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The Protective Impact of Learning to Juggle in a Caring, Task-Involving Climate Versus an Ego-Involving Climate on Participants’ Inflammation, Cortisol, and Psychological Responses

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Abstract.

The impact of motivational climate on physiological responses to psychological stress remains largely unknown. The purpose of this experimental investigation was to examine the psychological and physiological stress and motivational responses of college students (N=57, *Mage* = 20.34) during a 30-minute instructional juggling session that was either caring, task-involving (C/TI) or ego-involving (EI). Cortisol and inflammation were assessed at six time points over the 2-hr study, and participants completed pre- and post-questionnaires. As hypothesized, the EI climate elicited concerning responses including greater psychosocial and state cognitive stress, negative affect, and cortisol, while the C/TI climate yielded adaptive responses including what may be a multifaceted physiologically protective mechanism to performance-related stress. Specifically, the C/TI climate yielded greater sTNFαRII, performance and social self-esteem, positive affect, and coping appraisals. Results suggest C/TI climates procure psychological and physiological responses that facilitate performance and well-being and foster a greater interest in physical activity.

Keywords: achievement goal perspective theory, motivational climate, performance stress, TNF, psychosocial stress

**Introduction**

The psychological stress that often accompanies physical activity-based performance-based settings can trigger a constellation of physiological and psychological responses that have a direct impact on athletic performance and participant well-being (Hogue, Fry, & Fry, 2017; Quested, Bosch, Burns, Cumming, Ntoumanis, & Duda, 2011). Whether the impact of performance stress is advantageous or acts counter to these aims is largely dependent on the psychosocial environment cultivated by leaders in performance contexts (i.e., the motivational climate). In achievement goal perspective theory (Nicholls, 1984; Nicholls, 1989), Nicholls argues that the motivational climate can be perceived as either task-involving or ego-involving, depending on the structure of the activities and feedback participants are given. In a task-involving climate, effort and personal improvement are rewarded, cooperation is encouraged, mistakes are treated as part of the learning process, and efforts are made so that each person feels he/she has an important role to play. In contrast, in an ego-involving climate, winning and outperforming others are of utmost importance, participants are pit against and compared to one another, mistakes are punished, and the best performers (e.g., “star” players) receive the majority of attention and recognition. Achievement goal perspective theory researchers have also shown that the motivational climate is made up of interpersonal relationships that reflect feelings of care, respect, belongingness, and safety (i.e., a caring climate; Newton et al., 2007).

While a body of literature has linked performance-based settings perceived to be highly caring and task-involving to advantageous cognitive, affective, and behavioural outcomes and ego-involving climates with maladaptive outcomes (Fry & Moore, 2018; Harwood, Keegan, Smith, & Raine, 2015), relatively little is known about how the motivational climate impacts the physiological responses of participants in relation to stress. Therefore, the purpose of this experimental investigation was to explore the psychological stress and motivational responses, as well as the physiological responses of participants (to psychological stress) in a performance-based setting manipulated to be either a caring, task-involving or an ego-involving motivational climate. Specifically, this study investigated how the perceived motivational climate impacts participants’ inflammation and cortisol, appraisals of stress and coping resources, social and performance self-esteem, affect, pride in accomplishments, and excitement to continue practicing a new physical activity-based skill (i.e., juggling).

In developing social self-preservation theory, Dickerson, Gruenwald & Kemeny (2004) helped to identify and explain many of the consequences of psychosocial stress in achievement settings. Dickerson et al. (2004) argue that threats to the social self (i.e., threats to social esteem, social status, and acceptance) elicit a coordinated response including emotional (e.g., shame) and physiological (e.g., cortisol) responses that adversely affect health. Cortisol is a physiological measure of stress with implications for mental and physical health and can be impacted by psychosocial factors that make up the motivational climate. For instance, reliable and robust psychosocial triggers of this coordinated, maladaptive stress response include feeling socially-evaluated and/or as though one does not have control over his/her own success in a performance context (i.e., uncontrollability; Dickerson, Gable, Irwin, Aziz, & Kemeny, 2009; Dickerson & Kemeny, 2004; Kemeny, Gruenewald, & Dickerson, 2004). Importantly the psychosocial triggers and subsequent responses proposed in social self-preservation theory are either characteristics of or correlates of ego-involving climates.

Experimental investigations have causally linked perceptions of an ego-involving climate to maladaptive stress responses that align with the predictions of social self-preservation theory (Breske, Fry, Fry, & Hogue, 2017; Hogue, 2019, Hogue, Fry, & Fry, 2017; Hogue, Fry, Fry, & Pressman, 2013). This research demonstrates that an ego-involving climate may present a threat to the social self for many participants. As a result, an ego-involving climate often yields problematic responses that likely extend beyond the psychological, affecting the physical health and well-being of participants. For instance, an experimental investigation conducted with college students linked perceptions of an ego-involving climate with the experience of social-evaluative threat, self-consciousness, uncontrollability, and shame, and triggered a spike in salivary cortisol (Hogue, Fry, Fry, & Pressman, 2013). Likewise, in a similar experimental investigation with youth participants who were taught to juggle in an ego-involving climate resulted in notable elevations in cortisol, as well as significantly higher levels of negative affect, humiliation, and stress compared to youth who learned how to juggle in a caring, task-involving climate (Hogue et al., 2017). Youth in the ego-involving group also reported feeling evaluated by their peers during the instructional juggling session and rated themselves much lower in a measure of social status (related to peer acceptance) compared to those placed in a caring, task-involving climate.

In stark contrast to ego-involving climates, the defining characteristics of a caring climate mirror the type of social support believed to elicit a protective physiological response to stress, including feeling cared for, respected, and having a sense of belonging (Cohen & McKay, 1984; Cohen & Pressman, 2004; Cohen & Wills, 1985; Reblin & Uchino, 2008). Emotional support is believed to be especially important in eliciting a protective physiological response when experiencing stress, as long as the demands of a situation are reasonably within reach for the participant (Uchino, 2006). Research on thriving suggests that responsive social support in challenging settings yields more adaptive responses in participants, thus enabling them to better handle performance pressure in the future, while also helping protect them from the negative physiological and psychological implications of stress (Feeney & Collins, 2015). Feeney and Collins (2015; p. 118) propose a model of thriving that places relationships at the centre and argues a caring-like climate that includes, “safety and protection; relief from burdens; emotional or physical comfort; a comfortable environment for the expression of negative emotion and vulnerability; expressing empathy, understanding, acceptance, reassurance; shielding and defending…” helps procure advantageous psychological, behavioural, and physiological responses to performance stress.

Performance settings where leaders emphasize both caring and task-involving features are consistently associated with positive outcomes that align with Feeney and Collins model of social support and thriving (Fry & Gano-Overway, 2010; Fry & Moore, 2018) and suggest the psychosocial threats identified in the social self-preservation theory are minimized. For example, a pronounced decrease in salivary cortisol levels after exposure to a caring, task-involving climate was found in an experimental investigation with college students, which led researchers to believe that caring, task-involving climates may actually buffer participants’ physiological responses to psychological stress in performance contexts (Hogue et al., 2013). Research also indicates that positive social support in the form of a leader-driven caring, task-involving climate promotes positive interpersonal behaviours of participants, including better sportspersonship, greater empathy, and more caring behaviours toward others (Fry & Gano-Overway, 2010; Iwasaki & Fry, 2013). Moreover, the Hogue et al., (2017) experimental investigation with youth linked caring, task-involving climates to markedly higher levels of positive affect, interest in continuing to participate, and a near complete absence of shame-related emotions.

Psychosocial stress, however, is inherent within group-based performance contexts (e.g., sport), and it is important researchers investigate how to protect participants against the negative effects of performance stress in order to help optimize their experiences and well-being. For example, psychosocial stress can trigger tumor necrosis factor-α (TNF-α), a marker of inflammation (Dickerson et al., 2009; Segerstrom & Miller, 2004). TNF-α has many important protective and regulatory functions pertinent to sport performance, but can also present a threat to health and well-being when not properly regulated. For instance, TNF-α plays a role in bronchoconstriction (Schnyder-Candrian et al., 2005) and a number of pain models, many of which limit flexibility and mobility (Zhang & An, 2007). Moreover, elevated TNF-α delays wound healing (Glaser et al., 1999), is positively correlated with burnout (von Känel, Bellingrath, & Kudielka, 2008), and increases the risk for depression and negative mood states (Raison, Capuron, & Miller, 2006). A soluble receptor for TNF-α, sTNFαRII, was used in the current investigation to identify a protective physiological response, as it has been shown to inhibit TNF-α (Heaney & Golde, 1998) and is more stable and less invasive to measure than TNF-α directly (Diez‐Ruiz et al., 1995).

State cognitive stress and coping appraisals also help researchers assess how well participants handle performance pressure. The Primary Appraisal/Secondary Appraisal Scales (PASA; Gaab, Rohleder, Nater, & Ehlert, 2005), for example, measures perceptions of threat and challenge (i.e., primary “stress appraisal”) and perceptions of competence and control (i.e., secondary “coping appraisal”). The better equip participants feel they are to handle performance pressure, the more adaptive the outcome is expected to be. In contrast, greater stress appraisals are believed to elicit a maladaptive response. In one relevant example, Gaab et al. (2005) linked both anticipatory and retrospective stress appraisals with cortisol elevations.

Because psychological stress, inflammation, and cortisol have the potential to adversely impact athletic functioning and participant well-being, it is important to investigate these relationships. As such, the purpose of this study was to examine participant inflammation and cortisol responses, as measured by sTNFαRII and salivary cortisol, to an experimentally manipulated motivational climate intervention. As a secondary purpose, state cognitive stress, affect, state self-esteem, and individual items examining motivational and stress-related responses were assessed. We hypothesized the caring, task-involving condition would yield more adaptive psychological and physiological stress and motivational responses than the ego-involving climate.

**Materials and Methods**

***Sample Characteristics***

The sample included primarily Caucasian (81%) university students (*n* =57, age range: 18-30 years, *Mage* = 20.34, *SD* = 2.48). Pre-screened participants were separated by gender and randomly assigned to a caring, task-involving or an ego-involving climate, resulting in the following: (1) males in a caring, task-involving climate (*n* = 15), (2) females in a caring, task-involving climate (*n* = 13), (3) males in an ego-involving climate (*n* = 14), and (4) females in an ego-involving climate (*n* = 15). Students who did not adhere to the pre-study instructions, were in poor health, and/or had taken a sport psychology class were excluded from the physiological analyses, resulting in: (1) males in caring, task-involving (*n* = 8), (2) females in caring, task-involving (*n* = 8), (3) males in ego-involving (*n* = 11), and (4) females in ego-involving (*n* = 10).

After receiving IRB approval (STUDY00000361) from the University of Kansas, participants from a large Midwestern university were invited to participate in a study examining physiological responses to learning a new skill (i.e., juggling) in a group setting, via class announcements and fliers. Participants were screened for potential confounds to the physiological assessments (i.e., acute or chronic illness, psychological disorders, medication intake, smoking more than 5 cigarettes/day, consuming more than 12 alcoholic drinks/week, or current pregnancy or breast-feeding), and prior to arrival were asked to avoid exercise for 48 hrs, more than 2 alcoholic drinks the day before, alcohol on the day of, caffeine and food 2 hrs prior, and dairy and smoking 1 hr prior.

***Procedure***

A timeline of activities and sample collection is provided in Figure 1. To control for diurnal variation in inflammation and cortisol, the study began at 4:00 p.m. (Kudielka, Schommer, Hellhammer, & Kirschbaum, 2004; Pruessner et al., 1997). Once consent was received, participants were given instructions on how to provide their saliva samples (i.e., cotton roll under the tongue and OraSure device swiped between the lower gums and lip). This was the first (*t =* -20 min) of the two baseline samples. Participants then completed the pre- questionnaires and were led to a gymnasium where the intervention was to take place. Immediately prior to the start of the juggling session participants provided the second baseline samples (*t =* 0). Three response samples were collected after the 30-minute juggling session (*t = +*30, +45, and +60 min), along with a return to baseline sample (*t = +*90 min), while participants completed post-session questionnaires and then sat in a neutral environment.

Juggling was selected for the physical activity-based achievement setting because the Hogue, Fry, Fry and Pressman (2013) protocol has been validated as a reliable means of creating both a caring, task-involving climate and an ego-involving climate in a short period of time (Breske, Fry, Fry, & Hogue, 2017; Hogue, 2019; Hogue, Fry, Fry, 2017; Hogue, Fry, Fry, and Pressman, 2013). Juggling also “levels the playing field” and can be challenging for both athletes and non-athletes to learn. Furthermore, the act of juggling itself is not likely to trigger an inflammatory response or rise in cortisol.

Graduate and undergraduate students from the investigators’ university took part in a series of training sessions in order to develop a greater understanding of achievement goal perspective theory and how to foster each climate as either an instructor or a confederate. The instructional juggling sessions followed the Hogue, et al. (2013) juggling study protocol, where researchers developed the activities to help balance the amount of physical expenditure and social evaluation (e.g., number of observers) for participants in the caring, task-involving and ego-involving groups. The activities also mirrored one another but reinforced their respective features. In the caring, task-involving group cooperative activities were chosen, participants were encouraged to help one another learn and reach group goals, instructors made an effort to speak to all participants and to treat them equally, and mistakes were treated as part of the learning process. In the ego-involving climate, instructors gave the majority of praise and recognition to the confederates, punished mistakes (e.g., took a ball away), and pit participants against one another during competitive, win/lose games where the importance of winning was emphasized. In order to help foster each respective climate, confederates pretended to be participants, but were trained to reinforce the features of the assigned climate for that particular session. They also knew how to juggle but pretended to learn just a little faster than the other participants. Also, in the ego-involving climate they received the majority of praise and competed against other participants. While in the caring, task-involving climate they helped other participants learn and made an effort to get to know them.

The juggling activities for the caring, task-involving group began with a 5-minute icebreaker where participants and instructor began learning everyone’s name. Three minutes were taken to provide detailed instruction on how to juggle, followed by 5-minute of practice. In the first 5-minute activity participants repeatedly juggled for 30 seconds and tried to beat their personal best. For the second 5-minute activity participants were placed in a group and helped teach one another how to juggle. For instance, one participant from each group juggled in front of their peers for 30-seconds as they helped coach the juggler. Each participant was given an opportunity to be the juggler. Participants were encouraged to identify what the juggler was doing well and to provide a tip for how they can improve, based on how well the juggler has mastered the skill of juggling as it was taught to the group (e.g., work to correct nonuniform tosses or the timing of the release of the second ball). In the final 5-minute activity groups juggled for 30 seconds, repeatedly, as they reflected on what they were doing well, how they could improve, and tried to beat their collective best.

The ego-involving climate began with a 5-minute icebreaker where participants shared their greatest sport achievement. The was followed by the same 3-minute instruction on how to juggle that the caring, task-involving group was given. The ego-involving participants then practiced for 5-minute in an ego-involving climate. In the next 5-minute activity instructors began ranking participants on a scale of 1 (best) -10 (worst) as they practiced juggling. They were then placed in groups for the next 5-minute activity. Participants juggled in front on their peers while they counted successful toss-to-catch scores. The final 5-minute activity included a championship match of juggling between two teams that included all participants.

***Physiological Assessments***

Participants provided oral samples at six time points throughout the 2-hour study, including six saliva samples to assess cortisol and six oral mucosal transudate (OMT) samples to assess sTNFαRII levels (See Figure 1 for timeline). Both saliva, via Salivettes (Sarstedt, Nümbrecht, Germany), and OMT, via OraSure collection devices (Epitope, Beaverton, Oreg.), were collected simultaneously. All samples were stored at -80° C until assayed, in duplicate, using R&D Systems (Minneapolis, MN) Quantikine Human sTNFαRII enzyme immunoassay (EIA) kits for OMT samples and Salimetrics EIA kits (Salimetrics, State College, PA) for cortisol. Concentrations were determined following the manufacturers’ assay procedures.

In order to determine the quantity of sTNFαRII for each sample, the analyte to protein ratio was calculated using the Bradford method-based Bio-Rad Colorimetric protein assay kit II with bovine plasma albumin. The mean sTNFαRII and cortisol intra-assay CV% was 4.7% and 3.2%, while the inter-assay CV%’s were 7.1% and 4.8%, respectively.

***Motivational Climate Perceptions***

The Perceived Motivational Climate in Sport Questionnaire (Seifriz, Duda, & Chi, 1992) and Caring Climate Scale (Newton et al., 2007) were used to examine climate perceptions. Students responded to statements using a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Composite scores were calculated by averaging the items for each respective scale. Each item had the stem, *“*During the juggling session…”.

*Task- and Ego-involving Climates*

The 21-item Perceived Motivational Climate in Sport Questionnaire has two scales that assess the extent to which participants perceive task-involving and ego-involving features of the motivational climate. Sample items include, “…each participant’s improvement was important” (task), and, “…out-playing the other participants was important*”* (ego). The Perceived Motivational Climate in Sport Questionnaire has demonstrated adequate psychometric properties (Seifriz et al., 1992).

*Caring Climate*

The 13-item Caring Climate Scale was used to assess elements of caring including support and concern during the juggling session. A sample item is, “…the teachers accepted participants for who they are”. The Caring Climate Scale has previously demonstrated strong psychometric properties (Gano-Overway et al., 2009; Newton et al., 2007).

***Psychological Assessments***

*State Cognitive Stress*

The Primary Appraisal/Secondary Appraisal Scales (Gaab et al., 2005) were used to assess cognitive stress appraisals during the juggling session. The Primary Appraisal/Secondary Appraisal Scales is comprised of four subscales including “Threat” and “Challenge”, which form a Primary Stress Appraisal score (by averaging the threat and challenge responses) and “Competence” and “Control”, which form a Secondary Coping Appraisal score (by averaging the competence and control responses). An example reverse-scored threat (i.e., stress) item included, “I did not feel threatened during the juggling session”, while an example control (i.e., coping) item included, “I was able to determine a great deal of what would happen during the juggling session”. Each subscale consists of four items with responses on a 6-point scale ranging from 1-6: 1 (*strongly disagree*), 2 (*disagree*), 3 (*slightly disagree*), 4 (*slightly agree*), 5 (*agree*), to 6 (*strongly agree*)*.*The Primary Appraisal/Secondary Appraisal Scales have displayed adequate psychometric properties for use with an adult population (Gaab et al., 2005).

*Affect*

Feelings and emotions reflecting positive and negative affect during the juggling session were assessed using the Positive Affect and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS is a two-factor scale measuring both positive affect (e.g., inspired) and negative affect (e.g., afraid) on a scale from 1 (*very slightly or not at all*), 2 (*a little*), 3 (*moderately*), 4 (*quite a bit*),to 5 (*extremel*y)*.* Scores are summed to determine a composite score for each of the two, 10 item subscales. The PANAS is a well-validated and widely used measure of affect (Watson et al., 1988).

*State Self-Esteem*

The State Self-Esteem Scale(Heatherton & Polivy, 1991) was used to assess short-lived changes in self-esteem and consists of 10 statements which operationalize social, performance, and appearance self-esteem. Only the social and performance self-esteem subscales were examined in this study. A 5-point scale ranging from 1 (*not at all)*, 2 (*a little bit*), 3 (*somewhat*), 4 (*very much so*),to 5 (*extremely*) was used to assess items such as, “I was concerned about the impression I was making” (social self-esteem, reverse scored item) and “I felt I was as capable as others of learning to juggle” (performance self-esteem item). Scores for each scale (i.e., the social and performance self-esteem subscales) were averaged to determine the final composite scores. Psychometrics for this scale has been established (Heatherton & Polivy, 1991).

*Individual Items*

Five individual items were included in order to assess stress and shame-related responses (i.e., humiliation, embarrassment, stress, social-evaluation, and uncontrollability) during the juggling session. An example item is, “I felt like I did not have control over how much I learned during the juggling session” (i.e., the uncontrollability item). Three individual motivational items were included and examined participant responses to learning to juggle in their assigned motivational climate. These items assessed participants’ pride in their accomplishments, excitement to continue juggling, and whether they planned to continue juggling. Each item was assessed using a 7-point scale ranging from 1 (*not at all*), 3 (*somewhat*), 5 (*moderately*), to 7 (*very much so*) and a score for each item was calculated by averaging each respective group’s score on that item.

**Statistical Analyses**

A 2 (Climate: caring, task-involving vs. ego-involving) x 2 (Gender: men vs. women) ANOVA was used to assess differences in background characteristics (i.e., age, total sleep, menstruation cycle and oral contraceptive use for women, and race) between the caring, task-involving and ego-involving groups. Psychological responses were assessed using 2 (Climate) x 2 (Gender) MANOVAs. To assess fluctuations in salivary cortisol and sTNFαRII, two separate 2 (Climate) x 2 (Gender) x 6 (Time: *t* –20 vs. *t* 0 vs. *t* +30 vs. *t* +45 vs *t* +60 vs. *t* +90) mixed design, repeated-measures ANOVAs were used. Time of sample collection was treated as the within-subjects variable, and climate assignment and gender were treated as between subjects’ variables.

All alpha levels were adjusted with a Bonferroni correction, when necessary, and were set at .05. For assessments using repeated measures, when Mauchly’s test of sphericity determined heterogeneity of covariance, the results were assessed using Greenhouse-Geisser corrections. Investigations of single time point differences between climate groups were conducted using paired *t*-tests.

**Results**

Correlations and Cronbach’s alphas are presented in Table 1, while means and standard deviations for psychological measures are presented by climate and gender within each climate in Table 2. Group differences in individual items are presented in Figure 2. Results indicate random assignment was successful, in that there were no significant differences across groups.

***Manipulation Check***

*Motivational Climate*

As a manipulation check, a 2 (Climate) x 2 (Gender) MANOVA examining group differences in the perception of a caring, task-, and ego-involving climate was run. Results indicate climate assignment and climate perception were in agreement, with the caring, task-involving group perceiving a significantly more caring climate (*M* = 4.87 ± 0.24), *F* (1, 56) = 134.49, *p* < .001, η2 = .72 and TI climate (*M* = 4.38 ± 0.34), *F* (1, 56) = 49.40, *p* < .001, η2 = .48, and less ego-involving climate (*M* = 1.85 ± 0.51), *F* (1, 56) = 222.87, *p* < .001, η2 = .81, than the ego-involving group (*M*CARING = 2.99 ± 0.83, *M*TASK = 3.38 ± 0.66, and *M*EGO= 3.92 ± 0.55).

***Physiological Responses***

Figure 3 displays the salivary cortisol and sTNFαRII levels by climate for each of the six time points. The sTNFαRII values were skewed and were log transformed in order to correct for non-normality.

*Salivary Cortisol*

Results revealed a significant Time x Climate interaction, *F* (5, 25) = 3.59, *p* < .05, η2 = .42, suggesting salivary cortisol responses were significantly different between the caring, task-involving and ego-involving groups over time, and that climate explained approximately 42% of the variance. The ego-involving group responded with higher salivary cortisol levels post climate exposure compared to the caring, task-involving group. Follow up analyses by climate indicated the salivary cortisol levels of the caring, task-involving group decreased significantly from baseline levels at (*t = +*45 and +60) response measures, *t* (1, 14) = 2.32, p = .036, and *t* (1, 14) = 3.09, p = .008, respectively. In contrast, cortisol increased for the ego-involving climate group from baseline to (*t = +*30), immediately post juggling session, *t* (1, 17) = 2.20, p = .04. Results also revealed a non-significant 3-way interaction, *F* (5, 25) = .63, *p* = .68, η2 = .11, and a non-significant Time x Gender interaction, *F* (5, 25) = .86, *p* = .52, η2 = .15.

*sTNFαRII*

Results revealed a significant Time x Climate interaction, *F* (5, 36) = 3.34, *p* < .05, η2 = .39, suggesting sTNFαRIIresponses to the motivational climate intervention differed according to climate assignment, and that the motivational climate explained approximately 39% of the variance. the caring, task-involving group responded to the motivational climate intervention with significantly higher levels of the receptor, sTNFαRII. Follow-up analyses revealed a significant rise in sTNFαRIIfrom baseline levels to the response measure (*t* = +60) for the caring, task-involving group, *t* (1, 13) = 2.81, p = .015. There was a non-significant 3-way interaction, *F* (5, 26) = .94, *p* = .471, η2 = .15, and Time x Gender interaction, *F* (5, 26) = 1.16, *p* = .35, η2 = .18.

***Psychological Variables***

*State Cognitive Stress Appraisal*

Examination of group differences in the Primary Appraisal/Secondary Appraisal Scales revealed a significant main effect for climate *F* (2, 52) = 5.27, *p* < .01, η2 = .17, with the ego-involving group reporting greater cognitive stress during the intervention, as measured by perceived threat and challenge (i.e., Primary Appraisal), and the caring, task-involving group reporting greater coping, as measured by perceived control and competence (i.e., Secondary Appraisal) during the juggling session.There was also a significant main effect for gender, *F* (2, 52) = 4.36, *p* < .05, η2 = .14, with the males reporting greater control and competence, and females reporting greater threat and challenge. The Climate x Gender interaction was non-significant, *F* (2, 52) = 2.55, *p* = .09, η2 = .09.

*Affect*

Examination of group differences in positive and negative affect revealed a significant main effect for climate, *F* (2, 52) = 18.77, *p* < .001, η2 = .42, with the caring, task-involving group reporting more positive affect and less negative affect during the juggling session, compared to the ego-involving group. The main effect for gender, *F* (2, 52) = 1.14, *p* = .336, η2 = .04, and Climate x Gender interaction, *F* (2, 52) = .87, *p* = .424, η2 = .03 were non-significant.

*State Self-Esteem*

Examination of group differences in state social and performance self-esteem during the juggling session revealed a significant main effect for climate *F* (2, 52) = 5.74, *p* < .01, η2 = .18, with the caring, task-involving group reporting significantly higher social and performance self-esteem, relative to the ego-involving group. The main effect for gender, *F* (2, 52) = 1.58, *p=*.215, η2 = .06, and the Climate x Gender interaction, *F* (2, 52) = .257, *p =* .774, η2 = .010, were non-significant.

*Individual Items*

Stress-related items including shame-based feelings, humiliation and embarrassment, as well as perceptions of stress and social-evaluation during the juggling session were considered dependent variables in one MANOVA. In a separate MANOVA, adaptive motivational responses including feeling proud of one’s accomplishments during the juggling session and interest in and excitement to continue juggling in the future were treated as dependent variables.

*Stress-Related Items****.*** For the stress related items, there was a significant main effect for climate, *F* (4, 50) = 5.79, *p* < .001, η2 = .32, with the ego-involving group reporting feeling more humiliated (*M*EI = 3.13, *M*C/TI = 1.94), η2 = .25, embarrassed (*M*EI = 3.45, *M*C/TI = 2.56), η2 = .10, stressed (*M*EI = 3.45, *M*C/TI = 2.50), η2 = .08, and socially evaluated (*M*EI = 3.47, *M*C/TI = 2.05), η2 = .18, than the caring, task-involving group. There was a non-significant main effect for gender, *F* (4, 50) = 1.51, *p* = .214, η2 = .11, and a significant Climate x Gender interaction, *F* (4, 50) = 2.66, *p* < .05, η2 = .18, with females reporting experiencing significantly more humiliation than males in the ego-involving group.

*Adaptive Motivational Items****.*** Examination of the adaptive motivational items resulted in significant main effect for climate, *F* (3, 51) = 15.08, *p* < .001, η2 = .47, with the caring, task-involving group reporting being significantly more proud of their accomplishments during the juggling session (*M*EI = 3.00, *M*C/TI = 5.25), η2 = .41, greater interest in continuing to juggle in the future (*M*EI = 3.03, *M*C/TI = 5.61), η2 = .35, as well as excitement to continue juggling (*M*EI = 2.72, *M*C/TI = 5.39), η2 = .36, relative to the ego-involving group. There was a non-significant main effect for gender, *F* (3, 51) = .41, *p* = .745, η2 = .02, and a non-significant Climate x Gender interaction, *F* (3, 51) = 2.00, *p* = .126, η2 = .11.

**Discussion**

The purpose of the current study was to investigate whether learning a new physical activity-based skill in an achievement setting manipulated to be either a caring, task-involving or an ego-involving climate would differentially impact participants’ psychological and physiological responses related to performance stress and motivation. Specifically, cortisol, inflammation, perceptions of stress and coping resources, shame-related emotions, and motivational responses were examined. The present study extends the achievement goal perspective theory (Nicholls, 1984, 1989) literature by providing supporting evidence that an ego-involving climate may elicit a coordinated stress response that adversely impacts the motivation, health, and well-being of participants in a manner that aligns with the predictions of social self-preservation theory. In contrast, the responses of participants assigned to a caring, task-involving instructional juggling session were far more promising, procuring adaptive physiological and psychological responses that align with predictions of the stress buffering hypothesis (Cassel; 1976; Cobb, 1976; Cohen & Pressman, 2004).

For instance, the ego-involving group reported high levels of social evaluation and not having control over their own success during the juggling session, which may have potentiated a stress response commensurate to the response to social-self threats proposed in social self-preservation theory (i.e., threats to social esteem, social status, and acceptance). Such threats include doubting an individual’s capability in front of others, for example, and are believed to elicit a coordinated response that includes elevated cortisol and shame related emotions (e.g., humiliation and embarrassment). Participants in the ego-involving group not only responded in kind, but also reported experiencing cognitive stress (i.e., perceived greater stress than coping resources) and more negative affect during the juggling session compared to the caring, task-involving group. Moreover, self-ratings of social and performance self-esteem were notably lower for participants in the ego-involving group than those in the caring, task-involving group. Although these findings suggest an ego-involving climate may intensify more threatening aspects of performance stress, caring, task-involving climates seem to help participants better handle performance stress in achievement settings.

Results in the caring, task-involving group suggest participants had a better experience while learning juggle, felt more equip to master the skill of juggling, and performed better during the instructional juggling session (according to anecdotal reports from the confederates and instructors). Moreover, being taught in a supportive space where participants were encouraged to work together seems to have elicited a protective physiological response in participants. To begin, the caring, task-involving climate fostered a greater interest in and more excitement to continue juggling in the future compared to the ego-involving group. This is perhaps not surprising given the caring, task-involving participants also reported notably higher levels of positive affect, suggesting they had a more pleasurable experience while learning to juggle than the ego-involving group. Not only is positive affect an indicator of well-being, but it is believed to play a positive role in a wide range of health outcomes, including cardiovascular health, morbidly, and mortality (Pressman & Cohen, 2005; Pressman Jenkins, & Moskowitz, 2019).

With regard to psychological stress responses, the caring, task-involving group reported greater perceived control and competence, suggesting participants were better able to deal with the stress of learning a new activity-based skill among peers. Perceptions of both caring and task-involving features were also strongly correlated with perceived coping resources and moderately negatively correlated with perceived demands (cognitive stressors). These findings mirror those of the Hogue, Fry, Fry (2017) study with adolescents. The higher ratings of social and performance self-esteem in the current study by the caring, task-involving group indicate that caring, task-involving climates may promote better interpersonal-relations, while fulfilling both the need to connect with others and to feel capable of achieving success in performance settings. Performance and social self-esteem were also moderately and positively related to perceptions of both caring and task-involving features.

The physiological findings replicate and extend previous work by Hogue, Fry, Fry (2017) and Hogue, Fry, Fry and Pressman (2013) which also found that exposure to an ego-involving climate triggered a rise in salivary cortisol levels and a caring, task-involving climate resulted in a decline in salivary cortisol, although neither investigation included a measure of inflammation. The cortisol levels of participants in the caring, task-involving group also declined in the current study, however it should be noted that this may be due to diurnal variation in cortisol. Importantly, the caring, task-involving climate also generated a prominent rise in the concentration of the receptor, sTNFαRII, to levels which suggest the receptor will act to counter inflammation – specifically, by decreasing TNF-α availability (i.e., a mechanism for which inflammation is controlled; Wang et al., 2003). Soluble TNF-α receptors initiate a number of signal transduction pathways that result in a range of cellular responses, including contradictory regulatory roles with respect to inflammation (Bradley, 2008). For instance, in addition to augmenting TNF-α bioactivity (Aderka, Engelmann, Maor, Brakebusch, & Wallach, 1992), TNF-α receptors can also neutralize TNF-α bioactivity (Wang et al., 2003). Specifically, soluble TNF-α receptors originate from the shedding of membrane-bound receptors (i.e., the primary mechanism of TNF-α bioactivity; Rose-John & Heinrich, 1994) and also compete with membrane-bound receptors for TNF-α, thus inhibiting TNF-α bioactivity on multiple fronts (Engelmann, Novick, & Wallach, 1990). Interestingly, the biological activities of TNF-α decline exponentially when sTNFαRII concentrations rise to similar levels found in the caring, task-involving group after the climate intervention (Aderka et al., 1992).

A plausible reason for the increase in sTNFαRII levels and decrease in salivary cortisol in the caring, task-involving group is that the positive social interactions experienced in a highly caring climate, paired with the lack of psychosocial stressors within a task-involving setting, buffered the stress that often accompanies group-based performance settings. Perceptions of task-involving features were moderately and positively linked to sTNFαRII levels for the second response measure (i.e., at *t* = +45 min). According to the stress-buffering hypothesis (Cassel, 1976; Cobb, 1976; Cohen & Pressman, 2004), positive social interactions (i.e., feeling cared for and having a sense of belonging) can also facilitate better health and well-being (Cohen & McKay, 1984; Cohen & Pressman, 2004). Specifically, the stress-buffering literature has shown that empathy, care, and social support yield protective physiological responses, including decreased cortisol and inflammation (Costanzo et al., 2005; Loucks, Berkman, Gruenewald, & Seeman, 2006). Future investigations should incorporate a variety of inflammatory markers in order to validate these contentions.

There are a number of noteworthy limitations in the current study. To begin, a major limitation of this study was including only a single marker of inflammation, as we were unable to verify our interpretation of the inflammatory response found, aside from the psychological responses of participants and significant decrease in salivary cortisol. Furthermore, this was a 30-minute intervention in a laboratory-based setting with a manipulated motivational climate that is likely less intense than is typically seen in sport and exercise-based settings. It may be that real world settings would elicit more pronounced responses reflecting a higher level of investment. Finally, our population was limited to a specific population of college students (e.g., do not take medication or regularly drink moderate to high quantities of alcohol) and cannot be generalized to other populations. Future researchers should investigate whether the psychological and physiological benefits of caring, task-involving climates translate to real world settings.

Researchers may also consider examining whether exposure to highly caring, task-involving climates impacts stress-induced hormones or immunity, and whether this translates into more expedient healing from injury or recovery from training. Researchers may also consider examining whether playing on a caring, task-involving team would help athletes cope with greater life stress unrelated to their sport. Also important, researchers should examine whether an ego-involving climate triggers a rise in cortisol in real-world settings, as well as the long term implications of consistent exposure to an ego-involving climate on participants’ HPA axis functioning, health, and ability to perform up to their potential sport and exercise settings.

In conclusion, the achievement goal perspective theory research has illustrated caring, task-involving performance settings consistently yield adaptive responses in participants, while ego-involving climates are consistently linked to more troubling outcomes. Researchers have just begun to investigate the impact of the perceived motivational climate in physical activity settings on physiological stress responses. Such findings may help play a role in efforts to promote more caring, task-involving climates in physical activity settings. In line with previous research, the stress-related and motivational responses for the caring, task-involving group in this experimental investigation were distinctly more positive than the responses of the ego-involving group, including what may be a multifaceted physiologically protective mechanism to performance-related stress, as well as psychological responses suggesting caring, task-involving climates may engender better health and performance outcomes. In contrast, results from the ego-involving group indicate that an ego-involving climate can trigger concerning psychological and physiological responses (e.g., humiliation and cortisol) that are not only likely to undermine efforts to optimize motivation, but may also have a lasting impact on participants. This should be recognized in coaching education and physical education efforts and also taken into consideration in future investigations.

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**-20**

**(Time 1)**

**Salivary Sample Collection Timeline**

**(Minutes Relative to the Start of the Intervention)**

**Baseline**

**Manipulation**

**Recovery**

**Response**

**0**

**(Time 2)**

**+30**

**(Time 3)**

**+45**

**(Time 4)**

**+60**

**(Time 5)**

**+90**

**(Time 6)**

Introduction

& Pre-Session Questionnaires

Instructional

Juggling Session

Post-Session Questionnaires

Rest

Figure 1. Timeline of salivary sample collections (below) and study activities (above) relative to the beginning of the experimentally manipulated juggling session, *t = 0 min.*

Figure 2. Stress-Related and Motivational Responses to the Motivational Climate Intervention

*Figure 2*. Group means to individual items examining stress-related and motivational responses to the experimentally manipulated motivational climate intervention are presented by motivational climate assignment. Caring/Task = Caring, Task-Involving Climate and is presented in light grey. Ego = Ego-Involving Climate in dark grey. All group means differ significantly (*p* < .01).

Figure 3. Salivary Cortisol Responses Over Time by Motivational Climate

*a*

\*

*a*

*a*

*Figure 3.* Saliva sample and OMT collection times are stated with respect to the start of the experimentally manipulated motivational climate intervention (i.e., the start of the juggling session, *t = 0 min).* Mean salivary cortisol in nanomoles per liter and mean receptor for tumor necrosis factor-α (sTNFαRII) in picograms per milliliter at baseline and following the experimentally manipulated motivational climate intervention for the Caring/Task and Ego-Involving Groups. Vertical lines with cross bars represent ± standard error, while \* indicates significant (*p* < .05) group differences (i.e., C/TI vs EI). aindicates significant within group differences.

Table 1. Correlation Table Among Motivational Climates and Post-Intervention Variables

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Measure | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.Caring Climate | 1 | |  |  | |  | | |  | |  | | | |  | | | | |  | | | |  | | |  | | | | |  | | | |  | | | |  | | | | | |
| 2.Task Climate | .81\*\* | | 1 |  | |  | | |  | |  | | | |  | | | | |  | | | |  | | |  | | | | |  | | | |  | | | |  | | | | | |  | | | | | | | | | | | |  | |  | |  | | | | | |  |  | | | | |  | |
| 3.Ego Clim. | -.80\*\* | | -.59\*\* | 1 | | |  | | |  | |  | | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | | | | |  | | | | | | | | | |  | |  | | | | |  | |  | | | |  | |  | |
| 4.Stress Appr. | -.45\*\* | | -.33\* | .37\*\* | | | 1 | | |  | | |  | | | | | |  | | | |  | | |  | | | |  | | | | |  | | |  | | | | |  | | | | | | | | | | | | |  | |  | |  | | | |  | |  | | | |  | |  | | | | |
| 5.Coping Appraisal | .61\*\* | | .53\*\* | -.41\*\* | | | -.53\*\* | | | 1 | | |  | | | | | |  | | | |  | | |  | | | |  | | | | |  | | |  | | | | |  | | | | | | | | | | | | |  | |  | |  | | | |  | |  | | | |  | |  | | | | |
| 6.Shame Emotions | -.61\*\* | | -.37\*\* | | .55\*\* | | | .56\*\* | | -.47\*\* | | 1 | |  | | | |  | | | | | | | | |  | | | | | |  | | | | | |  | | | | |  | | | | | |  | | | |  | | | |  | |
| 7.Pos. Aff. | .75\*\* | .70\*\* | | | -.62\*\* | | | -.29\* | | .61\*\* | | -.59\*\* | | | | 1 | | | | | |  | | | | | |  | | | | | | | | |  | | | |  | | | | | |  | | | | | | | |  | | |  | |  | |
| 8.Neg. Aff. | -.71\*\* | -.52\*\* | | | .60\*\* | | | .68\*\* | | -.66\*\* | | .82\*\* | | | | -.61\*\* | | | | | | | | | 1 | | | | | |  | | | | | | |  | | | | |  | | | | | |  | | | |  | | | | |  | |  | |
| 9. Stressed | -.51\*\* | -.40\*\* | | | .37\*\* | | | .44\*\* | | -.50\*\* | | .68\*\* | | | | -.55\*\* | | | | | | | | | .73\*\* | | | | | | | | 1 | | | | | |  | | | | | |  | | | | | |  | | | | | |  |  | |  | |
| 10.Uncontr | -.41\*\* | -.48\*\* | | | .32\* | | | .43\*\* | | -.33\* | | .37\*\* | | | | -.35\*\* | | | | | | | | | .51\*\* | | | | | | | | .35\*\* | | | | | 1 | | | | |  | | | | | |  | | | |  | | | | | |  | |  | | | | | | | | | | | | | | | |
| 11.Perf. SE | .41\*\* | .36\*\* | | | -.30\* | | | -.01 | | .44\*\* | | -.44\*\* | | | | .62\*\* | | | | | | | | | -.38\*\* | | | | | | | | -.39\*\* | | | | | -.06 | | | | | | | 1 | | | | | | |  | | | | | |  | |  | |  |
| 12.Soc. SE | .48\*\* | .41\*\* | | | -.52\*\* | | | -.61\*\* | | .56\*\* | | -.75\*\* | | | | .60\*\* | | | | | | | | | -.75\*\* | | | | | | | | -.61\*\* | | | | | -.45\*\* | | | | | | | .47\*\* | | | | | | | 1 | | | | | |
| 13.Cort. 3 | -.12 | -.05 | | | .28 | | | .04 | | .13 | | .06 | | | | -.12 | | | | | | | | | .08 | | | | | | | | .11 | | | | | .23 | | | | | | | -.03 | | | | | | | -.14 1 | | | | | |
| 14.Cort. 4 | -.22 | -.11 | | | .35\* | | | .04 | | .24 | | .08 | | | | -.19 | | | | | | | | | .10 | | | | | | | | .08 | | | | | .11 | | | | | | | -.04 | | | | | | | -.06 .89\*\* 1 | | | | | |
| 15.Cort. 5 | -.26 | -.16 | | | .39\* | | | .03 | | .33 | | .08 | | | | -.22 | | | | | | | | | .15 | | | | | | | | .11 | | | | | .11 | | | | | | | -.15 | | | | | | | -.10 -.77\*\* .94\*\* 1 | | | | | |
| 16.TNFα 3 | .05 | .18 | | | -.24 | | | -.20 | | -.22 | | .01 | | | | .03 | | | | | | | | | -.04 | | | | | | | | -.24 | | | | | -.18 | | | | | | | .16 | | | | | | | .10 -.14 -.06 -.15 1 | | | | | |
| 17.TNFα 4 | .25 | .42\* | | | -.31 | | | .06 | | -.33 | | -.03 | | | | .23 | | | | | | | | | -.03 | | | | | | | | -.05 | | | | | .09 | | | | | | | .26 | | | | | | | .10 .14 -.20 -.13 .56\*\* 1 | | | | | |
| 18.TNFα 5 | .32 | .34 | | | -.27 | | | -.03 | | -.44\*\* | | -.13 | | | | .16 | | | | | | | | | -.20 | | | | | | | | -.18 | | | | | . -.07 | | | | | | | .21 | | | | | | | .08 .26 .09 -.05 -.49\*\* .49\*\* 1 | | | | | |
| Chronbach α | .97 | .85 | | | .95 | | | .64 | | .61 | | --- | | | | .88 | | | | | | | | | .88 | | | | | | | | . --- | | | | | .64 | | | | | | | .94 | | | | | | |  | | | | | |

\**p* < .05. \*\**p* <.01.

*Note.* Cort. 3-5 and TNFα 3-5 refer to response samples 3-5 (i.e., *t* = +30, +45, and + 60 minutes post-juggling session start, respectively).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2. Means (SD) for Post-Climate Manipulation Scores for PASA, PANAS, SSES by Motivational Climate and Gender within Motivational Climate | | | | | | | | | | | | | | | | | | | |
| **Variable** | **Total**  **C/TI** | | **Total EI** | | **Cohen’s** | | **C/TI** | | | |  | | | **EI** | | | | |
| ***d*** | | **Female** | | **Male** | | | |  | | **Female** | | | **Male** |
| **PASA** |  | |  | |  | |  | |  | | | |  | |  | |  | |
| Stress Appraisal | 3.13b (0.32) | | 3.45b (0.66) | | .62 | | 3.21 (0.35) | | 3.07  (0.29) | | | |  | | 3.74c (0.63) | | 3.13c (0.57) | |
| Coping Appraisal | 4.31a (0.63) | | 3.61a (0.77) | | .74 | | 4.34 (0.60) | | 4.27  (0.67) | | | |  | | 3.30 (0.76) | | 3.94 (0.64) | |
| **PANAS** |  | |  | |  | |  | |  | | | |  | |  | |  | |
| Positive Affect | 36.64a  (6.49) | | 25.45a  (6.39) | | 1.74 | | 37.23 (7.36) | | 36.13  (5.85) | | | |  | | 24.47 (6.50) | | 26.50 (6.33) | |
| Negative Affect | 11.64a (2.18) | | 17.07a (6.44) | | 1.13 | | 11.77 (2.35) | | 11.53  (2.10) | | | |  | | 18.73 (7.96) | | 15.29 (2.79) | |
| **SSES** |  |  | |  | |  | |  | |  | |  | | | |
| Performance Self-Esteem | 3.09b (0.56) | | 2.76b (0.52) | | .61 | | 3.09 (0.66) | | 3.09 (0.48) | | | |  | | 2.70 (0.52) | | 2.83 (0.52) | |
| Social Self-Esteem | 4.35a (0.81) | | 3.54a (1.02) | | .88 | | 4.21 (0.88) | | 4.47 (0.76) | | | |  | | 3.25 (1.05) | | 3.85 (0.93) | |

*Note.* Group means (*SD*) in each row that share subscripts differ significantly. For all scales, higher scores are indicative of more extreme responses for the construct assessed and reflect participant experiences during the motivational climate intervention. C/TI = Caring, Task-Involving Climate; EI = Ego-Involving Climate; PASA = Primary Appraisal/Secondary Appraisal Scales; PANAS = Positive Affect and Negative Affect Schedule; SSES = State Self-Esteem Scale.

a *p* < .01, between C/TI and EI. b *p* < .05, between C/TI and EI. c *p* < .01, between males and females.