larsen & McGraw, 2011; Kreibig & Gross, 2017), we plan to create two factors. To account for the nested structure in our data (i.e., measures nested by the participant), we will fit multilevel structural equation models with the condition as the predictor and positive affect and negative affective experiences as the outcomes. We plan to create latent factors for positive and negative affective experiences as long as the model converges. If the model fails to converge, we will explore other reasonable models, e.g., using Principal Component Analysis component scores.

**Physiological data reduction**. We will calculate the 60-s ensemble averages from the last minute of the resting baseline and pre-match baselines for physiological measures. We will use reactivity scores corrected for the resting state levels to operationalize physiological changes. Thus, we will subtract the last minute of resting baseline levels from pre-match baselines. Using difference scores is a standard strategy for studying autonomic responses to psychological factors (Behnke, Kreibig, et al., 2022; Gross & Levenson, 1995; Kreibig et al., 2013).

Following the approach from the initial study on synergistic mindset intervention (Yeager et al., 2022), we will use TPR as the primary measure of challenge/threat cardiovascular response. Furthermore, for the robustness check in the secondary analysis, we will use the challenge-threat index (CTI) and CO. CTI integrates the TPR and CO information. The CTI is based on the assumption that the TPR and CO are two related measures of the same underlying nervous system activation (Blascovich, 2008). Thus, we will convert TPR and CO values into z-scores and will sum them with an assigned weight of -1 for TPR and 1 for CO. This approach has been used in studies examining the effect of challenge and threat responses on performance outcomes (Moore et al., 2012, 2014, 2015; Seery et al., 2011; Turner et al., 2014). Greater CTI and CO change scores indicate a greater cardiovascular challenge response.

To evaluate whether the gamers were engaged in the performance, we will use PEP and HR reactivity, which measure sympathetic nervous system activation (Blascovich et al., 2008). A greater PEP decrease and HR increase will indicate greater physiological engagement in the performance.

***Missing Data***

We will use the Mplus default estimation option (i.e., the full-information maximum likelihood) to impute the missing values.

***Outliers***

We will identify outliers with the median absolute deviation (MAD), with a cutoff of 3, as recommended by Leys et al. (2013, 2019). We will then delete the data if the data is identified as an error. We do not expect any measurement errors and encoding errors in affective experience data and gaming data. Even if a data point is identified as an outlier, we will not delete it if it represents real data rather than an error. For the cardiovascular data, we will double-check the identified outliers. If we find biologically impossible values, we will delete them. We will report the number of outliers for a given variable.

***Manipulation Checks***

Although we will run a series of manipulation checks, we will use intention-to-treat analyses. Thus, the data will be analyzed for all individuals who will be randomized to condition and provide outcome data, regardless of their adherence to the affect regulation intervention. We will use Principal Component Analysis component scores for multi-item scales.

**Negative Mindsets.**To test whether the synergistic mindset intervention will decrease negative mindsets more strongly than the control condition, we will use the *t-test* with the condition as a predictor and change in fixed and stress mindsets as the outcomes. We will calculate the change in fixed and stress mindsets by subtracting the values of Stage 1 from Stage 3.

**Negative Appraisals.**To test whether the synergistic mindset intervention will facilitate situational appraisals more strongly than the control condition, we will use the *t-test* with the condition as a predictor and the situational appraisal index as the outcome.

**Intervention and Study Evaluation.**To test whether gamers evaluated the synergistic mindset intervention and the whole study differently than the control intervention, we will use the *t-test* with the condition as predictor and acceptability, beliefs, and motivation items as the outcome.

**Affect Regulation Strategy Adherence.**To test whether gamers in the synergistic mindset intervention will use a reappraisal more often than in the control condition, we will use the *t-test* with the condition as a predictor and situational affect regulation from the end of Stage 3 as the outcomes.

**Motivated Performance.** To test whether gamers will be engaged in gaming performance, we will run a two-level manipulation check model with the study phase (resting baseline vs. pre-match baseline) as the predictor and PEP and HR as the outcomes. We will assume that participants are engaged in the performance – and in turn, we will evaluate performance challenge/threat cardiovascular responses – if, in the sample as a whole, PEP will decrease and HR will increase significantly from baseline.

**Demands and Resources Evaluations**. To test whether gamers in the synergistic mindset intervention will appraise gaming performance as a challenge more than in the control condition, we will include the appraisal ratio in the two two-level manipulation check model.

***Analytic Plan for Primary Hypotheses***

In our primary analysis, we will focus on two general research questions, namely, does synergistic mindsets intervention lead to greater challenge affective response and superior performance compared to control intervention? Specifically, whether synergistic mindsets intervention leads to more positive and less negative affective experience (RQ1a & b), greater cardiovascular challenge responses (RQ2), and superior performance (RQ3) compared to control condition? We will use a two-level structural equation modeling (SEM) approach with an MLR estimator, using Mplus 8.0 (Muthén & Muthen, 2012) to test our hypotheses. We used this method of hypothesis testing in similar gaming projects (Behnke et al., 2020; Behnke, Gross, et al., 2022). This technique tests direct and indirect effects between experimental factors (dummy-coded groups with intervention type) and outcomes (Muthén & Asparouhov, 2015). We will account for the non-independence of observations by nesting each round of responses within individuals (Muthén & Muthen, 2017). The two-level SEM model is presented in Figure 3.

Performance

Level

Synergistic Mindsets Intervention

+

+

+

Cardiovascular Challenge

-

-

+

+

Figure 3. Statistical Model for Role of Affect Regulation in Esports Performance.

We expect that the synergistic mindsets intervention (vs. control) will lead to a greater challenge affective response, namely synergistic mindsets intervention (vs. control) will lead to an increase in positive affective experience (hypothesis 1a), to a decrease in negative affective experience (hypothesis 1b), and to an increase in challenge cardiovascular response (hypothesis 2) before the tournament performance in Stage 3. We also expect synergistic mindsets intervention (vs. control) will lead to better performance levels during the tournament performance in Stage 3 (hypothesis 3).

We will test hypotheses 1a, 1b, 2, and 3 by comparing the intervention types – the synergistic mindsets group vs. the control group (Table 1). In the models, the intervention type will be introduced as a predictor (dummy-coded). The support for the hypotheses will be provided if the models fit the data well, i.e., RMSEA < .06; SRMR < .08; CFI > .95, the *p*-value for theχ2 > .05 (Bentler, 1990); and the 95% confidence intervals of effect sizes for the regression coefficients for hypothesized paths will not include zero. We will evaluate multiple fit indices as evaluating any single index might be problematic (e.g., a significant χ2 test does not have to imply the model misfit, as the significance of the test can be affected by many factors, including clustered data, non-normal data big samples; Bergh, 2015; Geiser, 2012; Kenny, 2023). We will not interpret effect sizes if χ2 test for model fit and all fit indices suggest model misfit. If the χ2 test detects beyond-chance discrepancies between the model and the data (significant *p*-value), we will examine the possible local sources of a causal misfit by examining the matrix of residuals for correlations and modification indices. If the modification indices suggest some small model modifications that also have a theoretical foundation, we will include them in the model. Then, if χ2 test still suggests model misfit but (a) there are no large modification indices and/or residuals, (b) all other fit indices suggest model fit, and (c) there are no Haywood cases (e.g., negative variances, standardized coefficients above 1.00), we will conclude that the theoretical model is likely to be close to the observed reality and we will interpret the effect sizes. Further, suppose the confidence intervals for regression coefficients for hypotheses 1a, 1b, and 3 will include zero. In that case, we will use the equivalence test to determine whether synergistic mindsets intervention and control intervention had the same effects on gamers. Suppose the observed effect lies inside the boundaries of the smallest effect of interest, and the confidence interval around the observed effect does not overlap with the smallest effect of interest. In that case, we will conclude that the synergistic mindsets and control interventions have the same practical effects on gamers.

Similarly, for hypotheses 1a, 1b, and 3, we will consider the practical value of the synergistic mindsets intervention with a minimum effect test. Suppose the confidence interval around the observed effect does not overlap with the smallest effect of interest. In that case, we will conclude that synergistic mindsets are a practically beneficial (harmful) approach for gamers. As with the SESOI, we aimed to identify changes that are likely to be observed by people and to make an impact in real circumstances; we do not plan to use the same approach for hypothesis 2 because we did not find a way to operationalize the smallest effect of interest for the practical value of cardiovascular responses.

We also expect that the effects of synergistic mindsets intervention (vs. control) on better performance levels will be mediated by challenge affective response. The mediational effects of challenge affective response will be tested in three ways (positive and negative affective experience and cardiovascular response). Therefore, we expect that the effects of synergistic mindsets intervention (vs. control) on better performance levels will be mediated by more positive affective experience (hypothesis 4a), by less negative affective experience (hypothesis 4b), and greater challenge cardiovascular response (hypothesis 5) before tournament performance in Stage 3. We will test mediational effects because including mediators often increases power relative to testing total effects only (Kenny & Judd, 2014; O'Rourke & MacKinnon, 2015). Thus, testing mediations decreases the odds of type II error when less pronounced effects are studied.

***Exploratory Analyses***

We will explore whether other factors can moderate the effect of the intervention by adding to the primary model the moderation of the negative prior mindsets, self-esteem, interoception ability, and gaming experience. We decided not to test moderation within the primary model, as we did not find strong enough evidence on whether these factors moderate the effects of synergistic mindset intervention on cardiovascular and performance outcomes (Yeager et al., 2022). Furthermore, we will test the effects of synergistic mindset intervention when controlling for the differences in intervention evaluations.

We will also explore the robustness of our findings by testing alternative operationalizations of the variables used in the model. For positive/negative affect, we will use the overall negative and positive affective experiences scores by a) using Principal Component Analysis component scores for positive and negative experiences b) averaging raw scores of the four negative or positive affective experiences (as originally intended by the scale, Fredrickson, 2013; and used in a recent large-scale study, Wang et al., 2021). For cardiovascular challenge response, we will use CTI or CO from the pre-match baseline or CO from the match instead of TPR. We will also use the cardiovascular reactivity scores corrected for the resting state levels from Stage 1 instead of the resting state levels from Stage 3. For performance level, we will use a number of kills or deaths instead of match scores. This analysis aims to describe the range of effect estimates based on all reasonable data analytical decisions. Finally, in the exploratory analysis, we will test other reasonable SEM models (e.g., one mediational model for affect and a second for the cardiovascular challenge).

Furthermore, our study will provide data that might serve future studies for hypothesis formulation. For instance, our data will present how appraisals change during positive and negative situations after the synergistic mindsets intervention and control intervention. The data might also be used to explore methodological (e.g., is there a difference in conclusions when using cardiovascular signals from pre-match baseline compared to match period), theoretical (e.g., does affect regulation facilitate the cardiovascular recovery from performance), and practical (e.g., whether the effects of the intervention are stronger after two weeks than immediately after learning the information) aspects related to performance. We will provide raw data, means, and standard deviations in the *Supplementary Materials*.

# Data availability

All data and materials will be made openly available on the Open Science Framework (OSF) website https://doi.org/10.17605/OSF.IO/WSG28.

# Code availability

All analysis code (completed in MPlus) will be made openly available on the Open Science Framework (OSF) website https://osf.io/c72un.

**Supplementary Materials**

All supplementary materials are available on the Open Science Framework (OSF) website https://osf.io/c72un.

# Results

Do **not** include a **Results** section.

# Discussion

Do **not** include a **Discussion** section.

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# Author contributions

M.B., D.L., K.P., P.C, L.D.K, J.P.J & J.J.G designed research. M.B., L.D.K, & J.J.G secured funding. M.B., D.L., K.P., J.P.J & J.J.G wrote the initial manuscript and revision. M.B. and P.C. will coordinate the experimental research and manage the data processing, analysis, and OSF repository of the project. M.B. & D.L. contributed to the analysis plan.

# Competing interests

The authors declare no competing interests.

# Table 1. Design Table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Question | Hypothesis | Sampling plan (e.g., power analysis) | Analysis Plan | Rationale for deciding the sensitivity of the test for confirming or disconfirming the hypothesis | Interpretation given to different outcomes | Theory that could be shown wrong by the outcomes |
| Will synergistic mindsets intervention (vs. control) lead to an increase in positive affective experience before the tournament performance in Stage 3? | Synergistic mindsets intervention (vs. control) will lead to an increase in positive affective experience before the tournament performance in Stage 3 (hypothesis 1a). | Prior works suggest an effect size of *d* = 0.45 for the difference between reappraisal interventions and the control conditions for hypothesis 1a. Our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the significant regression coefficient of β = .22 between the dummy coded intervention group and positive affective experience. | We will include the positive affective experience in the two-level SEM model as the outcome (latent factors). In the model, the intervention type will be introduced as a predictor (dummy-coded). We will account for the non-independence of observations by nesting each round of responses within individuals. | We determined the relevant effect size for statistical power analysis based on effect sizes found in studies that tested similar research questions (see, *Sampling Plan* section, for details). | If the positive affective experience is significantly higher (lower) in the synergistic mindsets conditions than in the control conditions, we will conclude finding evidence for (against) hypothesis 1a.  If hypothesis 1a will be rejected, we will then use the equivalence test to determine whether synergistic mindsets and control intervention had the same effects on gamers.  If the observed effect will lie inside the boundaries of the smallest effect of interest (-.22, .22) and the confidence interval around the observed effect does not overlap with the smallest effect of interest, we will conclude that the synergistic mindsets and control intervention has the same effects on gamers.  If hypothesis 1a will not be rejected, we will then consider the practical value of the synergistic mindsets interventions with minimum effect test. If the confidence interval around the observed effect does not overlap with the smallest effect of interest (*r* = .22), we will conclude that the synergistic mindsets approach is a beneficial (harmful) approach for gamers. | Mainly: the synergistic mindset model (Yeager et al., 2022);  Partially: the biopsychosocial model of challenge and threat (Blascovich, 2008), the growth mindset model (Dweck & Yeager, 2019; Yeager & Dweck, 2020), the arousal reappraisal model (Jamieson et al., 2018), the stress-can-be-enhancing mindset model (Crum et al., 2013, 2017);  In case of mixed findings (not significant and not equivalent), we do not draw full theoretical implications for alternative or null hypotheses. |
| Will synergistic mindsets intervention (vs. control) lead to a decrease in negative affective experience before the tournament performance in Stage 3? | Synergistic mindsets intervention (vs. control) will lead to a decrease in negative affective experience before the tournament performance in Stage 3 (hypothesis 1b). | Prior works suggest an effect size of *d* = 0.45 for the difference between reappraisal interventions and the control conditions for hypothesis 1b. Our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the significant regression coefficient of β = .22 between the dummy coded intervention group and negative affective experience. | We will include the negative affective experience in the two-level SEM model as the outcome (latent factors). In the model, the intervention type will be introduced as a predictor (dummy-coded). We will account for the non-independence of observations by nesting each round of responses within individuals. | We determined the relevant effect size for statistical power analysis based on effect sizes found in studies that tested similar research questions (see, *Sampling Plan* section, for details). | If the negative affective experience is significantly lower (higher) in the synergistic mindsets conditions than in the control conditions, we will conclude finding evidence for (against) hypothesis 1b.  If hypothesis 1b will be rejected, we will then use the equivalence test to determine whether synergistic mindsets and control intervention had the same effects on gamers.  If the observed effect will lie inside the boundaries of the smallest effect of interest (-.16, .16) and the confidence interval around the observed effect does not overlap with the smallest effect of interest, we will conclude that the synergistic mindsets and control intervention have the same effects on gamers.  If hypothesis 1b will not be rejected, we will then consider the practical value of the synergistic mindsets interventions with a minimum effect test. If the confidence interval around the observed effect does not overlap with the smallest effect of interest (*r* = .16), we will conclude that the synergistic mindsets approach is a beneficial (harmful) approach for gamers. | Mainly: the synergistic mindset model (Yeager et al., 2022);  Partially: the biopsychosocial model of challenge and threat (Blascovich, 2008), the growth mindset model (Dweck & Yeager, 2019; Yeager & Dweck, 2020), the arousal reappraisal model (Jamieson et al., 2018), the stress-can-be-enhancing mindset model (Crum et al., 2013, 2017);  In case of mixed findings (not significant and not equivalent), we do not draw full theoretical implications for alternative or null hypotheses. |
| Will synergistic mindsets intervention (vs. control) lead to an increase in challenge cardiovascular before the tournament performance in Stage 3? | Synergistic mindsets intervention (vs. control) will lead to an increase in challenge cardiovascular before the tournament performance in Stage 3 (hypothesis 2). | Prior works suggest an effect size of *d* = 0.44 for the difference between reappraisal interventions and the control conditions for hypothesis 2. Our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the significant regression coefficient of β = .22 between the dummy coded intervention group and challenge cardiovascular response. | We will include challenge cardiovascular response in the two-level SEM model as the outcome. In the model, the intervention type will be introduced as a predictor (dummy-coded). We will account for the non-independence of observations by nesting each round of responses within individuals. | We determined the relevant effect size for statistical power analysis based on effect sizes found in studies that tested similar research questions (see *Sampling Plan* section for details). | If the challenge cardiovascular response is significantly higher (lower) in the synergistic mindsets conditions than in the control conditions, we will conclude finding evidence for (against) hypothesis 2. This will lead us to the interpretation that using synergistic mindsets in performance may be a beneficial (harmful) strategy for gamers' health. | Mainly: the synergistic mindset model (Yeager et al., 2022);  Partially: the biopsychosocial model of challenge and threat (Blascovich, 2008), the growth mindset model (Dweck & Yeager, 2019; Yeager & Dweck, 2020), the arousal reappraisal model (Jamieson et al., 2018), the stress-can-be-enhancing mindset model (Crum et al., 2013, 2017);  In case of mixed findings (not significant and not equivalent), we do not draw full theoretical implications for alternative or null hypotheses. |
| Will  synergistic mindsets intervention (vs. control) lead to better performance levels during the tournament in Stage 3? | Synergistic mindsets intervention (vs. control) will lead to better performance levels during the tournament in Stage 3 (hypothesis 3). | Prior works suggest an effect size of *d* = 0.66 for the difference between reappraisal interventions and the control conditions for hypothesis 3. Our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the significant regression coefficient of β = .22 between the dummy coded intervention group and performance level. | We will include the performance measures in the two-level SEM model as the outcome. In the model, the intervention type will be introduced as a predictor (dummy-coded). We will account for the non-independence of observations by nesting each round of responses within individuals. | We determined the relevant effect size for statistical power analysis based on effect sizes found in studies that tested similar research questions (see, *Sampling Plan* section, for details). | If the performance level is significantly higher (lower) in the synergistic mindsets than in the control conditions, we will conclude finding evidence for (against) hypothesis 3.  If hypothesis 3 is rejected, we will then use the equivalence test to determine whether synergistic mindsets and control intervention had the same effects on gamers.  If the observed effect will lie inside the boundaries of the smallest effect of interest (-.03, .03) and the confidence interval around the observed effect does not overlap with the smallest effect of interest, we will conclude that the synergistic mindsets and control intervention have the same effects on gamers.  If hypothesis 3 will not be rejected, we will then consider the practical value of the synergistic mindsets intervention with a minimum effect test. If the confidence interval around the observed effect does not overlap with the smallest effect of interest, we will conclude that the synergistic mindsets approach is a beneficial (harmful) approach for gamers. | Mainly: the synergistic mindset model (Yeager et al., 2022);  Partially: the biopsychosocial model of challenge and threat (Blascovich, 2008), the growth mindset model (Dweck & Yeager, 2019; Yeager & Dweck, 2020), the arousal reappraisal model (Jamieson et al., 2018), the stress-can-be-enhancing mindset model (Crum et al., 2013, 2017);  In case of mixed findings (not significant and not equivalent), we do not draw full theoretical implications for alternative or null hypotheses. |
| Mediational Hypothesis | | | | | | |
| Will the effects of synergistic mindsets intervention (vs. control) on better performance levels be mediated by more positive affective experience before tournament performance in Stage 3 | Effects of synergistic mindsets intervention (vs. control) on better performance levels will be mediated by more positive affective experience before tournament performance in Stage 3 (hypothesis 4a). | Prior works suggest an effect size of *r* = 0.15 for the relation between positive affective experience and performance levels.  Our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the significant regression coefficient of β = .15 between positive affective experience and performance levels.  Furthermore, our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the total effect of reappraisal intervention (vs. control) of β = .31 on performance levels, as well as the indirect effect of reappraisal intervention (vs. control) of β = .03 on performance levels via more positive affective experience. | In the two-level SEM model, we will include intervention type as a predictor (dummy-coded), the positive affective experience as the mediator (latent factor), and performance level as the outcome. We will account for the non-independence of observations by nesting each round of responses within individuals. We will test mediational effects because the inclusion of mediators often increases power relative to testing total effects only (Kenny & Judd, 2014; O'Rourke & MacKinnon, 2015). Thus, testing mediations decreases the odds of type II error when less pronounced effects are studied. | We determined the relevant effect size for statistical power analysis based on effect sizes found in studies that tested similar research questions (see *Sampling Plan* section for details). | If the performance level is significantly higher (lower) in the synergistic mindsets conditions than in the control conditions due to increased positive affective experience, we will conclude finding evidence for (against) hypothesis 4a. This will lead us to the interpretation that using synergistic mindsets in performance may be a beneficial (harmful) strategy for gamers' effectiveness, thanks to increased positive affective experience. | Mainly: the synergistic mindset model (Yeager et al., 2022);  Partially: the biopsychosocial model of challenge and threat (Blascovich, 2008), the growth mindset model (Dweck & Yeager, 2019; Yeager & Dweck, 2020), the arousal reappraisal model (Jamieson et al., 2018), the stress-can-be-enhancing mindset model (Crum et al., 2013, 2017);  In case of mixed findings (not significant and not equivalent), we do not draw full theoretical implications for alternative or null hypotheses. |
| Will the effects of synergistic mindsets intervention (vs. control) on better performance levels be mediated by less negative affective experience before tournament performance in Stage 3? | Effects of synergistic mindsets intervention (vs. control) on better performance levels will be mediated by less negative affective experience before tournament performance in Stage 3 (hypothesis 4b). | Prior works suggest an effect size of *r* = -0.15 for the relation between negative affective experience and performance levels.  Our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the significant regression coefficient of β = -.15 between negative affective experience and performance levels.  Furthermore, our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the total effect of reappraisal intervention (vs. control) of β = .31 on performance levels, as well as the indirect effect of reappraisal intervention (vs. control) of β = .04 on performance levels via less negative affective experience. | In the two-level SEM model, we will include the intervention type as a predictor (dummy-coded), the negative affective experience as the mediator (latent factor), and performance level as the outcome. We will account for the non-independence of observations by nesting each round of responses within individuals. We will test mediational effects because the inclusion of mediators often increases power relative to testing total effects only (Kenny & Judd, 2014; O'Rourke & MacKinnon, 2015). Thus, testing mediations decreases the odds of type II error when less pronounced effects are studied. | We determined the relevant effect size for statistical power analysis based on effect sizes found in studies that tested similar research questions (see *Sampling Plan* section for details). | If the performance level is significantly higher (lower) in the synergistic mindsets conditions than in the control conditions due to decreased negative affective experience, we will conclude finding evidence for (against) hypothesis 4b. This will lead us to the interpretation that using synergistic mindsets in performance may be a beneficial (harmful) strategy for gamers' effectiveness, thanks to decreased negative affective experience. | Mainly: the synergistic mindset model (Yeager et al., 2022);  Partially: the biopsychosocial model of challenge and threat (Blascovich, 2008), the growth mindset model (Dweck & Yeager, 2019; Yeager & Dweck, 2020), the arousal reappraisal model (Jamieson et al., 2018), the stress-can-be-enhancing mindset model (Crum et al., 2013, 2017);  In case of mixed findings (not significant and not equivalent), we do not draw full theoretical implications for alternative or null hypotheses. |
| Will the synergistic mindsets intervention (vs. control) on better performance levels be mediated by greater challenge cardiovascular response before tournament performance in Stage 3? | Effects of synergistic mindsets intervention (vs. control) on better performance levels will be mediated by greater challenge cardiovascular response before tournament performance in Stage 3 (hypothesis 5). | Prior works suggest an effect size of *r* = -0.10 for the relation between challenge cardiovascular response and performance levels.  Our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the significant regression coefficient of β = -.10 between challenge cardiovascular response and the performance levels.  Furthermore, our power simulation suggests that 250 participants (each playing eight matches) would provide over 95% power to detect the total effect of reappraisal intervention (vs. control) of β = .31 on performance levels, 88% power to detect the indirect effect of reappraisal intervention (vs. control) of β = .02 on performance levels via greater challenge cardiovascular response. | In the two-level SEM model, we will include the intervention type as a predictor (dummy-coded), the challenge cardiovascular response as the mediator, and the performance level as the outcome. We will account for the non-independence of observations by nesting each round of responses within individuals. We will test mediational effects because the inclusion of mediators often increases power relative to testing total effects only (Kenny & Judd, 2014; O'Rourke & MacKinnon, 2015). Thus, testing mediations decreases the odds of type II error when less pronounced effects are studied. | We determined the relevant effect size for statistical power analysis based on effect sizes found in studies that tested similar research questions (see *Sampling Plan* section for details). | If the performance level is significantly higher (lower) in the synergistic mindsets conditions than in the control conditions due to greater challenge cardiovascular response, we will conclude finding evidence for (against) hypothesis 5. This will lead us to the interpretation that using synergistic mindsets in performance may be a beneficial (harmful) strategy for gamers' effectiveness, thanks to challenge cardiovascular responses. | Mainly: the synergistic mindset model (Yeager et al., 2022);  Partially: the biopsychosocial model of challenge and threat (Blascovich, 2008), the growth mindset model (Dweck & Yeager, 2019; Yeager & Dweck, 2020), the arousal reappraisal model (Jamieson et al., 2018), the stress-can-be-enhancing mindset model (Crum et al., 2013, 2017);  In case of mixed findings (not significant and not equivalent), we do not draw full theoretical implications for alternative or null hypotheses. |