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The protective impact of a mental skills training session and motivational priming on participants' psychophysiological responses to performance stress

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ABSTRACT

The purpose of this investigation was to examine whether a motivational priming session (i.e., educational lecture) and/or cognitive restructuring-based mental skills training session can elicit a protective physiological response to performance stress (i.e., an ego-involving climate). The stress hormones dehydroepiandrosterone (DHEA) and cortisol were assessed. DHEA is a neurosteroid that counters many of the negative effects of cortisol (Morgan et al., 2004). As a secondary purpose, threat and challenge appraisals (Mendes, Gray, Mendoza-Denton, Major, & Epel, 2007), stress mindset (Crum, Salovey, & Achor, 2013a), and affect (Watson, Clark, & Tellegen, 1988) were examined. Male college students ($N = 59$, $M_{age} = 20.25$) were screened for potential confounds and randomly assigned to a control group ($n = 16$), a mental skills training group ($n = 27$), or an achievement goal perspective theory-based (AGPT; Nicholls, 1984, 1989) educational lecture group ($n = 16$). The experimental manipulation (i.e., lecture/session) took place during the 15 min prior to exposure to the performance stressor. The mental skills training session that aimed to foster a stress-is-enhancing mindset and a more task-oriented approach toward achievement yielded more adaptive responses to stress including a significant spike in DHEA-sulfate (i.e., DHEA-S), a challenge appraisal of the performance stressor, and a stress-is-enhancing mindset, compared to the control and AGPT groups. The AGPT lecture prevented a rise in salivary cortisol (i.e., a potentially threatening stress hormone) in response to the performance stressor. These findings suggest individuals can better protect themselves against psychosocial threats in performance settings, for which they have little control over, through education and training.

Performance stress in sport is unavoidable and can compromise participants' health and their ability to perform up to their potential. Despite the import of this issue, researchers are just beginning to understand how individuals can protect themselves against the physiological repercussions of threatening psychological stressors for which they have little control over (Crum, Akinola, Martin, & Fath, 2017a). Moreover, researchers are exploring how to elicit a more adaptive response to potentially threatening stressors in order to better facilitate performance and enhance psychological well-being (Jamieson, Crum, Goyer, Marotta, & Akinola, 2018). Stress researchers have identified stress mindset (i.e., the extent to which an individual holds the mindset that stress has enhancing consequences or debilitating consequences) as a moderator of the physiological response to psychosocial stress in performance settings. Similarly, the balance of state cognitive demand and resource appraisals have been shown to be central to the stress response (Crum et al., 2017a; Crum et al., 2013a). More advantageous responses to stress include a mindset or belief that the consequences of stress experiences can be adaptive – that is, such experiences can make you smarter, stronger, more capable than you were before the experience (i.e., a stress-is-enhancing mindset; Crum et al., 2013a). Also adaptive are challenge appraisals of stress, where the demands of a particular situation are perceived to be outweighed by the appraisal of resources available to meet those demands (Skinner & Brewer, 2002). Nicholls (1984, 1989) and other achievement goal perspective theory (AGPT) researchers (e.g., Newton et al., 2007) have also suggested that the psychosocial environment fostered by leaders plays a key role in determining how participants experience and respond to performance stress in achievement settings.

1. Achievement goal perspective theory

Nicholls (1984, 1989) argued that when leaders praise participants for trying hard, recognize improvement and the role each individual plays, encourage cooperation, and use mistakes as an opportunity to

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further understanding, participants have a more positive experience and respond more favorably during goal directed endeavors (e.g., feel competent and have fun). This type of environment is referred to as a task-involving or mastery motivational climate (Walling, Duda, & Chi, 1993). Caring climates, defined by Newton et al. (2007) as settings where leaders make an effort to get know all participants, treat them fairly with kindness and respect, and foster a sense of belongingness among group members, have been shown to compliment task-involving climates (Fry & Hogue, 2018; Poux & Fry, 2015; Stark & Newton, 2014). A body of research has shown that a caring, task-involving climate helps to minimize maladaptive stressors (e.g., uncontrollability and social evaluation) and enhance the experience and positive responses of participants in physical activity-based performance settings (Fry & Hogue, 2018; Fry & Moore, 2019).

In contrast, when leaders create an environment where winning is the focus, star performers are favored, participants are pit against one another, and mistakes are punished (i.e., an ego-involving climate), this often elicits more problematic stress responses. For instance, ego-involving climates have been shown to compromise performance and adversely impact participant well-being (Hogue, Fry, & Iwasaki, 2018; Reinboth & Duda, 2016). There is a body of literature indicating that a caring, task-involving climate evokes more advantageous responses in physical activity settings. Despite the overwhelming evidence that an ego-involving climate evokes suboptimal, often deleterious reactions in participants, ego-involving climates are still present in sport and exercise settings (e.g., Al-Yaaribi & Kavussanu, 2018; Brown, Fry, & Moore, 2017; Brown, Fry, Wilkinson, Breske, & Iwasaki, 2019). Given the potential implications of creating an ego-involving climate (e.g., a diminished interest in physical activity and elevated stress, shame, and anxiety), greater exploration of how to best protect athletes and exercisers is warranted. As such, it is worth investigating whether mental skills training and educational workshops can help protect performers exposed to an ego-involving climate.

In developing AGPT, Nicholls also recognized that how individuals define success (i.e., their goal orientations) plays a role in how they will respond to performance stress. These *goal orientations* can be distinguished based on how success in an achievement setting is defined for a particular individual. A high task orientation is defined as one where an individual feels successful when learning new skills, improving, and trying hard. In contrast, a high ego orientation is one where an individual feels most successful when outperforming others and winning (Duda, 1989; Duda & Nicholls, 1992). Goal orientations are orthogonal, and individuals can be high in both, low in both, or high in one and low in the other goal orientation (Roberts, Treasure, & Kavussanu, 1996). A body of research has revealed that a high task orientation helps individuals optimize their performance, as well as their experience, during physical activities (Biddle, Wang, Kavussanu, & Spray, 2003; Fry & Moore, 2019). Moreover, a high task-orientation may be psychologically protective for performers placed in an unfavorable achievement context. Experiencing a sense of achievement after having tried one's very best may help buffer the performance stress that can occur as a result of not having control over winning or outperforming others. A task-oriented approach toward achievement focuses individuals on controllable aspects of their performance (e.g., personal effort and skill development). This is likely to yield greater appraisal of resources available to meet the demands of a given achievement setting (i.e., yielding a challenge appraisal of stress). As such, it may be that promoting a more task-oriented approach toward achievement helps protect against maladaptive forms of performance stress (Quested et al., 2011).

2. Mental skills training

It is worth considering whether cognitive restructuring exercises impact beliefs about success and subsequently alter psychophysiological stress responses in physical activity-based performance settings. For instance, directing goal orientation away from an ego orientation toward a more task-oriented definition of success, as well as a more positive view of stress, may yield adaptive responses. According to the challenge and threat model (Blascovich et al., 1999), a challenge appraisal of stress is more advantageous than a threat appraisal. A challenge appraisal reflects a belief that resources in a particular performance setting outweigh demands. In contrast, a threat appraisal reflects the belief that one does not have the resources to meet expected demands. Having a challenge appraisal of stress, as opposed to a threat appraisal, has yielded greater positive affect and lower negative affect in athletes (Hase, O'Brien, Moore, & Freeman, 2018; Skinner & Brewer, 2004). Moreover, a stress-is-enhancing mindset has been shown to positively impact neuroendocrine responses to socially-evaluative, achievement-based settings (Crum et al., 2017a).

There is growing evidence that, when under psychological stress, a stress-enhancing mindset elicits an advantageous response, including a rise in dehydroepiandrosterone (DHEA). DHEA is a neurosteroid that promotes nervous tissue growth (Pediaditakis, et al., 2015) and counterregulates cortisol, helping buffer its negative effects (Morgan et al., 2004; Wolkowitz, Epel, & Reus, 2001). Cortisol has been causally linked to a range of outcomes that adversely impact mental and physical health, many of which are particularly damaging to athletic performance and recovery (e.g., impacts sleep, breaks down muscle; McEwen & Stellar, 1993). The testosterone-to-cortisol ratio, for instance, is also a marker of physiological stress known to predict performance, with lower ratios (e.g., an increase in cortisol and/or decrease in testosterone) linked to diminished athletic performance (HÄkkinen, Pakarinen, Alén, & Komi, 1985; Kraemer et al., 2004). Likewise an elevated cortisol-to-DHEA ratio has been linked to impaired immunity and impaired glycemic control (Lee et al., 2006; Wisniewski, Hilton, Morse, & Svec, 1993). In contrast, DHEA is believed to facilitate health and well-being (Mendes et al., 2007). For instance, DHEA acts as a neurosteroid by influencing neurotransmitter receptors in the brain and has been linked to better mood and cognitive performance, as well as lower anxiety (Arlt, Callies, & Allolio, 2000).

A meta-analysis of over 200 studies examining acute psychological stress identified both the belief that one does not have control over his/her success (i.e., uncontrollability) and social evaluation as the most reliable and robust psychological triggers of the cortisol response (Dickerson & Kemeny, 2004). Furthermore, according to social self preservation theory (Dickerson, Gruenewald, & Kemeny, 2004) when ability and social status are questioned in group-based performance settings, ensuing shame related experiences have been shown to elicit a coordinated psychophysiological stress response that compromises mental and physical health. Of relevant note, a series of experimental investigations conducted by Hogue and colleagues (Hogue, Fry, & Fry, 2019, 2017; Hogue, Fry, Fry, & Pressman, 2013) have shown that an ego-involving climate reliably elicits a similar coordinated response to psychosocial stress. This response has included feelings of uncontrollability and shame, notably low self-ratings of social status, and a rise in salivary cortisol. In contrast, perceptions of a caring, task-involving climate in this series of experiments consistently yielded adaptive responses, including minimal levels of psychosocial stress and shame, as well as a protective physiological response (e.g., a decrease in cortisol). Psychological responses to a caring, task-involving climate also included significantly higher ratings of social status, performance and social self-esteem, effort, enjoyment, and positive affect, relative to an ego-involving climate group.

Promoting a stress-is-enhancing mindset may help protect performers from the negative effects of ego-involving climates. Stress-mindsets can be influenced through brief interventions to the extent that a physiologically and psychologically protective response to stress is initiated. For example, Crum and colleagues were successful in orienting participants toward a more stress-enhancing mindset that moderated their physiological response to stress using brief, 3-min videos (Crum, Salovey, & Achor, 2013b; Crum, Akinola, Martin, & Fath, 2017b). Therefore a 15-

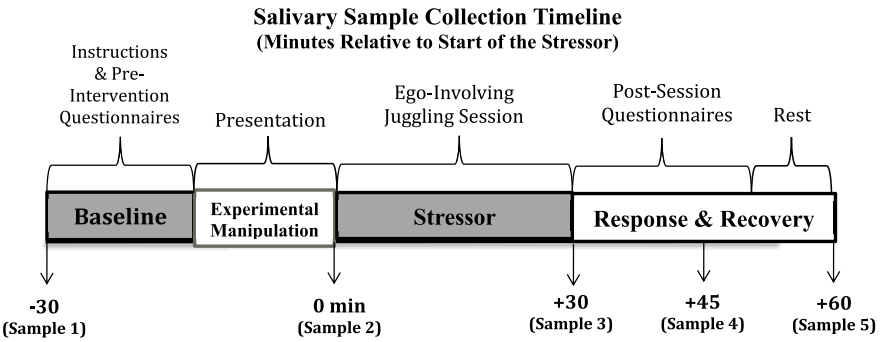

Fig. 1. Timeline of activities (above) for control group and experimental groups. Numbers (below) represent saliva collection times relative to the start of the stressor (i.e., juggling session with an ego-involving climate).

min mental skills training session aimed at fostering a stress-is-enhancing mindset and a more task-oriented approach toward achievement may procure a similar adaptive response. Moreover, recent research conducted by Breske, Fry, Fry, and Hogue (2017) suggests that motivational priming (i.e., an educational lecture) based on AGPT (Nicholls, 1984, 1989) may also function as a psychological and physiological buffer to maladaptive performance-related stress elicited by an ego-involving climate. Breske et al. (2017, p. 76) defined priming according to Molden (2014) as "the stimulation of mental representations of a situation that influence people's subsequent behavior or judgments in said situation". Specifically, during the priming session, participants were given a 15-min lecture that reviewed the motivational climate and goal orientation (i.e., AGPT) literature before being placed into an ego-involving climate. They were never overtly encouraged to adopt a task-orientation or to foster a task-involving climate. Rather, the participants were simply told that everyone who takes part in a study through the laboratory is asked to listen to this short lecture highlighting the laboratory's guiding philosophy. This AGPT-based educational lecture buffered the hormonal response to psychosocial stress (i.e., yield a blunted cortisol spike in response to an ego-involving climate; Breske et al., 2017). Researchers, however, have yet to investigate whether simply learning about AGPT and the supporting literature elicits a multi-faceted protective physiological response to performance stress. Likewise, researchers have not investigated whether a targeted mental skills training session has the same stress buffering effects as the Breske et al. (2017) AGPT-based educational lecture.

The primary purpose of this study was twofold: (1) to examine whether an educational lecture based on AGPT elicits a multifaceted protective response to performance stress (i.e., an ego-involving climate) and (2) to examine whether a mental skills training session, specifically cognitive restructuring aimed at promoting a task orientation and stress-is-enhancing mindset, elicits an advantageous response to performance stress. A secondary purpose was to examine the impact of the respective presentations (i.e., lecture/session) on positive and negative affect and threat and challenge appraisals. It was hypothesized the mental skills training and AGPT groups would respond more favorably than the control group, including significantly greater positive affect, lower negative affect, and a challenge appraisal of stress (vs. a threat appraisal). It was also hypothesized that the mental skills training group would respond with a significant rise in DHEA-S, and that both the mental skills training session and AGPT lecture would buffer the cortisol response to an ego-involving climate (i.e., prevent a significant rise in cortisol in response to the ego-involving climate).

3. Methods

3.1. Participants

This experimental investigation was approved by Pennsylvania State University's Office of Research Protections (STUDY00009507). Male college students were recruited from a small east coast university and were screened, via a health history questionnaire, for potential confounds to the cortisol and DHEA-S measures (e.g., medication, depression; Goodyer et al., 1996). Participants were randomly assigned to a control group (n = 16), a mental skills group (n = 27), or an educational lecture group ("AGPT"; n = 16). Six participants requested to reschedule and were moved to the mental skills training data collection as a result of scheduling conflicts, resulting in unequal group numbers. The participants (N = 59, M_{age} = 20.25, sd = 3.15) were paid $20 for participating and identified as 22% African American, 58% Caucasian, 15% Pacific Islander/Asian , and 3% "Other".

3.2. Procedure

Data collection took place on three consecutive Tuesday afternoons in the middle of the spring semester from 4 to 6 pm (i.e., control group, followed by the mental skills training group, followed by the AGPT lecture group). A timeline of activities is provided in Fig. 1. Upon arrival, once consent was given, participants were taught how to provide their first of five saliva samples, which included two baseline (t = −30, 0 min, relative to the start of the stressor) and three response measures (t = +30, +45, +60 min). Saliva samples allowed for the quantification of salivary cortisol and DHEA-S, valid and reliable means of measuring cortisol and DHEA levels, but less invasive than measuring these hormones through plasma (Ahn, Lee, Choi, Kwon, & Chun, 2007). Participants then completed pre-stressor surveys. At this point the experimental manipulation took place, which included a 15 min presentation (see "Experimental Manipulation" below), followed by completion of the Stress Mindset Measure (Crum et al., 2013a) in order to examine changes in stress mindset post-presentation.

Participants then provided their second baseline saliva sample (t = 0 min) and were led to a gym across the hall where the stressor took place. The stressor included a 30-min instructional juggling session that was perceived to be ego-involving and followed the protocol explained by Hogue et al. (2013). The juggling session protocol was the same for each group (see "Stressor" below). Immediately following the juggling session, a third sample was collected. This was the first of three response samples (+30, +45, and +60 min). Because there is a lag time between a rise in cortisol and DHEA-S and the ability to capture that rise in saliva, the samples were delayed (Dickerson & Kemeny, 2004). Therefore, the t = +30, +45 and + 60 min samples reflect the respective physiological response to psychological stress experienced during the instructional juggling session (i.e., t = 0–30 min). After the stressor and collection of the third sample (t = +30 min), participants completed the post-stressor questionnaires and sat in a neutral environment until the end of the study. The fourth and fifth saliva samples were collected at t = +45 and + 60 min.

All participants were debriefed as to the true purpose of the investigation. It was noted that many people benefit from having a more task-oriented approach toward achievement and a stress-is-enhancing

mindset. Likewise, the investigator explained that much of the research suggests ego-involving climates are not the best way to optimize the experience, learning, or motivation of participants. Caring, task-involving climates were briefly explained, and participants were invited to contact the investigator if they would like to learn more about sport and exercise psychology or to see the other presentations from the study.

3.2.1. Experimental Manipulation

The experimental manipulation consisted of a 15-min presentation that was given to participants just prior to their immersion into an ego-involving climate. The experimental presentations are available under supplemental materials. A brief history of sport psychology was presented to the control group. A lecture on AGPT and a summary of the motivational climate and goal orientation research was presented to the educational lecture ("AGPT") group, in accordance with the motivational priming protocol used in the Breske et al. (2017) experiment (p. 77–78). The mental skills training group received a presentation encouraging them to adopt a more task-oriented approach toward achievement and a stress-is-enhancing mindset.

Specifically, during the AGPT presentation (see Hogue AGPT Educational Lecture Presentation in "supplemental material"), the Penn State, Harrisburg Sport & Exercise Psychology Laboratory's mission was explained and the participants were told that everyone who works with the lab receives the same presentation "since it explains the guiding framework for any work that is conducted through the lab". Our mission was stated to be to understand how we can bring out the best in everyone in physical activity settings. Motivational climates were then introduced, and the supporting literature was summarized. Participants were told that although leaders often have the greatest impact on the motivational climate, everyone can play a role in creating the motivational climate. Task-involving climates (i.e., that focus on cooperation, learning from mistakes, putting forth high effort, and recognizing improvement) were referred to as "mastery climates" in the presentation. Many of the benefits linked to task-involving climates were highlighted for the participants. Goal orientations were then explained. This research was summarized by highlighting some of the benefits of having a high task orientation, along with the potential adverse consequences of holding a high ego orientation/low task orientation. Participants were not explicitly encouraged to foster a particular climate or to adopt a particular orientation during the AGPT educational lecture. The lecture was a simple presentation summarizing the AGPT literature that did not include any encouragement for participants to change their behavior or approach toward achievement.

The laboratory mission and goal orientation literature were also covered during the mental skills presentation. However, this was the only overlap with the AGPT educational lecture (see Hogue Mental Skills Training Presentation in "supplemental material"). The mental skills group was not provided a summary of the motivational climate literature, for instance, but this material was covered during the educational lecture. The mental skills training presentation also differed from the AGPT lecture in that the leader in the mental skills training session overtly encouraged the participants to adopt a task orientation. Participants in the mental skills training presentation were carried through brief cognitive restructuring activities that illustrated how they might adopt a task orientation and stress-is-enhancing mindset. Potential benefits of adopting a task-oriented approach toward achievement were summarized (e.g., a willingness to persevere in performance settings, even when an individual has low perceived ability). Participants were then encouraged to consider working to adopt this orientation in future achievement endeavors. Participants were also encouraged to develop a stress-is-enhancing mindset through cognitive restructuring activities. This included recognizing that messages are often sent that stress-is-debilitating and has negative consequences, but there are many reasons to believe that performance stress is enhancing and has a positive impact (McGonigal, 2015).

More specifically, the mental skills training session began by introducing the Penn State Harrisburg Sport & Exercise Psychology Laboratory and mission. The participants were then introduced to mental skills training, followed by a more detailed explanation of cognitive restructuring and the purpose of the session. The purpose of the session was stated to be two-fold: 1) to identify and dispute two specific maladaptive (unhelpful) thoughts that are prevalent in performance contexts and 2) learn to restructure them in a way that facilitates performance. The two specific maladaptive thoughts at the center of the session were: 1) basing your own personal definition of success on how someone else is performing or what they are saying to you and 2) perceiving that performance stress is debilitating (i.e., hinders performance) rather than a facilitator or motivator.

Goal orientations (i.e., task and ego orientations) were introduced and the goal orientation literature was briefly summarized. Participants were encouraged to define success in a way that aligns with a task orientation, rather than having an ego-oriented approach. The presenter compared a task orientation to an ego orientation and highlighted many of the advantages of holding a high task orientation. Examples of how to begin developing this orientation toward achievement were also shared (e.g., focusing on mastering new skills and using self-referenced criteria, such as personal effort and improvement, as a measure of success in achievement contexts). Stress mindsets and the supporting literature were then introduced and summarized (Crum et al., 2013a; Crum, Akinola, Martin, Fath, & Crum, 2015; Crum et al., 2017a; Jamieson et al., 2018). Specifically, participants were encouraged to develop a stress-is-enhancing mindset toward performance stress, and examples of how stress experiences can help enhance current and/or future performance were included. For instance, three examples from the Stanford Mind & Body Lab (e.g., Crum et al., 2013b; Crum et al., 2017b) were used, including how performance stress can enhance productivity, learning, and personal growth (e.g., can give us energy to thrive in performance settings). The notion that performance pressure can lead to better health and well-being was also shared. Examples included how people often experience a sense of accomplishment and pride after having the courage to face challenges and grow from their experiences.

The presenter noted that it can be rewarding to challenge ourselves to try our very best, to learn something new, and to accomplish a new personal best. This approach toward achievement reflects a task orientation, as many of the examples did. A specific example includes "That pressure to perform that you experience in class, at the gym, playing basketball – can help motivate you to realize your full potential." An emphasis was placed on the controllable aspects of performance and how they can be achieved (e.g., trying hard and listening to instruction, then "leaving the rest" when in a more negative environment). Participants were encouraged to seek out and recognize resources available to them, including cooperating with and learning from others, a key tenant of AGPT. The presentation closed by encouraging participants to have a stress-is-enhancing mindset and a task-oriented approach toward achievement in performance settings.

3.2.2. Stressor

The stressor was an ego-involving instructional juggling session shown to trigger psychophysiological stress responses (e.g., Breske et al., 2017; Hogue et al., 2013, 2017, 2019). This 30-min instructional juggling session followed the same protocol for each group. This consisted of six activities, including an icebreaker, instruction on how to juggle, time to practice juggling, and three competitive games. Ego-involving features were emphasized throughout each of the activities, including placing high value on winning and athleticism, punishing mistakes, promoting inter- and intra-group rivalry, and comparing abilities and performances. Confederates were planted in the study in order to give the instructors someone to consistently praise and compare participants to. Confederates pretended to be participants and "learned to juggle" a little faster than the other participants. They also helped reinforce the ego-involving climate by promoting competition and rivalry among participants.

The icebreaker consisted of game called "Glory Days" where participants went around the circle introducing themselves by sharing their names and their greatest sport accomplishment (approx. 5 min). The instructors then introduced the basic skills of juggling and provided time for the participants to practice (approx. 8 min). The first activity consisted of a game called "Rank Order" where participants were ranked on a scale taped to the wall that ranged from 1 (best) to 5 (average) to 10 (worst) as they juggled. The second activity consisted of a game called "On the Spot" where participants competed to see who could successfully complete the most toss-to-catches in 30 s. The final activity included a "Championship Match" where teams competed juggling until there was a winner.

3.3. Physiological responses

3.3.1. Salivary cortisol and DHEA-S

Saliva was collected using a passive drool method via collection and storage devices purchased from Salimetrics (State College, PA). Once each round of samples was collected, they were quickly walked to a nearby building (< 15 min) and frozen at −80 °C until the assays were completed. Sample levels were determined using salivary cortisol and DHEA-S enzyme immunoassay kits (Salimetrics, State College, PA). The assays were analyzed by the investigator using a microplate reader available in-house (i.e., using the Kinesiology Department's laboratory equipment at Pennsylvania State University, Harrisburg). Each sample was thawed to room temperature and assays were conducted following the manufacturer's protocol. Samples were assayed in duplicate and each participant's samples were analyzed in the same assay. Inter- and intra-assay CV% were < 8% for both DHEA-S and cortisol.

3.4. Psychological questionnaires

3.4.1. Motivational climate perceptions

Perceptions of a caring, task- and ego-involving climate were assessed using the Caring Climate Scale (Newton et al., 2007) and the Perceived Motivational Climate in Sport Questionnaire (PMCSQ; Seifriz, Duda, & Chi, 1992). Participants answered questions about the juggling session on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) using the prefix "During the juggling session …". An example caring item is "… the instructors wanted to get to know the participants". Example task and ego-involving items from the current investigation include "… participants tried to learn new skills" and "… performing better than others was important", respectively. Internal consistency ($\alpha_{task} = 0.85$, $\alpha_{ego} = 0.83$, $\alpha_{caring} = 0.96$) was acceptable.

3.4.2. Mindset

Stress mindset (i.e., stress-is-enhancing and stress-is-debilitating) was assessed prior to and after the experimental manipulation (i.e., presentations) using Crum et al's (2013a) Stress Mindset Measure, with all references to "stress" changed to "performance stress" (e.g., "Experiencing performance stress facilitates my learning and growth."). Four items assess the belief that the effects of stress are positive and should be utilized (i.e., stress-is-enhancing mindset) and four items assess the belief that the effects of stress are negative and should be avoided (i.e., a stress-is-debilitating mindset). Another example stress-is-enhancing mindset item is "Experiencing performance stress enhances my performance and productivity", while an example stress-is-debilitating mindset item is "Experiencing performance stress debilitates my performance and productivity". The scales range from 0 (*strongly disagree*) to 4 (*strongly agree*). The Stress Mindset Measure has shown acceptable internal consistency in previous research (Crum et al., 2017a), as well as the current investigation ($\alpha_{baseline} = 0.77$, $\alpha_{post\text{-}presentation} = .85$).

3.4.3. Affect

Positive and negative affect were assessed prior to and after the stressor using the 20 item Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). Ten items assess positive affect and ten assess negative affect using a scale of 1 (*not at all*) to 5 (*a great deal*), using the stem "I currently feel …" (pre) or "During the juggling session I felt …" (post). Positive affect quantifies the extent to which an individual experiences or feels positive emotions including feeling proud, excited, and interested. Negative affect quantifies the extent to which an individual experiences or feels negative emotions including feeling upset, irritable, and ashamed. The positive affect ($\alpha_{baseline} = 0.89$, $\alpha_{post\text{-}stressor} = 0.86$) and negative affect ($\alpha_{baseline} = 0.70$, $\alpha_{post\text{-}stressor} = 0.81$) subscales had acceptable internal consistency.

3.4.4. Threat and challenge appraisals

Demand and resource appraisals during the stressor were appraised using Mendes, Gray, Mendoza-Denton, Majory & Epel's (2007) threat and challenge measure. Examples of the six demand and five resource items include "The juggling session was very demanding" and "I felt I had the abilities to perform well during the juggling session", respectively. Responses were recorded on a scale that ranged from 1 (*strongly disagree*) to 7 (*strongly agree*). Demand and resources appraisals were averaged, and the demand/resource ratio was used to calculate a threat index for each group (Akinola & Mendes, 2014). A threat index above 1 indicates a threat appraisal, while ratios below 1 indicate a challenge appraisal (e.g., Crum et al., 2017a). The resources and demands subscales had acceptable internal consistency, $\alpha = 0.77$ and $\alpha = 0.72$, respectively.

3.5. Analysis

In order to examine changes in DHEA-S and salivary cortisol, two separate 3 (Condition: control vs. AGPT lecture vs. mental skills) x 5 (Time: t – 30 vs. t 0 vs. t + 30 vs. t + 45 vs. t + 60 min) repeated-measures ANOVAs were conducted. Time of sample treated as the within-subjects variable and condition (i.e., presentation) was treated the between subjects variable. Ten participants were removed from the physiological analyses for reporting a current sickness or not adhering to the pre-study instructions, resulting in the following groups: Control ($n = 13$), AGPT ($n = 13$), mental skills training ($n = 23$). Two baseline measures of DHEA outliers (> 3SD above M) were replaced (M + 3SD). Cortisol and DHEA-S were log transformed prior to analysis due to positive skew.

In order to assess whether random assignment was successful, baseline group differences in stress mindset, affect, and age were examined. Baseline stress-is-enhancing and stress-is-debilitating mindsets were assessed in one MANOVA. Baseline positive and negative affect were assessed in a separate MANOVA. Condition was treated as the between subjects variable for each analysis. For pre- and post-psychological measures, 3 (Condition) x 2 (Time: pre vs. post) repeated-measures ANOVAs were conducted. This allowed for an examination of group differences over time. Condition was treated as a between subjects variable, while time was treated as a within subjects variable for pre- and post-measures. Significant baseline differences in affect (see below) were controlled for by treating pre-stressor levels as covariates in the respective MANCOVA when examining post-stressor differences. MANOVAs were run for the post-only variables (i.e., threat and challenge appraisals and the perceived motivational climate manipulation check). Condition was treated as a between subjects variable for the post-only variables.

When significant group differences were found, Cohen's d was provided. Paired sample t-tests were used to test single time point differences within groups. All alpha levels were set at 0.05 and were adjusted with a Bonferroni correction for multiple comparisons, when relevant.

4. Results

All pre- and post-stressor means and standard deviations for the psychological variables are presented in Table 1 by group, while all

Table 1
Means (SD) and Cohen's *d* for pre- and post-stressor score for stress mindset, post-stressor threat and challenge appraisals, and pre- and post-stressor affect by Group.

Variable	Cohen's *d* *(Group Differences)*	Control Group	AGPT Lecture Group	Mental Skills Group
Stress Mindset				
Pre Stress-is-Enhancing		1.72 (.69)	1.77 (.83)	1.92 (.62)
Post *Stress-is-Enhancing*	[a].88, [b]1.16	1.80 (.91)[a]	1.66 (.81)[b]	2.45 (.52)[ab†]
Pre Stress-is-Debilitating		1.83 (.66)	1.52 (.68)	1.79 (.77)
Post Stress-is-Debilitating	[a].71, [b]1.01	1.81 (.78)[a]	1.59 (.78)[b]	2.35 (.73)[ab†]
Threat & Challenge Appraisals				
Demand Appraisals		4.26	4.44	3.89
Resource Appraisals		4.01	4.40	4.61
"Threat Index"		1.06 (threat)	1.01 (threat)	0.84 (challenge)
Affect				
Pre Positive Affect	[a].86, [b].82	25.00 (6.47)[ab]	31.56 (9.34)[b]	30.67 (6.35)[a]
Post Positive Affect		27.00 (6.79)	31.31 (9.27)	33.04 (6.65)
Pre Negative Affect		15.19 (5.00)	13.00 (2.58)	14.67 (4.28)
Post Negative Affect		20.81 (7.42)*	20.69 (8.02)[×]	17.44 (5.63)[†]

Note. Same subscripts note significant differences at $p < .01$. Subscripts [a, b] reflect differences between groups, while subscripts [*, †, ×] reflect differences within groups from pre-to post-stressor.

physiological responses are presented in Table 2. Within group and between group differences are indicated. Correlations among psychological variables are reported in Table 3. DHEA-S responses over time are presented in Fig. 2, while salivary cortisol responses are presented in Fig. 3.

Table 2
Means (SE) and Cohen's *d* for pre- and post-stressor levels of salivary DHEA-S (pg/min) and cortisol (nmol/L) by Group.

Variable	Cohen's *d* *(Group Differences)*	Control Group	AGPT Lecture Group	Mental Skills Group
Salivary DHEA-S				
Sample 1 (Baseline)		2228.34 (262.18)	2430.52 (367.40)	2858.87 (364.67)
Sample 2 (Baseline)		2424.20 (271.76)	2407.79 (374.01)	2836.67 (363.08)
Sample 3 (Response)	[a]1.31, [b]1.38	2391.21[a] (489.59)	2519.52[b] (591.37)	7537.42[ab]* (1626.45)
Sample 4 (Response)	[a].80, [b]1.10	2743.84[a] (681.01)	2435.44[b] (419.62)	8236.53[ab]* (1216.12)
Sample 5 (Response)		2865.06 (670.99)	1997.80 (292.93)	6209.70 (3095.07)
Salivary Cortisol				
Sample 1 (Baseline)		6.27 (1.90)	4.85 (1.20)	5.31 (1.67)
Sample 2 (Baseline)		5.97 (2.21)	4.91 (1.18)	4.94 (1.38)
Sample 3 (Response)		10.12* (2.38)	7.47 (1.44)	9.31[†] (1.12)
Sample 4 (Response)		10.51* (2.38)	7.42 (1.42)	10.48[†] (1.25)
Sample 5 (Response)		9.60 (2.37)	6.10 (1.32)	9.78 (1.18)

Note. Same subscripts note significant differences at $p < .01$. Subscripts [a, b] reflect differences between groups, while subscripts [*, †, ×] reflect differences within groups from pre-to post-stressor.

Table 3
Correlation table among post-stressor psychological variables.

	1	2	3	4	5	6
1. Stress-is- Enhancing Mindset	1					
2. Stress-is-Debilitating Mindset	.647**	1				
3. Positive Affect	.409**	.351*	1			
4. Negative Affect	-.288*	-.348*	-.483**	1		
7. Resources	.434**	.337*	.593**	-.353*	1	
8. Demands	-.222	-.214	-.433**	.706**	-.250	1

Note. $^{**}p < .01$, $^{*}p < .05$.

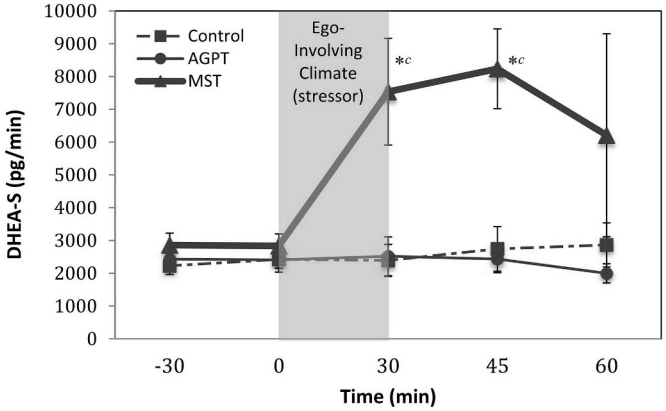

Fig. 2. DHEA-S responses over time by group (i.e., control, AGPT, MST). Mean DHEA-S in pg per min at baseline ($t = -30$ & 0 min), and following the stressor (i.e., instructional juggling session with an ego-involving climate). Vertical lines with cross bars represent ± standard error, and * indicates significant group differences (i.e., MST from control and AGPT groups), while *c* represents within group significant differences from baseline for the MST group at $p < .05$. *Note.* AGPT refers to the achievement goal perspective theory lecture group; MST refers to the mental skills training group; and DHEA-S refers to dehydroepiandrosterone-sulfate.

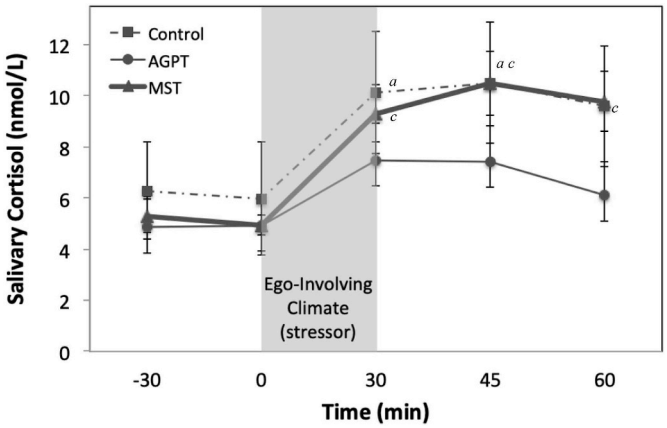

Fig. 3. Salivary cortisol responses over time by group (i.e., control, AGPT, MST). Mean salivary cortisol in nanomoles per liter at baseline ($t = -30$ & 0 min), and following the stressor (i.e., instructional juggling session with an ego-involving climate). Vertical lines with cross bars represent ± standard error. *a* and *c* represent within group significant differences from baseline for the control group and MST group, respectively. *Note.* AGPT refers to the achievement goal perspective theory lecture group; MST refers to the mental skills training group

4.1. Baseline differences

With the exception of positive affect F (2, 56) = 4.015, $p < .05$, $n^2 = 0.125$, there were no significant baseline differences between groups. Positive affect was lower for the control group, compared to both the mental skills and AGPT groups, prior to the start of the stressor.

4.2. Manipulation check

4.2.1. Climate

The motivational climate manipulation check revealed that the instructors were successful in creating a significantly more ego-involving climate ($M_{control}$ = 4.04, M_{AGPT} = 4.29, $M_{MentalSkills}$ = 3.95) than caring ($M_{control}$ = 2.84, M_{AGPT} = 2.47, $M_{MentalSkills}$ = 2.42) or task-involving ($M_{control}$ = 3.13, M_{AGPT} = 2.98, $M_{MentalSkills}$ = 3.07) in each juggling session. There are no significant differences between groups in their perception of a caring, $F(2, 56) = 1.02$, $p = .369$, task-involving, $F(2, 56) = 0.18$, $p = .840$, or ego-involving climate, $F(2, 56) = 1.66$, $p = .200$, during the instructional juggling session. Also, the motivational climate during the juggling session for the control, AGPT lecture, and mental skills training groups were all perceived to be significantly more ego-involving than caring [$t(1, 15) = 3.76$, $p < .005$; $t(1, 15) = 6.11$, $p < .001$; $t(1, 26) = 5.52$, $p < .001$, respectively] or task-involving [$t(1, 15) = 3.37$, $p < .005$; $t(1, 15) = 4.38$, $p < .005$; $t(1, 26) = 3.37$, $p < .001$].

4.2.2. Mindset

Results revealed non-significant main effects for Condition, $F(2, 54) = 2.45$, $p = .05$ and Time, $F(2, 54) = 1.67$, $p = .20$, and a significant Time × Condition interaction, $F(2, 55) = 6.82$, $p < .005$, $n^2 = 0.199$, indicating group differences in stress mindset over time. The stress-is-enhancing mindset of the mental skills training group was significantly greater post-presentation than the control group, $t(1, 41) = 2.98$, $p < .005$, and the AGPT lecture group, $t(1, 41) = 3.90$, $p < .001$. Follow-up analyses also revealed the mental skills training session was successful in eliciting a significantly greater stress-is-enhancing mindset, when compared to pre-presentation stress-is-enhancing mindset levels, $t(1, 26) = 4.23$, $p < .001$.

4.3. Physiological responses

4.3.1. DHEA-S

As hypothesized, analyses revealed a significant Time × Condition interaction, $F(4, 45) = 2.32$, $p < .05$, $\eta^2 = 0.17$, suggesting the DHEA responses over time varied by group. Condition explained approximately 17% of the variability. Follow up analyses revealed a significant difference between the mental skills training group and both the control group and the AGPT lecture group for samples three and four. There was a non-significant main effect for Time, $F(4, 44) = 1.88$, $p = .131$. Follow up analyses also revealed that the mental skills training group increased significantly in DHEA-S from baseline levels to the third, $t(1,13) = 2.86$, $p = .009$, and fourth, $t(1,13) = 2.86$, $p = .013$, samples.

4.3.2. Cortisol

Analyses revealed a non-significant Time × Condition interaction, $F(4, 45) = 1.61$, $p = .189$, and a significant main effect for Time, $F(4, 44) = 0.58$, $p < .001$, $\eta^2 = 0.53$. Follow up analyses revealed a significant difference between the mental skills training group and the AGPT lecture group for sample 5, with the AGPT lecture group responding with significantly lower cortisol at $t = +60$ post stressor. Follow up analyses also revealed that the control group increased significantly in cortisol from baseline for the third, $t(1,13) = 2.85$, $p = .014$, and fourth samples, $t(1,13) = 3.02$, $p = .010$, and the mental skills training group increased significantly in cortisol from baseline levels for the third, $t(1,13) = 4.33$, $p = .004$, fourth, $t(1,13) = 4.69$, $p < .001$, and fifth samples, $t(1,13) = 4.25$, $p < .001$. The AGPT lecture group did not increase significantly from baseline.

4.4. Psychological responses

4.4.1. Affect

After controlling for pre-affect levels, results revealed a non-significant main effect for Condition, $F(4, 108) = 1.73$, $p = .149$, suggesting differences in affect from pre- to post-stress exposure between groups may be due to differences in baseline affect. Follow up analyses revealed a significant rise in negative affect for the control, $t(1,15) = 3.42$, $p < .005$, AGPT lecture, $t(1,13) = 3.96$, $p < .005$, and mental skills groups, $t(1,13) = 3.24$, $p < .005$ from pre- to post-stressor. There were no significant changes within groups from pre-to post-stressor for positive affect.

4.4.2. Threat and challenge appraisals

A MANOVA was run in order to investigate differences in perceived demands and resources. While there were no significant differences between groups, $F(2, 56) = 1.74$, $p = .185$, the threat index (demands/resources) for the mental skills training group was < 1. According to Crum et al. (2013a), this indicates that the mental skills training group had a challenge appraisal (0.84), while both the control and AGPT lecture groups had a threat appraisal (i.e., an index > 1).

5. Discussion

This research provides a more nuanced understanding of Nicholls (1984, 1989) AGPT and the impact of applied efforts utilizing AGPT and the supporting literature. This research examined how a brief educational lecture or a mental skills training session, both based on AGPT, might help protect participants against potentially threatening performance stressors in physical activity-based achievement settings. Simply learning about the tenets of AGPT and supporting motivational climate and goal orientation literature procured an advantageous physiological response to performance stress. Specifically, a 15-min AGPT-based educational lecture prevented a significant rise in cortisol, post exposure to an ego-involving climate. According to Nicholls, recognizing that there is a more positive, cooperative way to approach achievement endeavors (e.g., creating a caring, task-involving climate and having a task-oriented approach toward achievement) may help protect against the negative effects of an ego-involving climate. Anecdotal evidence from the current investigation supports this notion. The instructors reflected that the AGPT group seemed to be (somewhat) more positive in their response to the ego-involving climate. For instance, many of the participants made efforts to laugh in response to comments and to work together, despite instructors fostering intragroup rivalry and giving most of the positive feedback to the confederates.

The blunted cortisol spike in the AGPT lecture group and rise in cortisol in the mental skills training group provides insight into the possible impact of educational workshops, specifically with respect to motivational climates (i.e., ego-involving vs. caring, task-involving). This differential response (between the two experimental groups) seems to suggest that learning about the different types of motivational climates empowers participants in a way that reduces feelings of social evaluation and/or uncontrollability (i.e., psychosocial stressors that trigger of cortisol. Dickerson, Gruenewald, and Kemeny's (2004) social self preservation theory would suggest that the lecture that buffered cortisol helped protect against social threats present in an ego-involving climate. For example, it may be that learning that others also experience feelings of shame and self-doubt when placed in an ego-involving climate might help some participants realize that they are not alone in feeling this way. Moreover, the participants were taught that success can also be defined by controllable factors (e.g., effort and improvement) and that working cooperatively with others is generally advantageous in competitive settings. Learning this may have prompted behaviors and responses that helped to minimize feelings of rejection and inadequacy. Dickerson, Gruenewald, and Kemeny (2004) would argue any successful efforts to minimize such feelings might yield a protective response, including a possible reduction in cortisol. Feelings of inadequacy and rejection were not assessed in the current investigation, however. Researchers should consider exploring what psychological factors may have mediated the physiological response to psychosocial stress in future investigations, including the role of affect.

The mental skills training session aimed at fostering a task-oriented approach toward achievement and a stress-is-enhancing mindset did not buffer the cortisol response, but did elicit protective psychological and physiological responses to performance stress. These findings suggest the session did not thwart feelings of uncontrollability and/or social evaluation (i.e., cortisol triggers). However, the mental skills training session did elicit the production of a protective neurosteroid known to counter the negative effects of cortisol (i.e., DHEA-S). Advantageous psychological responses to the mental skills training included a challenge appraisal of stress and a greater stress-is-enhancing mindset, relative to the control group and AGPT educational lecture group. These findings support Nicholls' contention that both the motivational climate and how participants conceptualize competence and achievement influence their responses in performance contexts. Likewise, Crum et al. (2013a, 2017a) argue that how we think about stress and the impact that it has influences our response to stress. The rise in a stress-is-enhancing mindset, the challenge appraisal, and the subsequent spike in DHEA-S support this contention. Findings from the Crum et al. (2013a; 2017a) investigations suggest that believing in the enhancing nature of stress (i.e., having a stress-is-enhancing mindset) triggers DHEA-S production when exposed to socially-evaluative and uncontrollable performance settings (e.g., during the Trier Social Stress Test). Moreover, the Crum et al. (2013a; 2017a) mindset interventions did not buffer the cortisol response to psychosocial stress, in line with findings from the current investigation. Given the blunted cortisol response in the AGPT lecture group in the current investigation, future research should examine whether encouraging participants to foster a caring, task-involving climate would protect against maladaptive forms of social-evaluation and feelings of uncontrollability in performance contexts.

The mental skills training group's challenge appraisal of the stressor suggests this adaptive state cognitive stress response to performance stress was a result of promoting a greater task orientation and stress-is-enhancing mindset toward performance stress. Challenge appraisals are linked to better psychological and physiological responses than threat appraisals, including more efficient cognitive performance and adaptive cardiac and motivational responses (Mendes et al., 2007). Both the AGPT and control group reported a threat appraisal of the stressor. Pearson correlations from the current investigation also moderately linked resource appraisals to positive affect, whereas demand appraisals were strongly linked to negative affect. The interplay between challenge versus threat appraisals of performance stress and the ability of performers to consistently play to their potential while experiencing stress should be examined in physical activity settings as well.

Future research should examine what specific information from the AGPT educational lecture buffered the stress response, cortisol. This information could be incorporated into mental skills training sessions and other informational sessions with athletes/students, parents, coaches/teachers, and athletic trainers. Researchers may consider exploring other potential physiological benefits of mental skills training and AGPT-based coach and parent workshops. Also, this is an experimental investigation that took place in a laboratory setting, and the impact of education and mental skills training on neuroendocrine stress responses should also be investigated in real-world settings. Researchers might also consider investigating what mediating factors play a role in buffering the stress response. For example, Iwasaki and Fry (2016) linked caring, task-involving climates to mindful engagement, and MacDonald and Minahan (2018) found mindfulness training attenuates the cortisol response to performance stress. This research suggests mindfulness may mediate the relationship between a caring, task-involving climate to a more salutary physiological response to performance stress. Lastly, the long-term implications of the hormonal changes revealed in the current experiment should be investigated further.

Sport psychology practitioners are often encouraged to guide their athletes to have a more adaptive view of stress in order to promote greater resilience and teach positive life skills. For instance, Danish, Petipas, and Hale (1993) encouraged athletes to view highly stressful events, such as severe injury, as an opportunity for personal growth (Danish, Petitpas, & Hale, 1993). This aligns with Crum et al.'s (2013a) stress-is-enhancing mindset, and is believed to promote greater resilience in athletes (Galli & Vealey, 2008). The findings from the current experimental investigation suggest researchers should investigate how practitioners impact their clients' psychophysiological responses to performance stress in these and other similar contexts.

This is the first experiment to reveal that a brief mental skills training session can elicit a protective physiological response to performance stress, as measured by DHEA. This rise in stress hormones is salient and worthy of investigation in physical activity settings, given their potential to have a wide-ranging impact on participant well-being and athletic performance. A rise in DHEA-S is considered to be indicative of a protective physiological response that yields more adaptive cognitive, affective, and physiological outcomes (Mendes et al., 2007). Therefore, if ego-involving climate induced cortisol elevations do affect immunity or the ability to recover from injury, it may be that elevated DHEA is protective, as neuroendocrine research suggests (Ahn et al., 2007; Boudarene, Legros, & Timsit-Berthier, 2002; van Niekerk, Huppert, & Herbert, 2001). The greater implications of a rise in DHEA should be explored, including whether the cognitive benefits associated with elevated DHEA transfer to the field/court.

5.1. Limitations

This experimental investigation was conducted in a laboratory setting, and as a result, the findings cannot be generalized to real world settings. Likewise, only male participants were included for participation, and the findings cannot be generalized to females. Only males were included in the experiment because funding limited the number of participants that could be included and birth control impacts the hormonal responses under investigation. The participants were also college aged students, and this experiment will need to be replicated with participants of different ages, as well as athletes. Finally, only the impact in an ego-involving climate was explored. Researchers should consider examining the impact of AGPT-based education and mental skills training in a caring, task-involving climate as well.

6. Conclusion

There is still much to be explored when considering the physiological and psychological implications of both the motivational climate and mental skills training in physical activity settings. It is worth calling attention to the fact that despite a body of literature spanning decades that highlights the threat posed by an ego-involving climate, along with the many benefits of creating more supportive, mastery-focused environments, ego-involving climates are still fostered in sport and exercise settings. It is also important to recognize that participants do not always have control over the motivational climate they are exposed to. Thus, researchers should not only continue to explore how practitioners can empower participants to better respond to psychosocial stress elicited by an ego-involving climate, but should also take steps to translate the research in a way that effects greater change within sport and exercise settings (i.e., promote creating caring, task-involving climates and a more task-oriented approach toward achievement). Finally, an argument can be made that this information would be beneficial for anyone engaging in goal-oriented behavior. This experimental investigation, along with a body of research, have identified AGPT as a guiding framework for which to approach such endeavors and opens the door to further psychophysiological explorations of stress in sport and exercise settings.

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Appendix A. Supplementary data

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