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The Physiological Effects of Appraisal of a Challenge or Threat State on Collegiate Athletes' Performance

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Abstract

This study investigated how athletes' appraisals of a challenge or threat state during competition impact performances. The physiological changes during challenge and threat appraisal include release of norepinephrine and epinephrine and increase in heart rate. However, threat appraisals are associated with the release of cortisol, a stress hormone. Blood pressure increases for threat but decreases with challenge appraisals[2]. The purpose of this study was to induce a challenge or threat state and measure psychological appraisals, physiological responses and performance of collegiate athletes using an actual sports-related task. College athletes matched on sport, gender and athletic ability ran half mile races (20 pairs). One member of the pair received instructions evoking a challenge and the other received threat inducing instructions. Both were measured on baseline, pre-performance, and post-performance heart rate and blood pressure. Stress appraisals were measured prior to the task using the Primary and Secondary Appraisal Scale (PASA)[9]. The results showed that athletes in the challenge condition appraised the situation as a challenge while the athletes in the threat condition appraised the situation as both a challenge and a threat. Athletes in the challenge condition ran significantly faster half mile times (M = 3min 45s, SD = 0.53s) than those in the threat condition (M = 3min 53s, SD = 0.52s). However the instructions had no significant effect on athletes' heart rate and blood pressure. This experiment showed that challenge appraisals lead to better performance. One application of these results could be to help athletes self-regulate to have a more positive stress response by simply altering their negative appraisal of threat and turning it into a positive challenge appraisal in order to attain higher athletic performance.

Keywords: Cognitive Appraisals, Biopsychosocial Model of Challenge and Threat States, Athletic Performance

1. Introduction

Sports psychology is a widely growing area within the field of psychology today. The purpose of understanding the elements that contribute to athletic performance can help sports and exercise psychologists provide elite athletes with the proper mental training to help the athletes achieve maximum performance. Because athletes are constantly placed under the stress of competition—whether it is the opposing competitor or the situation in its entirety, it is important to understand the underlying antecedents behind stress[15]. These antecedents entail the athletes' appraisal of the situation, which may be categorized as either a challenge state or a threat state. Challenge and threat states are two psychophysiological appraisals that act as predictors of athletic performance[23]. An athlete's appraisals of a stressor during competition in correspondence with the physiological responses that occur during appraisal entail the psychophysiology behind the athlete's performance[23]. Manipulation checks and task performance are two factors necessary for evaluating athletic performance. Manipulation checks ensure that the athlete's appraisal correctly reflects the physiological changes taking place during appraisal questionnaire [15]. The physiological components are important to understand because they reflect the biological responses that occur as the result of cognitive appraisal[15]. Task performance is necessary because it evaluates the final result of appraisal

and physiological responses by examining the impact of these factors on the athlete's performance[15]. When examining and evaluating athletic performance, it is important to consider cognitive appraisal as either a challenge or a threat and how the physiological responses corresponding with these appraisals determine the outcome of the athlete's performance.

1.1 The Biopsychosocial Model Of Challenge And Threat States

The biopsychosocial model of challenge and threat states is the most commonly studied paradigm in the field of sports psychology. In 2004, Blascovich and colleagues, the biopsychosocial model of challenge and threat states is applicable only to situations where an individual is trying to attain a goal, thus the task must be goal-driven, engaging, and must require a cognitive response[2]. The individual faced with the acute stressor must first evaluate the demands of the situation. If the individual feels that he or she has adequate resources to meet or exceed the demands of the situation, the individual will perceive the situation as a challenge[2]. If the individual feels that the demands of the situation exceed his or her resources, then the individual will perceive the situation as a threat[2]. Established by Lazarus and Folkman in 1986, the Appraisal Theory is applicable to Blascovich et. al.'s biopsychosocial model of challenge and threat states in that it suggests that cognitive appraisals of a potentially stressful situation determine how an individual will respond to it[20]. In the appraisal theory, Lazarus and Folkman divide appraisal into two categories: primary appraisals, which assess whether a situation is relevant to a person's well-being, and secondary appraisals, which assess the individual's coping resources and options to accomplish the goal[8]. One important difference to note between the appraisal theory and the biopsychosocial model of challenge and threat states is that the biopsychosocial model of challenge and threat states suggests that appraisal occurs in any situation that is task-driven, while the appraisal theory suggests that appraisal only occurs if the situation is relevant to an individual's own well-being, and will not occur otherwise[20]. A similarity between the two paradigms is the idea that a challenge state is associated with a positive valence, while a threat state is associated with a negative valence[20]. The biopsychosocial model of challenge and threat states begins with the individual's evaluation of the demands of the situation, and after acknowledging the situation as a challenge or threat, a series of changes in cardiovascular patterns accompany the individual's perception of a challenge or threat state.

1.2 Catecholamines Released In Challenge And Threat States

When an individual perceives a challenge state, arousal of the sympathetic-adrenal medullary, or SAM axis, occurs[13]. During arousal of the SAM axis, a release of norepinephrine and epinephrine, two important catecholamines that play key roles in the release of adrenaline that stimulate an individual's fight or flight response, takes place[13]. SAM activation can be observed through a change in cardiovascular patterns characterized by an increase in heart rate, cardiac output, and ventricular contractility and a decrease in total peripheral resistance[13]. When an individual perceives a threat state, not only does arousal of the SAM axis take place, but arousal of the pituitary-adrenal cortex, or the PAC axis, also takes place. During arousal of the PAC axis, an increase in cortisol is produced[13]. Cortisol is the catecholamine responsible for activating stress and anxiety responses[13]. PAC activation can be observed through a change in cardiovascular patterns characterized by little or no change in cardiac output, and an increase in total peripheral resistance, heart rate, and ventricular contractility[13].

1.3 Physiological Changes During Challenge And Threat States

In order to understand the significance of these cardiovascular patterns, one must first learn the functionality of each physiological change. Heart rate is measured by counting the individual's heartbeats per minute and is a crucial factor used in determining the individual's effort being put into a task[4]. The greater the amount of physical effort being put forth into a task, the higher the heart rate. Cardiac output is a measure of an individual's amount of blood in liters pumped by the heart per minute[4]. This measure is indirectly obtained through taking the individual's blood pressure. Blood pressure, along with heart rate, is another key element in understanding the individual's effort put into the task and also perception of a challenge or threat state. Blood pressure is measured in terms of systolic blood pressure over diastolic blood pressure[19]. The importance of systolic blood pressure is to keep blood flowing through the blood vessels so that the body's cells get the oxygen and nutrients they need and can get rid of waste matter[19]. If systolic and diastolic blood pressures are too low, the individual could suffer from hypotension, which is the result of the inability of blood to bring oxygen and nutrients to the body's cells and remove waste matter[19].

Athletes tend to have lower blood pressure readings because frequent physical activity strengthens the heart, which causes it to pump blood with less effort[19]. However, blood pressure levels rise during vigorous activity in

both static exercises (such as weightlifting) and dynamic or aerobic exercise (such as running, swimming, and bicycling). Ventricular contractility is a measure of the left ventricle's contractile force[4]. This is simply just a measure of the amount of blood being pumped out of the left ventricle into the aorta[4]. The final cardiovascular pattern to understand is total peripheral resistance, which is an index of the dilation of an individual's arterial veins[4]. Measures of cardiovascular reactivity are important to understand perception of challenge and threat states because not all individuals exhibit physical responses to either stressor. The reason some individuals do not exhibit physical responses to either state is because after years of competing, these individuals may become mentally conditioned to their cognitive appraisal and do not exhibit an evasive physical response, thus making it necessary to observe the cardiovascular responses that may seem less apparent through physical observation [4].

1.4 Attribution Of Achievement Motivation

Another important element to consider when predicting an athlete's perception of a challenge or threat state involves the individual's attribution of achievement motivation. In an article by Bernard Weiner, he states that, when predicting an athlete's outcome of a competition, there are three factors that must be considered which combine to make up the perceived causes of success and failure[24]. These three factors include locus, stability, and controllability. These three elements include a causal structure, which are the dimensions of causality defined by the person's motivation and the environment in which the task is taking place[24]. The locus is defined as the environment in which the individual has previously experienced success or failure. The locus is an important determinant of an athlete's success or failure because athletes show a tendency to succeed in environments in which they had previous successes, and fail in environments in which they had experienced previous failures[24].

The stability dimension of the causal structure refers to the frequency of which an athlete experiences a success or failure. Athletes who succeed frequently have higher levels of hope and motivation when placed in a stressful situation and display competence and confidence when placed in a stressful task[24]. This supports the idea that athletes who become accustomed to succeeding may perceive acute stressors as a challenge and focus on performing just as well or better than they performed in previous competition[5]. Athletes who fail frequently acquire negative appraisals of an acute stressor, which could be attributed to the fact that these athletes become accustomed to failure at a stable rate. This supports the idea that athletes who experience frequent failures may perceive acute stressors as a threat, as they feel that they lack the necessary resources to complete the task at hand[5].

The final dimension in the causal structure is controllability. Controllability refers to the athlete's ability to alter the situation[24]. For example, an athlete may base his or her expectations of an upcoming competition upon prior experiences they encountered while competing. The mindfulness of an athlete when faced with a stressor could lessen the degree to which he or she perceives it as a threat[24]. This simply means that if an athlete can mentally prepare for the competition he or she will soon be faced with, preparation may provide the athlete with greater confidence to achieve success, suggesting that individuals have the ability to reappraise a stressful situation[24].

Athletes who feel they have total control over a situation tend to achieve greater outcomes than those who feel they have limited control over the situation[24]. Controllability is typically associated with learning. Athletes who experience failure may attribute their failure to lack of controllability, which would entail lack of skill and ability[24]. Relevant to Weiner's attributional theory of achievement motivation and emotion[24] is an article by Dewar et. al.[7] addressing three theories proposed by Ames[1] and Jagacinski and Nicholls[10] which include the Achievement Goal Theory, the Differentiated Conception of Ability, and the Undifferentiated Conception of Ability. The Achievement Goal Theory states that individuals seek to develop or demonstrate competence when participating competitive tasks[1]. In the Differentiated Conception of Ability, effort and ability are differentiated from one another, and ability is constructed as capacity[10]. This simply means that ability is a learned skill, similar to controllability as stated in Weiner's article[24]. Individuals feel accomplished when they perform as well as others by putting in less effort or outperform others while exerting equal effort. In the Undifferentiated Conception of Ability, there is no difference between effort and ability, and more effort indicates higher ability. When using conception of ability, athletes achieve effortful accomplishment simply by showing competence during the task [7].

The Achievement Goal Theory and The Conceptions of Ability are then further categorized into two achievement goal tasks: task and ego involvement. Individuals who utilize task involvement evaluate their past performances to determine competence and feel successful when they improve or master a task[7]. Individuals who utilize ego involvement base the outcome of their performances on comparisons of their competitors and feel successful when they demonstrate superiority over others[7]. Ego involved individuals have proved to show greater feelings of anxiety when faced with an acute stressor and showed lower success levels compared to the task involved individuals, who tend to exhibit greater feelings of excitement and hopefulness when faced with an acute stressor and showed higher success levels[7].

1.5 Predicting Athletic Performance

In 2013, Moore and colleagues posed underlying mechanisms when determining how challenge threat states influence the outcome of athletic performance. The emotional response in appraisal of a challenge state, as Moore et. al. stated, is more favorable than the emotional response arising from perception of a threat state[14]. While this may seem like an obvious concept, Moore et. al. related this point to cognitive and somatic anxiety levels, which showed that positive emotions and facilitative interpretations (or interpretations that lead to hopefulness) of emotions are associated with successful athletic performance, while negative emotions and debilitative interpretations (or interpretations that lead to despair) of emotions are associated with unsuccessful performance[14]. The next point stated in Moore et. al.'s article is the divergent effects of attention accompanying each appraisal. Those who appraise a situation as a challenge state tend to focus on task-relevant cues, thus increasing their abilities and awareness in order to achieve their goal[14]. The latter applies to those who appraise a situation as a threat; those who appraise a situation as a threat state tend to focus on task-irrelevant cues and have a stronger tendency to focus on their own actions as opposed to the necessary actions needed to achieve the goal[14].

1.6 Stress Responses

In 2005, Gaab and colleagues conducted a study to determine the impact of general and situation-specific psychological measures of the neuroendocrine stress response during the presence of acute stress. In this study, the Trier Social Stress Test was used to determine psychological processes involved in the physiological mechanisms of HPA axis response and how are they related to the acute neuroendocrine stress response. Stress was assessed by measuring cortisol levels in the saliva of the participants. In this experiment, stress was defined as the result of a cognitive appraisal process resulting in an emotional, physiological, and behavioral stress response. The measures of this study included saliva samples that were centrifuged to measure cortisol levels, the Competence and Control Orientation (assessed 'self-concept of own competence, control expectancy: internality, control expectancy: powerful other's control, control expectancy: chance control'), and the Visual Analog Scale (assessed perceived stress, challenge, self-concept, and perceived control after cessation of the TSST). In this experiment, Gaab et. al. established the Primary and Secondary Appraisal Scale (PASA), which was used to measure the participants' primary appraisals of either a challenge or a threat state and the participants' secondary appraisals of their self-concept of their own abilities and control expectancy[9]. Their results showed that that an individual does not necessarily appraise a given situation in the same way in which he or she appraises situations in general[9]. This means that the influence of situation-specific factors is stronger than the influence of general personality factors on a given biological response. They also found that the retrospective perception of a situation doesn't adequately explain cortisol responses to the respective situation[9]. This means that cortisol levels do not necessarily indicate an individual's perception of a challenge or threat state.

1.7 Adaptive Appraisal And Physiological Responses

Jamieson and colleagues conducted a study in 2012 to test whether altering appraisals of stress arousal was sufficient to promote a more adaptive physiological response and decrease attention to emotionally negative information. In their study, participants were randomly assigned to one of three conditions to test the effects of reappraisal: the "reappraisal" condition in which participants were instructed that arousal is functional and aids performance, the "ignore external cues" condition which was an attention reorientation control designed to rule out the possibility that any face-valid attentional intervention is sufficient to improve outcomes, and the "no intervention control" condition[11]. A variety of measures were used in the study including the Trier Social Stress Test (TSST) to evoke the stress, the Stroop Task to assess attentional bias, electrocardiography (ECG), Impedance cardiography (NICO), blood pressure to measure cardiac output (CO) and total peripheral resistance (TPR) between challenge and threat states, and the Positive and Negative Affect Scale (PANAS) to measure positive/negative affect[11]. Jamieson et. al. hypothesized that "reappraisal" participants would demonstrate improved acute cardiovascular functioning and reduced attentional bias for emotionally negative information relative to ignore and no-intervention participants[11]. The results showed that "reappraisal" participants reported higher levels of perceived resources than the "no intervention" and "ignore" participants[11]. After completing the TSST, participants reported that they expended more effort than they expected to prior to the experiment[11]. Participants instructed to reappraise arousal exhibited lower TPR reactivity than participants assigned to the no-intervention and ignore conditions[11]. Reappraising arousal led to lower peripheral resistance compared with the control conditions. "Reappraisal" participants also displayed elevated CO compared with those in the "no-intervention" and" ignore" conditions[11]. The reappraisal condition was associated with lower TPR and greater CO, which indicates a more adaptive physiological response while engaged in a motivated performance task, and

participants instructed to reappraise arousal demonstrated less attentional bias for emotionally negative information versus the ignore condition and the no-intervention control[11].

1.8 Hypotheses

An athlete's perception of a challenge or threat state during athletic performance accompanied by physiological characteristics, impacts the athlete's overall performance. Previous literature has surfaced the importance of measuring cardiovascular reactivity after an athlete's perception of a challenge or threat state, and after athletic performance to determine if the cardiovascular reactivity reflects the physiological responses associated with perception of a challenge or threat state. Because previous research has not actually used a sports related task to measure athletic performance, I decided to create an experiment in which athletes performed a physical task that is common across all sports to understand how appraisal and physiological patterns affect the performance of an athlete. I hypothesized that athletes who perceive stress as a challenge would show an increase in heart rate and a decrease blood pressure, resulting in high athletic performance. I also hypothesized that athletes who perceived stress as a threat would show an increase in heart rate and an increase in blood pressure, resulting in low athletic performance.

2. Methodology

2.1 Research Design

In this study participants were asked to run a timed half mile and given a set of written instructions, randomly assigning the athletes to appraise the task as a challenge or a threat. The study consisted of matched pairs (30) of equal gender, sport, and ability. Baseline physiological effects (blood pressure and heart rate) were first measured. Then, the athletes were given written instructions that dictated appraisal as a challenge or a threat. Next, athletes were given the Primary Appraisal and Secondary Appraisal Scale[9] to measure their appraisal of the stressor. After completing the Primary and Secondary Appraisal Scale[9], pre-performance measures of heart rate and blood pressure were obtained. Then, the competition took place. Athletes ran a timed half mile, and athletic performance was measured as "high" or "low" based on the athletes' half mile times. Immediately after competition, post-performance physiological effects (blood pressure and heart rate) were measured. (Figure 1).

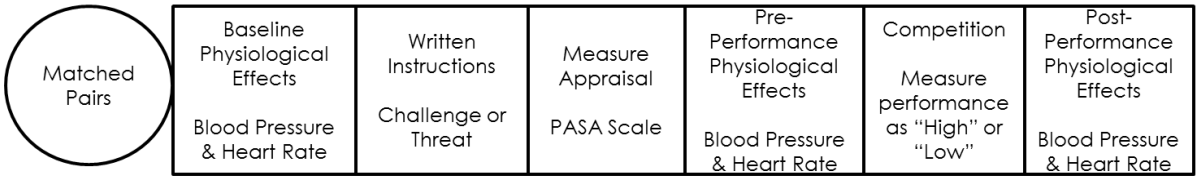

Figure 1. Stress appraised as a challenge will result in successful athletic performance accompanied by cardiovascular patterns displaying an increase in heart rate and a decrease in blood pressure. Stress appraised as a threat will result in unsuccessful athletic performance accompanied by cardiovascular patterns displaying an increase in heart rate and an increase in blood pressure.

2.2 Materials And Apparatus

The materials and apparatus used for this experiment included two WrisTech Blood Pressure Monitors Model HL 168, a stopwatch, and the Primary and Secondary Appraisal Schedule[9]. Primary appraisals are the athlete's perception of either a challenge or a threat state. Some items listed in the PASA Scale that measure primary appraisal include "I do not feel threatened by the situation," "I do not feel worried because the situation does not represent any threat for me," and "The situation is not a challenge for me." Secondary appraisals are the athlete's acknowledgment of the relevance and importance of the situation to his or her well-being. Secondary appraisals include self-efficacy and control expectancy. Items listed in the PASA Scale that measure secondary appraisals include "In this situation I know what I can do," "I have no idea what I should do now," and "In this situation I can think of lots of action alternatives."

2.3 Procedure

Participants were selected in yoked pairs (30) matched on gender, sport, and ability. Participants were asked to meet the investigator at the track where they first given an informed consent.

After agreeing to the informed consent form, baseline measures of the athletes' heart rate and blood pressures were obtained. Athletes then received a set of written instructions which described a general scenario regarding their placement on a sports team based on their performance of the task that either elicited a perception of a challenge state or a threat state .The written instructions for the participants assigned to the challenge condition state,

> "Imagine yourself in the beginning of your sport's season and your coach is trying to determine who he/she thinks will contribute most to the team's success. To determine the athletes that provide the most attributes to the team, your coach asks you and your teammates to run a timed half mile to test your fitness level. To earn your position on the team, you are required to run a timed half mile. If your half mile time meets the standard half mile time for your gender, you will earn your position on the team. Your goal is to obtain a spot on the team by running a half mile time equivalent to or better than the required half mile time. You and your teammate are working together to achieve your positions on the team, so it is important that you push each other to obtain your best half mile time."

The written instructions for the participants assigned to the threat condition state,

> "Imagine yourself in the beginning of your sport's season and your coach is trying to determine who he/she thinks will contribute most to the team's success. To determine the athletes that provide the most attributes to the team, your coach asks you and your teammates to run a timed half mile to test your fitness level. To earn your position on the team, you are required to run a timed half mile. If you fail to meet the required half mile time for your gender, you will not obtain the privilege of participating on the team. Your goal is to run a half mile equivalent to or better than the required half mile time. Your time will be compared to the times of your teammates, so it is important that you run a better half mile time than that of your partner, because you are both competing for that spot on the team."

After receiving these instructions, athletes were then presented with the "Primary and Secondary Appraisal Scale" (PASA)[9] which was used to measure the athletes' primary appraisals and secondary appraisals. Pre-performance measures of heart rate and blood pressure were obtained to observe the change in cardiovascular patterns after perception of a challenge or threat state from the participants' baseline measures.

Next, the athletes were asked to run a timed half mile with their partner. After completing the timed mile, the times were immediately recorded to the exact minute and seconds. Athletic performance was measured as either high or low based on which athlete had the higher half mile time (indication of low athletic performance) and which athlete had the lower half mile time (indication of high athletic performance).

After recording the half mile times of the athletes, post-performance blood pressure and heart rate were obtained. Post-performance measures were obtained in the exact same manner as the baseline measures were obtained. After post-performance measures were obtained, athletes were then given a debriefing form providing them with contact information if they have any follow-up questions pertaining to their participation in the experiment.

3. Data

3.1 Appraisals

A 2 (instruction) x 2 (appraisal) related measures ANOVA was used to determine the interaction between instructions (challenge or threat) and appraisal (challenge or threat). The results indicate a significant main effect on appraisal type on appraisal ratings, $F\ (1, 18) = 88.32$, $p < 0.001$, $\eta^2 = 0.83$, which verifies that athletes reported higher challenge than threat on the PASA scale. The results also indicate a significant interaction of instructions with appraisal type on appraisal levels, $F\ (1, 18) = 4.34$, $p = 0.026$ $\eta^2 = 0.19$. This finding verifies that the challenge instructions properly invoked the challenge appraisal, however, the threat instructions invoked higher challenge appraisals than threat appraisals, as athletes displayed higher means for appraising the task as a challenge than they did a threat when placed in the threat condition. A graph of these appraisals and their averages based on condition are shown in Figure 2. Though no predictions were made regarding secondary appraisals of control expectancy and self-efficacy, the results did indicate a significant main effect of instructions on secondary

appraisals which entail higher self-efficacy, F (1, 18) = 6.75, p = 0.018 η^2 = 0.273, and control expectancy, F (1, 18) = 5.869, p = 0.26 η^2 = 0.246, for athletes in the challenge condition and lower self-efficacy and control expectancy for athletes in the threat condition. These findings are consistent with previous research and descriptive statistics of secondary appraisals are shown in Table 1.

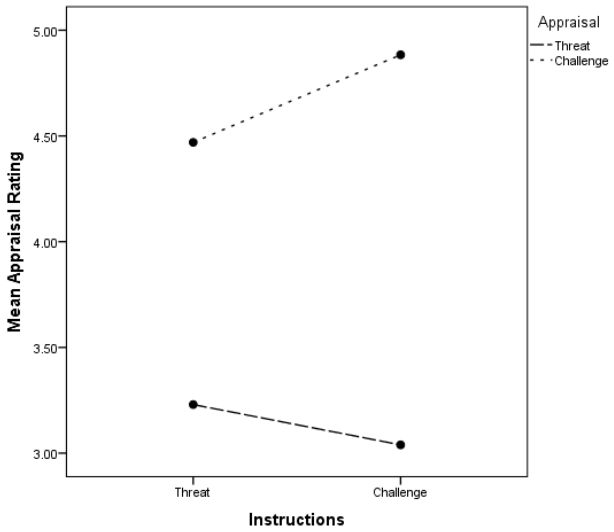

Figure 2. Athletes in the threat condition displayed higher means for perceiving the task as a threat as opposed to those in the challenge condition. Athletes in the challenge condition displayed higher means for perceiving the task as a challenge as opposed to perceiving the task as a threat.

Table 1. Average Secondary Appraisals Based on Condition

Appraisal	Challenge	Threat
Self-efficacy	4.90(0.71)	4.36(0.38)
Control Expectancy	5.11(0.65)	4.79(0.47)

*Note: Standard deviations indicated in parentheses

3.2 Physiological Measures

Three 2 (instructions) x 2 (gender) x 3 (time) repeated measures mixed ANOVAs were used to determine the interaction between instructions (challenge or threat) and time (baseline, pre-performance, and post-performance), and a related measures ANOVA was used to measure the physiological measures. The results indicate a significant main effect of increase in heart rate between the three times, F (2, 36) = 214.89, $p < 0.001$ η^2 = 0.923. This finding is consistent with the first hypothesis that athletes in both the challenge and the threat condition will show an increase in heart rate between baseline, pre-performance, and post-performance measures. The results also indicate no significant main effect for instructions on heart rate, F (1, 18) = 0.037, $p < 0.89$ η^2 = 0.002. This finding suggests that the instructions did not influence the change in heart rate, consistent with the hypothesis that a change in heart rate will take place regardless of instructions. The descriptive statistics of heart rates are shown in Table 2.

Table 2. Average Heart Rate Measures

Time	Challenge	Threat
Baseline	82.75(15.08)	83.80(17.35)
Pre-performance	91.60(15.87)	91.00(17.58)
Post-performance	143.45(24.76)	145.00(24.62)

*Note: Standard deviations indicated in parentheses

The results do not indicate a significant main effect of change in systolic blood pressure between the three measures. The results also do not indicate a significant main effect of change in diastolic blood pressure between the three measures.

3.3 Performance

A 2 (instructions) x 2 (gender) related measures ANOVA was used to determine the impact of instructions on performance. The results indicate that instructions did have a significant main effect on athletes' performances, F (1, 18) = 6.70, p > 0.02, η^2 = 0.21. Athletes in the challenge condition displayed significantly quicker half mile times than those in the threat condition. This finding is consistent with the hypothesis that athletes in the challenge condition will show high athletic performance while athletes in the threat condition will show low athletic performance. The means and standard deviations of athletes' half mile times are displayed in Figure 3 measured in minutes and seconds.

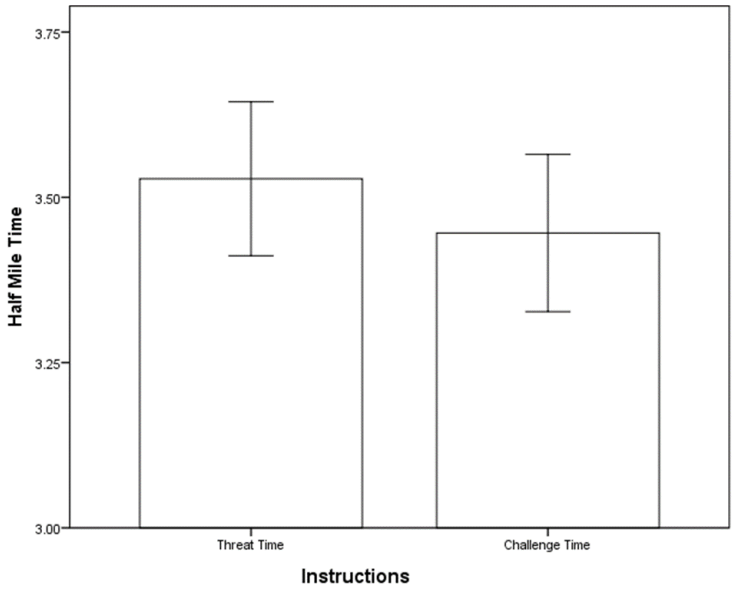

Figure 3. Athletes in the Challenge condition displayed quicker half mile times than athletes in the Threat condition, indicating high athletic performance for athletes in the challenge condition and low athletic performance for athletes in the threat condition. The bars indicate standard deviation measured in seconds. The 8s significance indicates approximately a 50 meter lead in a half mile race.

4. Conclusion

4.1 Primary Findings

The purpose of this study was to determine how the impacts of an athlete's appraisal of a challenge or threat state impact his or her overall athletic performance using a sports-related task. The findings suggest that athletes who perceive stress during competition as a challenge show higher athletic performance and an increase in heart rate, however, they did not show a decrease in blood pressure. The athletes who perceive stress during competition as a threat show lower athletic performance and an increase in heart, however, they did not show an increase in blood pressure. The athletes in the challenge condition tend to show higher levels of self-efficacy and control-expectancy, suggesting that these athletes feel that they have the resources necessary to meet the demands of the task and feel that they have greater control over the outcome of the task. Athletes in the threat condition tend to show lower levels of self-efficacy and control expectancy, suggesting that they feel that they do not have the necessary resources to meet the demands of the task and therefore have less control over the outcome of the task.

4.2 Implications

The implications of this study could be to help athletes who perceive stress during performance as a threat alter their appraisal to a perception of a challenge in order to achieve better athletic performance. The reappraisal of a threat to a challenge state, however, involves the prediction of emotion. Previous research suggests that a relationship exists between achievement goals and affective outcomes based on emotion. Emotion is a cognitively appraised response to an event and is triggered by a specific stimulus[12]. Challenge appraisal is associated with a positive outcome, and is typically associated with emotions of hope and excitement[12]. Threat appraisals are associated with the expectation of a negative outcome for the task, and are typically associated with negative emotions of anxiety and failure[12]. Task-involvement and ego-involvement are two types of emotional indicators that predict emotion when an athlete is faced with a stressor. Task-involved individuals tend to focus solely on completion of the task with mastery and display high levels of perceived competence when presented with a task. Ego-involved individuals, however, focus on completion of the task and display lower levels of perceived competence when faced with a stressor and higher levels of anxiety, tension, and apprehension[12].

An athlete can reappraise a situation from a threat to a challenge by changing his or her mentality to task-involvement rather than ego-involvement. Rather than focusing on measuring up to the performance or standards of others (as ego-involved athletes tend to do), athletes should alter their mindset to become task-involved and focus on accomplishing the task at hand with mastery, even if that athlete does not out-perform others. Task-involved individuals achieve much better outcomes than those who are ego-involved because these individuals are not constantly comparing themselves to others.

4.3 Strengths Of Study

One of the strengths of this study was the use of an actual sports-related task to measure athletic performance. While previous research has used other strategies, such as the Trier Social Stress Test[11] or a variety of evaluations (such as the Positive and Negative Affect Scale) measuring stress appraisals and performance[9], this study allowed athletes to participate in a task that is common across all sports: running. The use of a running task accurately measured performance by evaluation of the half-mile times.

Another strength of this study was the use of dyads matched on gender, sport, and athletic ability. The use of matched pairs made it a fair comparison between the two athletes in each condition. Matching athletes on sport and athletic ability also proved to be a strength because it ensured that the two athletes had experienced the same training. By matching athletes based upon sport, it also helped the athletes imagine the situation presented in the instructions more vividly.

4.4 Limitations

Failure to obtain cortisol samples was one weakness of this study. By obtaining a cortisol sample through saliva, stress levels would have been more accurately measured. Another limitation of this study was the failure to measure galvanic skin responses. By using electromyography to measure muscle tension, a more accurate evaluation of stress would be obtained through observation of a change in facial muscular tension/relaxation and through skin conductance by observation of vein constriction.

4.5 Areas Of Future Research

Future research may be conducted to determine how the presence of an audience impacts an athlete's appraisal of stress during competition and how the presence of the audience impacts the athlete's performance. The audience effect, a concept studied by Norman Triplett in 1898, is a form of social facilitation through the presence of a spectator or audience[22]. A studied conducted by Travis[21] found that subjects performed better in a psychomotor task in the presence of an audience, while Pessin[17] found that subjects actually struggled to successfully complete a task in the presence of an audience. Therefore, further research is necessary to make a generalized conclusion on how the impact of an audience affects the outcome of a person's performance on a task.

In accordance with the presence of an audience impacting appraisal and performance, perhaps a closer look into athlete-coach relationships may also be observed. Previous research has indicated that athletes who have stronger relationships with coaches tend to perform better because they are more motivated to achieve better athletic performance based on the coach-athlete motivation model (CAMM) [18]. Further areas of research may apply this model in conjunction with physiological measures to observe an athlete's appraisal of a stressor during performance, the impact of an audience or coach, and how these elements impact the athlete's performance.

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