Effects of Self-Esteem, Grit, and Resilience on Physiological Stress Response

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Abstract

Physiological stress response is an adaptive, automatic response to increase attention and motivation under threatening conditions. Frequent and maladaptive activation, however, has adverse physical and mental health outcomes. Our study examined the use of a dialectic behavioral technique to alter self-esteem, evaluating the effects of reduced and improved affect on stress response. Measures of pulse, blood oxygenation, and skin conductivity—indicators of stress—were taken during a frightening virtual reality simulation. Trait grit and resilience personality inventories were taken as potential modulators of self-esteem on stress response. We hypothesized that an increase in self-esteem would decrease stress response, and that grit and resilience would enhance this reduction. Results suggested that trait grit modulates the directionality of stress response following self-esteem coping techniques. Results demonstrated that increased self-esteem reduced stress response in individuals with low grit, but increased physiological response in high grit individuals. The current study showed the importance of administering personality assessments before implementation of coping techniques in a therapeutic setting.

Effects of Self-Esteem, Grit, and Resilience on Physiological Stress Response

Stress response is an adaptive survival characteristic that automatically and unconsciously prepares the body to engage in increased activity to combat an imminent threat. During states of low arousal, individuals generally do not possess appropriate quantities of motivation and attention to combat most dangers that they may encounter. Instead, stress can increase arousal to a level that is optimal for performance (Yerkes & Dodson, 1908). Attention precipitated from optimal stress manifests itself in quicker reaction time (Wu, Courtney, Lance, Narayanan, Dawson, Oie, & Parsons, 2010). Despite this, there is a limit to the positive benefits of physiological arousal after a situation is deemed threatening. Under conditions where stress response surpasses this optimal range, the physiological ramifications of stress can cause alterations to brain functioning and ultimately result in mental and physical impairment, including dysfunction of the immune, endocrine, and central nervous systems (Chaby, Cavigelli, Hirrlinger, Caruso, & Braithwaite, 2015; Glaser & Kiecolt-Glaser, 2005). To mitigate these adverse effects, cognitive behavioral therapy (CBT) is widely used to manage symptoms of both anxiety and depression when faced with everyday stressors (Driessen et al., 2017).

The technique of CBT changes the meaning of a situation through reinterpretation (Gross, 2002). Cognitively changing this interpretation, an individual learns how to appraisal a moderately fearful situation as exciting, as opposed to stressful. Situational reinterpretation has been shown to work through a variety of modalities including changing personal relevance, envisioning alternative outcomes, and regulating emotions (Ochsner et al., 2004). Research conducted by Brooks (2014) demonstrated that emotional regulation is an effective means to improve performance during a fear inducing task. This enhanced performance could be attributed to emotional regulation achieving optimal levels of arousal, as opposed to other techniques that focus exclusively on decreasing arousal and calming an individual down. Research conducted by Carryer and Leslie (2010) showed a stronger client working alliance and fewer depressive symptoms when individuals learned to regulate their emotion. These finding suggest that functionality can be optimized through a focus on regulation of emotions, and that decreasing emotional response is not favorable in improving overall quality of life.

Emotional regulation adjusts physiological arousal, bring an individual's arousal closer to their optimal level. At this optimal level, the appropriate levels of motivation and attention for a specific situation is afforded. Under a state of moderate physiological arousal, an individual's emotional state will change based on cognitive appraisal of the event (Schachter & Singer, 1962). Arousal in and of itself is not detrimental when at this moderate level; it is the emotions behind the arousal (determined by cognitive interpretation) that can alter performance. During CBT, cognitive appraisal is altered by modifying self-esteem. Since self-esteem can mediate stress in multiple situations, including those of high intensity stress, it can prevent feelings of being overwhelmed and stressed by an experience (Schönfeld, Brailovskaia, Bieda, Zhang, & Margraf, 2016). Thus, an individual's confidence in their ability to succeed during times of stress serves as an influential factor in how they will respond to the event (Bandura, 1977). If a high level of confidence can be achieved, an individual will be more apt to manage a threat when it arises. While stress often precipitates from circumstances outside an individual's control, research conducted by Shelley and Pakenham (2004) suggests that an external locus of control is not what causes distress, but lack of self-efficacy during the situation. Consequently, even if an event is (or is believed to be) largely controlled by external factors, confidence in one's ability to carry out even one action to address the situation can mitigate feeling of distress. It comes to surface that to manage distress, alterations need to be made to adjust cognition through state self-esteem when approaching a challenge, permitting dialectic thinking.

Emotion is one of the most important factors in altering self-esteem. Research conducted by Campbell, Chew, and Scratchley (1991) supports the idea that savoring past affective positive states is associated with higher levels of self-esteem. This has shown to be successful in temporarily altering confidence of patients in eating disorder treatment programs, allowing them to resist acting on symptoms (Troop, Holbrey, & Treasure, 1998). Through the simple cognitive dialectic technique of reflecting and writing about an accomplishment in their lives, followed by reading it aloud, the esteem of patients was temporarily elevated. This technique simultaneously harnesses the understanding of two perspectives in a situation, helping form a basis for analytical reasoning and constructive conflict through the holding of opposing viewpoints. This esteem-based intervention temporarily alters mindset, profoundly impacting a range of health domains including psychological, behavioral and physiological responses in measures such as blood pressure, heart rate, and cardiovascular health (Levy, Hausdorff, Hencke, & Wei, 2000). The current dialectic technique exerts this alteration through framing a past experience as just that, an experience, and not a reflection of an individual's identity.

Since dialectic alterations have effects that span a range of health domains, the current study seeks to investigate whether this same technique of altering mindset is effective in reducing stress of individuals when facing a fear-inducing situation. Research conducted by Dienstbier (1989) identifies that in response to a challenge, physiological markers can be measured in the moment to evaluate unconscious, automatic reactivity. Arousal has been seen to manifest itself through an increase in heart rate and the initiation of emotional perspiration (Fechir et al., 2010). These effects result in heightened blood pressure and have been identified to inversely correlate with blood oxygenation (Gianaros, May, Siegle, & Jennings, 2005). Since self-reported stress is often unreliable because it is given in both hindsight and vulnerable to reporting bias, physiological measures provide insight into presence and quantity of arousal to a threatening situation, which impacts overall health (Martinek, Oberascher-Holzinger, Weishuhn, Klimesch, & Kerschbaum, 2003). As research conducted by Weinberger, Schwarts, and Davidson (1979) shows, repressors may self-report lower stress levels despite a physiological stress responses, manifested in increased heart rate and skin conductivity, as well as behavioral reductions through delayed reaction time. These physiological and behavioral responses have been shown to be elicited during a virtual environment (Meehan, Insko, Whitton, & Brooks, 2002).

While physiological stress response is mediated by self-esteem in the moment during a stressful situation, personality traits such as grit exert effects on cognitive appraisal as well. Since this personality characteristic is stable throughout one's life, grit impacts stress response in a consistent manner throughout variation in state traits such as self-esteem (Duckworth & Quinn, 2009). This influence of grit exerts its effects through predicting achievement in a broad range of challenging domains (Duckworth, Peterson, Matthews, & Kelly, 2007). This achievement can be attributed to grit's ability to promote perseverance despite adversity and disadvantage, both of which are attributes of stressful situation which possess an external locus of control. Therefore, grit serves as a secondary variable of interest since it will exert effects consistently in a broad range of situations.

Combating situations where one lacks control frequently reduce self-worth of an individual, as the lack of control can make them feel helpless. As research conducted by Wagner and Abaied (2016) suggests, external control can lead to sympathetic nervous system activity, suggesting skin conductivity as an objective stress measure. Under conditions where an individual feels a sense of control over a situation, automatic stress response is less likely to be activated. This reduces risk for stress-related disorders such as hypertension (Karasek, 1979). The degree to which these feelings of helplessness occur are mediated by trait resilience, the key influential factor in feelings regarding self-worth (Bonanno, 2014). When possessing resilience, individuals are guarded against emotional distress (Bryan, Ray-Sannerud, & Heron, 2015). Emotion distress reduction subsequently reduces adverse consequences of stress, both of which may be attributed to resilient individual's automatic use of positive emotions to cope with situations as they arise (Tugade & Fredrickson, 2004). Automatic use of positive emotions may be likened to the technique of reflection on past accomplishments in that both redirect cognition onto positive affect.

The current study hypothesized that when combating a fear-inducing situation that is externally controlled, individuals with a positive affective state, established by an increase in self-esteem, will have reductions in their physiological stress response. This external local of control will be established through the use of a virtual reality environment. Reduction in stress response will be further mediated by traits of grit and resilience. It was hypothesized that both of these trait characteristics would lead to slight reductions of physiological response in and of themselves since individuals expressing high levels of these traits are more likely to automatically interpret situations in a more positive light, thereby lowing their perceived stress. In all cases, though, small reductions of arousal are expected in participants primed with success since they are interpreting an experience as exciting. Inversely, slight increases are expected to be seen in participants primed with failure who are more likely to appraise the situation as threating. This threat interpretation may heighten arousal that surpasses optimal performance levels, preventing individuals from coping with stress in the state of minimized self-esteem.

Method

Participants

Fifty individuals, 72% female, M_{age} =20.380 (*SD*=1.958), 44% Caucasian, 34% African American, 10% Asian, 12% Hispanic, gave informed consent to participate in the study. Albright undergraduate students were requested to participate through verbal invitation by their professors and through written flyers posted around Albright campus. No monetary compensation was allotted, but participants were offered an opportunity for extra credit in a psychology course if they chose. This study was approved by the IRB of Albright College.

Materials

The current experiment used two computers with GTX1080 graphic processing unit. The first was connected to the Oculus Rift Virtual Reality program. The Oculus Rift DK2 software technology (Oculus, Inc.) and headset projects two digitally created images onto the retinas of participants. These images were slightly offset to mimic the spatial difference between eyes under normal vision (Figure 1). The current study used digitally created images that exposed participants to a fear-inducting simulation comprised of an elevator ride which opened onto various scenes. These scenes included lights turning off in a hallway, the elevator "malfunctioning" in a way that created complete darkness, a scene in which a ball popped into frame, and a final scene where a man snuck up behind the participant. Participants experienced this virtual reality environment for approximately three minutes during which time feelings of fear and helplessness were elicited.

The second computer was connected to PO2-100, C-ISO-B3G, and PT-104 iWorx hardware (Figure 2) which collected physiological stress response in the forms of blood oxygenation, pulse, and galvanic skin response (Iworkx Systems, Inc.,Dover, NH). The LabScribe3 software program installed on the second computer recorded these physiological measures for all participants.

Blood Oxygenation. The percentage of participants' red blood cells saturated with oxygen was measured using a Pulse Oximeter. This technology projected infrared light through capillaries in the thumb. Normal blood oxygenation falls between 95% and 100% at rest.

Pulse. The peripheral measure of heart rate was measured using a Pulse Oximeter. This technology detected throbbing of arteries as blood flows through them. Normal pulse rate falls between 60 and 100 beats per minute at rest.

Galvanic Skin Response. The change in electrical conductivity (microSiemens) of the skin was detected by electrodes on the fingertips. Electrodes measured sweat secreted from sweat glands at this location.

Grit. The 12-item Grit scale was used to quantify the personality trait of grit as a mediating factor in stress appraisal. This scale assessed participant's perseverance in the achievement of long-term goals through a series of questions aimed at measuring motivation to achieve goals correlated with their personal values (see Appendix A). Participants scored each statement on a 5 point Likert scale with 1 being "not like me at all" and 5 being "very much like me." The sum of all Likert scale ratings was average to provide a grit score. A score of greater than 3.3 was categorized as high grit, and a score lower than 3.3 as low grit. This scale has been validated for reliability and construct validity in past research (Duckworth et al., 2007).

Resilience Appraisal Scale. The 12 question Resilience Appraisal Scale (RAS) was used to quantify the degree of adaptability participants possess in overcoming disadvantage and adversity. This empirically validated scale measures psychological resilience in three domains—social, situation, and emotional—through a series of statement in which participants indicated the strength in which the statements described them (see Appendix B). Participants scored each statement on a 5 point Likert scale with 1 being "strongly disagree" and 5 being "strongly agree". The sum of scores was considered total resilience. Sub-scores were also totaled for social, situation, and emotional resilience domains. Participants were differentiated into high and low for each of the resilience domains based on if their score fell above or below the mean for that specific subcomponent of resilience.

Procedure

Participants provided written consent for participation in the current study. Participants completed the Grit Scale and then the RAS. Each participant was randomly assigned to a self-esteem condition intending to increase (primed with success) or reduce (primed with failure) state self-esteem for the current study's between-subjects design. Participants in the primed with success group were instructed to reflect and write about an experience in their life when they had accomplished a difficult task, an accomplishment of which they were proud. The primed with failure group was instructed to reflect and write about an experience in their life when they were unsuccessful in accomplishing a difficult task, a failure they had experienced in their life. After completing the written prompt, both groups were instructed to read their experience aloud.

Next, each participant's left ring and pointer fingers were wiped with a damp paper towel. Electrodes were attached to fingertips to measure skin conductivity. A pulse oximeter was attached to participant's left thumb to measure blood oxygenation and pulse. The Oculus Rift headset was placed on participant's head. After a 30 second waiting period, the simulation began. The simulation lasted approximately 3 minutes, at which time participants sat still in a chair, moving their head to alter the angle of their perception of the elevator. During the last interval of the simulation, participants heard the instructions, "look behind you." When participants turned their heads back around towards the screen, a monster jumped out at them for the final scare scene. At the conclusion of the simulation participants removed the Oculus Rift headset, electrodes, and pulse oximeter. Participants completed a demographics questionnaire asking for gender, age, and ethnicity. Participants were debriefed and given disclosure regarding self-esteem prime conditions and the intended physiological purpose.

Data Analysis

We used 5 time intervals of the 3-minute virtual reality experience to analyze physiological stress: Overall (all 3 minutes), first minute, second minute, third minute, and the most intense final section of the experience (minute 3 until end of the simulation) featuring a monster. For the overall measures, we looked at GSR (in microSiemens), blood oxygenation (in percentage of saturation), and pulse (in beats per minute) using the mean value, max – min value (to measure change), and the absolute area under the curve (to measure overall stimulation). For the other sections, we did not use the absolute area under the curve but all other measures were the same. Analysis focused on overall and monster scene intervals, but all intervals were considered to provide further insight into stress response. Participants were recorded for 30 seconds before the procedure to establish baseline physiological values, and that baseline was set to 0 such that all measures are deviations from their baseline state for between-subjects comparison.

Results

To test the hypothesis that increasing state self-esteem would reduce physiological stress response and that this effect would be heightened by grit and resilience, a series of 2 (self-esteem) x 2 (grit) x 2 (total resilience) between subjects ANOVA was conducted for all stress measures for the duration of the simulation. Results showed a main effect approaching significance of self-esteem in max-min blood oxygenation during the entirety of the simulation, $F(1,46) = 3.26$, $p = .078$. Participants primed with success had a smaller physiological stress response (*M*= 7.228, *SD*=5.228) compared to participants primed with failure (*M*=9.193, *SD* =6.835). Results show no main effect of grit for any physiological measures. Results showed a significant interaction between condition and total resilience during the entirety of the simulation in max-min blood oxygenation, $F(1, 46) = 4.723$, $p < .05$. When analyzing this interaction, individuals high in total resilience, primed with success showed the smallest physiological response in max-min blood oxygenation (*M* = 5.86, *SD* = 5.703). The largest stress response was demonstrated by high total resilience individuals primed with success (*M* = 10.866, *SD* = 7.375). Means and standard deviations for all conditions of max-min blood oxygenation are displayed in Table 1. This suggests that an increase in state self-esteem may increase stress response in individuals already high in trait resilience.

A significant 3-way interaction was additionally seen between self-esteem, grit, and total resilience in max-min blood oxygenation over the entirety of the simulation, $F(1, 46) = 12.493$, $p = .001$. Interaction effect is displayed in Figure 3. For participants who had high trait grit, reduction in state self-esteem increased physiological stress response to a higher degree in low total resilience participants than for individuals who possessed high trait resilience. Data suggests that alterations in self-esteem have minimal effects for individuals who possess both high grit and high total resilience. For participants with low trait grit, this trend was seen in reverse. Individuals who possessed low grit, but high social resilience had the greatest increase in physiological response when primed with failure. For individuals low in both grit and total resilience, a decrease in state affect had only a small increase in physiological response; they also benefited less from the increase in state self-efficacy. This suggests that self-esteem increase works most effectively for individuals who possess low grit. For those with high grit, this technique may be detrimental.

As a follow up to the primary hypothesis, trait total resilience was compartmentalized into each of the three domains and analyzed to evaluate which component of resilience drives the interaction between condition, grit, and resilience. A series of 2 (self-esteem) x 2 (grit) x 2 (situational resilience) between subjects ANOVA was conducted for all physiological measures over the entirety of the simulation. Results did not show any significant main effects. Results did not suggest any significant 2-way interactions. A 3-way interaction demonstrated a significant effect in the mean galvanic skin response over the entirety of the simulation, $F(1, 46) = 7.525$, $p<.01$. Interaction effect is displayed in Figure 4. For individuals high in grit, an increase in self-esteem significantly increased physiological stress response in low situational resilient participants. Individuals with both high social situational resilience and high grit were not impacted significantly by alterations in self-esteem. For participants with low grit, priming with success decreased physiological stress response if they additionally had low situational resilience. This trend was opposite if the low grit individual primed with success had high situational resilience. This suggests that situational resilience modulates the effects of self-esteem on stress response directionally depending on trait grit.

This series of 2 (self-esteem) x 2 (grit) x 2 (situational resilience) ANOVAs demonstrated a similar significant 3-way interaction during the monster scene in average galvanic skin response as was seen over the entirety of the simulation, $F(1,46) = 6.633$, $p<.05$. Interaction effect is displayed in Figure 5. High grit, low situational resilience individuals had an increase in physiological response when primed with success while high grit, high situational resilience individuals showed minimal alterations in physiological stress response from self-esteem alterations. For individuals low in grit and low in situational resilience, priming with success reduced physiological arousal compared to low grit, low situational resilience participants primed with failure. The inverse trend was seen for low grit, high situational resilience individuals who had an increase in physiological stress response when primed with success.

A series of 2 (self-esteem) x 2 (grit) x 2 (social resilience) between subjects ANOVA was conducted for all physiological measures over the entirety of the simulation. Results showed no main effects. This series of ANOVAs demonstrated a significant interaction effect between self-esteem and social resilience in mean oxygenation over the entirety of the simulation, $F(1, 46) = 4.339$, $p<.05$. During the entirety of the simulation, the smallest physiological response was displayed by the high resilience participants primed with failure who had the highest mean blood oxygenation. The lowest mean blood oxygenation was measured for participants with high social resilience primed with success (Figure 6). Similar trends remained consistent over first, second, and third minute time intervals. Means and standard deviations for all time intervals are displayed in Table 2. This suggests that in individuals with high social resilience, an increase in self-esteem increases physiological response. This additional suggests that an opposite trend may be true for low social resilient individuals who showed a decrease in physiology response with high state self-esteem. This interaction effect was additionally seen in measures of max-min galvanic skin response during the second and third minute of the simulation (Figure 7). Mean and standard deviations for all groups in max-min galvanic skin response are displayed in Table 3.

A series of 2 (self-esteem) x 2 (grit) x 2 (emotional resilience) between subjects ANOVA was conducted for all physiological measures for the duration of the simulation and during the monster scene. Means and standard deviations for all intervals in mean galvanic skin response are displayed in Table 4. Results showed no significant main effects. Results demonstrated a significant interaction effect between condition and emotional resilience in mean galvanic skin conductivity during the monster scene of the simulation, $F(1,46) = 4.671$, $p<.05$. Participants with low trait emotional resilience demonstrated the smallest mean amount of conductivity in response to stress when primed with failure. For participants with high trait emotional resilience, analysis showed that a smaller physiological response was demonstrated by participants primed with success than by those primed with failure. The greatest physiological response detected through mean galvanic skin response during the monster scene was displayed by low emotional resilient participants primed with success. This suggests that increasing state self-esteem decreased physiological stress response in only participants who possess high emotional resilience. It is also supported that this increase in state self-esteem can increase arousal in participants who are low in emotional resilience, especially during the highest point of intensity during a stressful situation. The interaction effect between condition and emotional resilience was seen during the third minute of the simulation as well.

Discussion

Our results did not suggest a consistent, significant overall difference in physiological stress response between self-esteem conditions. This is inconsistent with findings by Troop, Holbrey, and Treasure (1998), in which the same dialectic technique reduced anxiety in eating disorder patients so that they could resist acting on symptoms, and research by Brown and Creaven (2017) who demonstrated that cardiovascular response to recurring stressors was reduced following positive feedback geared towards enhancing self-esteem. This inconsistency could be due to the interaction effects demonstrated by the current study between self-esteem, grit, and domains of trait resilience.

The current study demonstrated that a significant 3-way interaction exists between self-esteem, grit and the domain of situational resilience specifically. The directionality of physiological response to the self-esteem alteration, when modulated by situational resilience, was largely dependent on trait grit. We demonstrated that high grit participants primed with failure were more stressed than low grit participants. This is inconsistent with research conducted by Bhanji, Kim, and Delgado (2016) which showed that low grit participants were more stressed than high grit individuals when encountering acute setbacks. This discrepancy offers support that the current study's manipulation through state self-esteem alteration did, in fact, alter self-esteem. The differentiation between high and low grit participants dovetails with findings by Pickering and Gray (1999), who concluded that variability exits in individual's likelihood to seek factors to increase their self-esteem, a buffer for anxiety. Those with high trait grit automatically process positive past accomplishments at a subconscious level, which allows them to persevere despite adversity. Research conducted by Meriac, Slifka, and LaBat (2015) demonstrated that it is not trait grit that reduces stress, but the tendency of these individuals to inherently use efficient coping strategies when encountering everyday life stressors. By intentionally altering their state self-esteem, this automatic processing could have been halted in the current study's primed with failure condition.

Inversely, when low grit individuals were primed with success, they showed reductions in physiological stress response. For low grit individuals, changing cognition through positive affect, appraisal of a fear-inducing situation is seen as a challenge as opposed to a threat. Having a positive mindset, participants are given the confidence that they are able to overcome an event. Since the current study's manipulation reduced physiological reactivity in low grit participants, self-esteem alteration in a therapeutic setting should focus on individualizing techniques with consideration to this personality trait. For low grit individuals who would benefit from practice in altering situational resilience and self-esteem, virtual reality sessions could be developed to assist in practicing combating fears and stressful situations. During these practice sessions, the current technique of self-esteem alteration could be further enhanced through success-priming with a related accomplishment. Research by Sanz and Villamarín (2001), demonstrated that self-efficacy is prominent influential factor in automatic arousal. Through success-priming with a related accomplishment, this therapeutic technique would increase both self-esteem and contextual self-efficacy relative to a specific situation, thereby reducing physiological stress response.

Our results showed that when used in a therapeutic setting, trait grit is most influential during situational stressors. In some cases, the current study found that individuals high in total trait resilience had a greater physiological stress response than their low resilient counterparts. This interaction is not consistent with previous research conducted by Bryan, Ray-Sannerud, and Heron (2015), who showed that resilience protected against emotional distress. The current study shows, though, that this discrepancies can be explained through the modulation of trait grit. When both high grit and low grit groups are primed with failure, low grit individuals showed a smaller physiological response to decreased self-esteem since they are already accustomed to thinking that is closer to the failure-primed group. In addition to this, the current study showed the importance of the componential nature of trait resilience. Dependent on the contextual situation, resilience in different domains could either hinder or help an individual combat a stressful situation. As shown by research conduct by Bonanno (2014), resilience is a key factor in feelings of self-worth. Considering this, self-worth may be more impactful when facing a stressful situation that involves social resilience than situational resilience.

Our results suggested that when separated by trait social resilience, groups responded differently to the self-esteem manipulation, suggesting that low social resilient participants primed with success manage stress better as a result of their positive affect than those who possess high trait social resilience. Research conducted by Bettschart, Bolognini, Plancherel, Nunez, and Leidi (1992) suggests that social esteem provides a positive context in which to view the event. This context may be similar to the mindset induced by the current dialectic technique. Notably, though, the current study demonstrated a trend that those high is social resilience primed with failure maintained the smallest physiological stress response in all measures. Conversely, this was followed by low social resilient, high self-esteem participants who often demonstrated smaller physiological response when primed with success than high social resilient, high self-esteem participants. The phenomenon may be explained when considering that automatic processing is fast and parallel while controlled processing is slow (Johnsen & Briggs, 1973). While low social resilient participants may benefit from the conscious reflection to enhance their state self-esteem, this same process may be detrimental to those who automatically think in this manner. This theory is supported by research conducted by Heuer, Spikers, Kiesswetter, and Schmidtke (1998), which demonstrated that performance under controlled processing is more sensitive to stressors than during automatic processing. In our study, intentionally trying to shifting self-esteem for high social resilience may have made them more vulnerable to the simulation. This suggests that before implementation of stress reduction techniques, consideration should be given to state social resilience in instances which the stressor encompasses a social component.

Expanding on this theme, the current study also suggests that these same considerations should be made in consideration to emotional events that may be deemed stressful. Participants low in trait emotional resilience demonstrated the largest stress response during intense stress (the monster scene), but in the opposite direction that our study hypothesized (Wilburn & Delores, 2005). We showed that increasing state self-esteem may have resulted in an increase stress appraisal when reflecting on an accomplishment for those who do not possess high emotional resilience. Without this emotional resilience, individuals have poor emotional regulation. In research conducted by Stoeber, Kobori, and Tanno (2013), perfectionism predicted embarrassment after success. Since those with deficient in cognitive emotional regulation have been seen to also possess this trait of perfectionism, the current study suggests that increased self-esteem for perfectionists low in emotional resilience may prove detrimental to stress appraisal (Rudolph, Flett, & Hewitt, 2007).

Considering the above, future studies could address the operationalization of stress appraisal. The current study posited that physiological reactivity accounted for stress, but physiological responses to stress can closely resemble the same response of excitement. Both stress and excitement elicit increases in heart rate and galvanic skin conductivity (Lole, Gonsalvez, Blaszczynski, & Clarke, 2012). Since cognitive interpretation is the distinguisher of this arousal—as either stress or excitement—quantitative physiological measurements alone do not differentiate these mental states from one another (Schachter & Singer, 1962). Extensions on this research many include simulations that focus on the excitement component as a basis of comparison between the two. This addition would include inventories to assess cognitive reports of fear and excitement in participants. Continuation of this research could also include an inventory to validate the assumption that priming with success was effective in altering mindset. With consideration to the interaction effect demonstrated with grit, extensions on the current study could attempt alternative techniques with high grit individuals. Research conducted Raio, Orederu, Palazzolo, Shurick, and Phelps (2013) shows that meditation works to alter mindset during stressors of high intensity. This therapeutic focuses individuals on the current moment as opposed to reflecting on past affect, this differential approach may work more effectively for those high in grit.

In sum, the current study suggests that the dialectic technique of reflecting on a passed accomplishment to alter state self-esteem could be an effective means to reduce physiological stress response when consideration is given to individualized personality traits and contextual situation in which the stressor arises. Interacting strongly with grit, situational resilience can be practiced through virtual reality to increase self-efficacy when combating a situation. Since physiological stress has benefits at a moderate level to increase motivation and attention (Yerkes & Dodson, 1908), optimal levels should be considered. Future studies should target everyday life stressors so that achievement to this optimal level is feasible, a factor that could be measured through performance tasks or cognition exercise (Schönfeld, Brailovskaia, Bieda, Zhang, and Margraf, 2016). In doing so, individuals would gain a coping technique effective in optimizing their quality of life as well as learn to become habituated to a repeated stress such as an exam or a presentation, which has been shown to be associated with long-term health (Einstein, Eisenstein, & Smith, 2001). Therefore, continued practice to address life stressors through increased self-esteem can have lasting impact in an individual's life and wellbeing. With the growing use of technology in the modern culture, therapeutic techniques coupled with virtual reality simulations may have the potential to alleviate some maladaptive stress. As suggested by our findings, though, screening for personality traits before implementing any coping techniques is imperative to address the interaction effect of personality and state traits. When coupling these considerations, a reduction in physiological stress response can be achieve, providing both immediate benefits such as memory recall, and lasting protection on the immune and central nervous systems (Schwabe, Wolf, & Oitzl, M. S., 2010; Chaby, Cavigelli, Hirrlinger, Caruso, & Braithwaite, 2015).

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Table 1.

Mean and Standard Deviations of Max-Min Blood Oxygenation in Percentage for High and Low Total resilience Participants Separated by Self-Esteem Condition

Time Interval	Total Resilience	Self-Esteem Condition: Reduce *M*	Reduce *SD*	Increase *M*	Increase *SD*
Overall*					
	Low	7.649	6.181	8.709	5.977
	High	10.866	7.374	5.861	5.704
Minute 1					
	Low	3.065	2.864	1.898	0.962
	High	4.432	6.188	3.050	2.892
Minute 2					
	Low	2.633	3.295	1.809	1.080
	High	1.532	0.675	2.591	4.088
Minute 3					
	Low	4.142	5.017	6.513	5.253
	High	2.298	1.318	3.911	4.147
Monster					
	Low	5.809	5.090	4.603	5.172
	High	5.987	7.544	2.202	1.843

**Denotes significance*

Table 2.

Mean and Standard Deviations of Average Blood Oxygenation in Percentage for High and Low Social Resilience Participants Separated by Self-Esteem Condition

Time Interval		Self-Esteem Condition			
	Social Resilience	Reduce		Increase	
		M	*SD*	*M*	*SD*
Overall*					
	Low	97.773	0.695	98.372	0.968
	High	98.484	0.928	97.157	2.170
Minute 1*					
	Low	97.805	0.757	98.453	0.987
	High	98.470	0.878	97.241	2.267
Minute 2*					
	Low	97.805	0.734	98.418	1.001
	High	98.557	1.037	97.207	1.037
Minute 3*					
	Low	97.847	0.706	98.328	1.080
	High	98.463	0.954	97.140	2.019
Monster					
	Low	97.413	0.952	98.028	1.265
	High	98.105	0.810	95.889	5.402

*Denotes significance

Table 3.

Mean and Standard Deviations of Max-Min Galvanic Skin Response in microSiemens for High and Low Social Resilience Participants Separated by Self-Esteem Condition

Time Interval		Self-Esteem Condition			
	Social Resilience	Reduce		Increase	
		M	*SD*	*M*	*SD*
Overall					
	Low	7.734	11.713	15.792	13.134
	High	14.845	13.019	10.508	6.111
Minute 1					
	Low	5.822	9.402	10.904	9.626
	High	9.852	12.272	7.376	5.306
Minute 2*					
	Low	8.234	11.739	15.882	13.028
	High	13.757	13.1889	10.852	5.234
Minute 3*					
	Low	9.265	13.534	19.720	15.339
	High	18.696	13.796	11.896	6.267
Monster					
	Low	11.334	15.473	22.716	17.049
	High	18.621	12.865	11.885	8.314

**Denotes significance*

Table 4.

Mean and Standard Deviations of Average Galvanic Skin Response in microSiemens for High and Low Emotional Resilience Participants Separated by Self-Esteem Condition

Time Interval		Self-Esteem Condition			
	Emotional Resilience	Reduce		Increase	
		M	*SD*	*M*	*SD*
Overall					
	Low	7.734	11.713	15.792	13.134
	High	14.845	13.019	10.508	6.111
Minute 1					
	Low	5.822	9.402	10.904	9.626
	High	9.852	12.272	7.376	5.306
Minute 2					
	Low	8.234	11.739	15.882	13.028
	High	13.757	13.1889	10.852	5.234
Minute 3*					
	Low	9.265	13.534	19.720	15.339
	High	18.696	13.796	11.896	6.267
Monster*					
	Low	11.334	15.473	22.716	17.049
	High	18.621	12.865	11.885	8.314

**Denotes significance*

Figure 1. Sample of the offset between the digitally constructed images, each being projected into one of the retinas simultaneously allowing for 3D simulation.

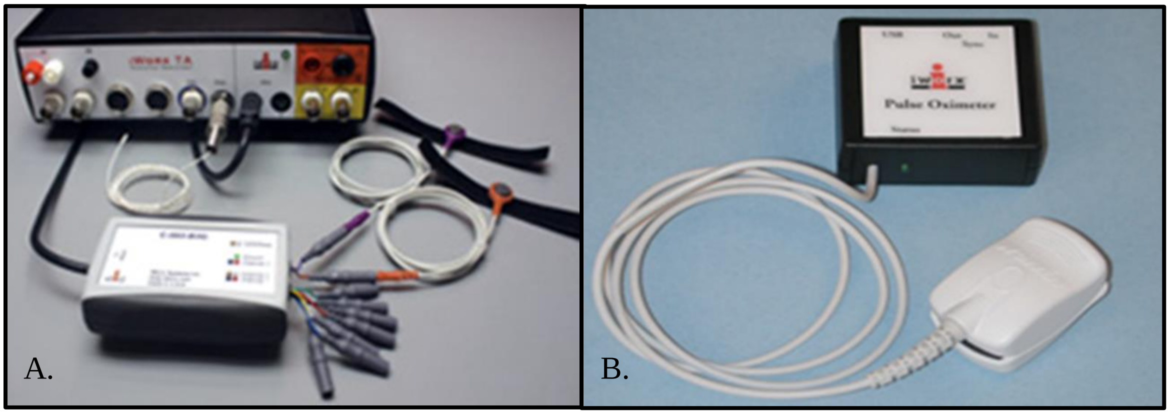

Figure 2. Technology used to monitor physiological stress response. Panel A showing electrodes for galvanic skin response. Panel B showing pulse oximeter to measure blood oxygenation and pulse.

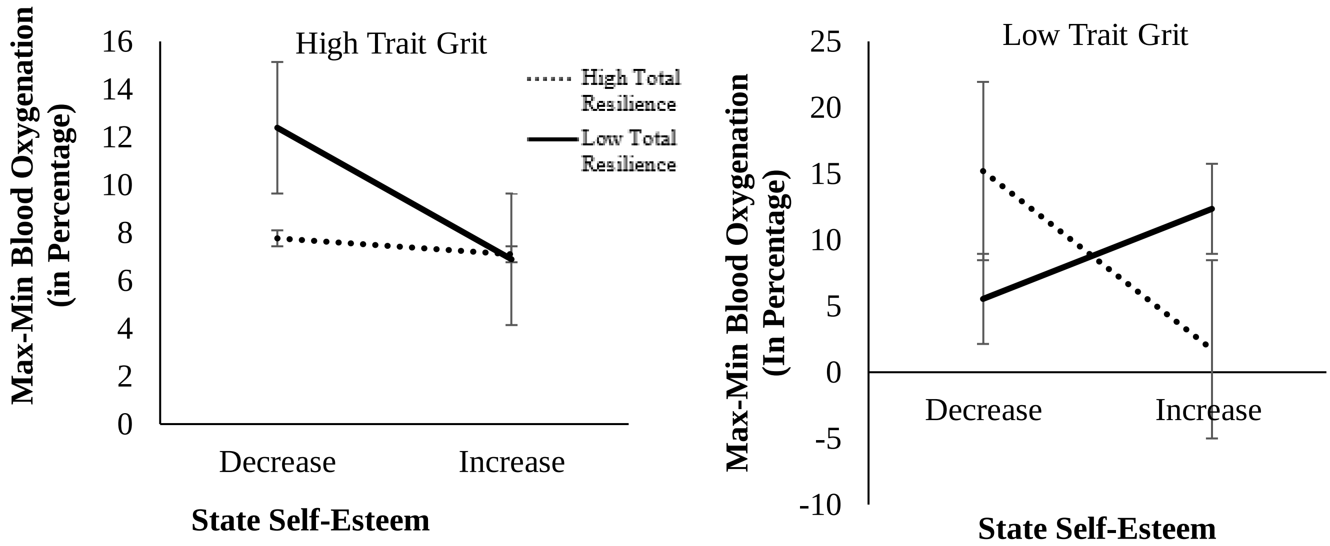

Figure 3. Max-min blood oxygenation during the entirety of the fear-inducing simulation for high and low total trait resilience participants under state self-esteem increase and reduction conditions. Graphs separate high and low trait grit participants. Error bars indicate standard error.

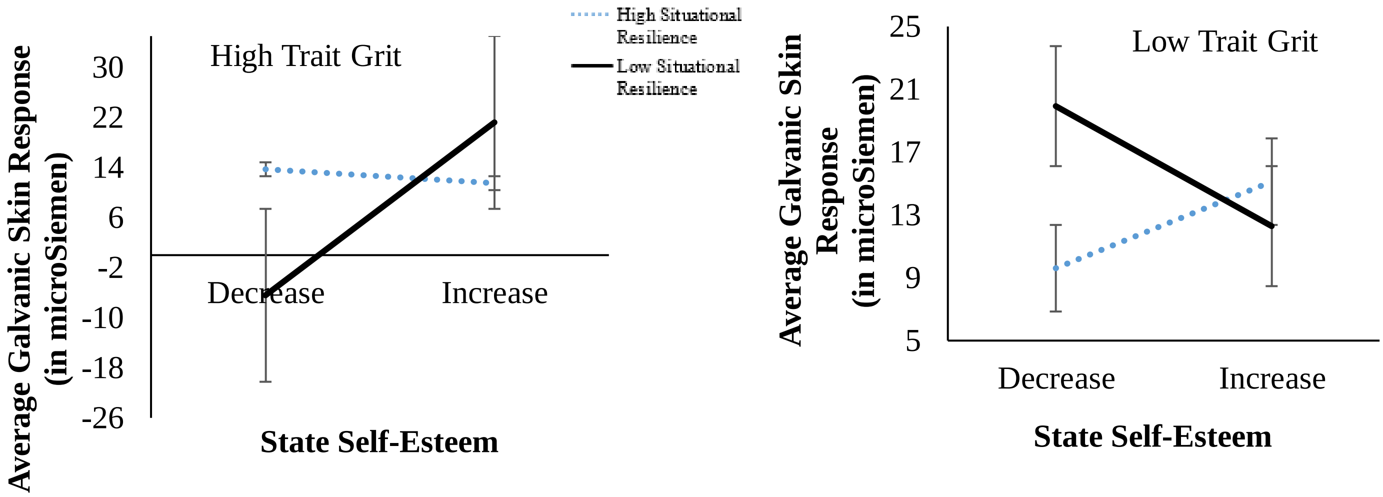

Figure 4. Average galvanic skin response during the entirety of simulation with high and low trait situational resilience under state self-esteem increase and reduction conditions. Graphs separate high and low trait grit individuals. Error bars indicate standard error.

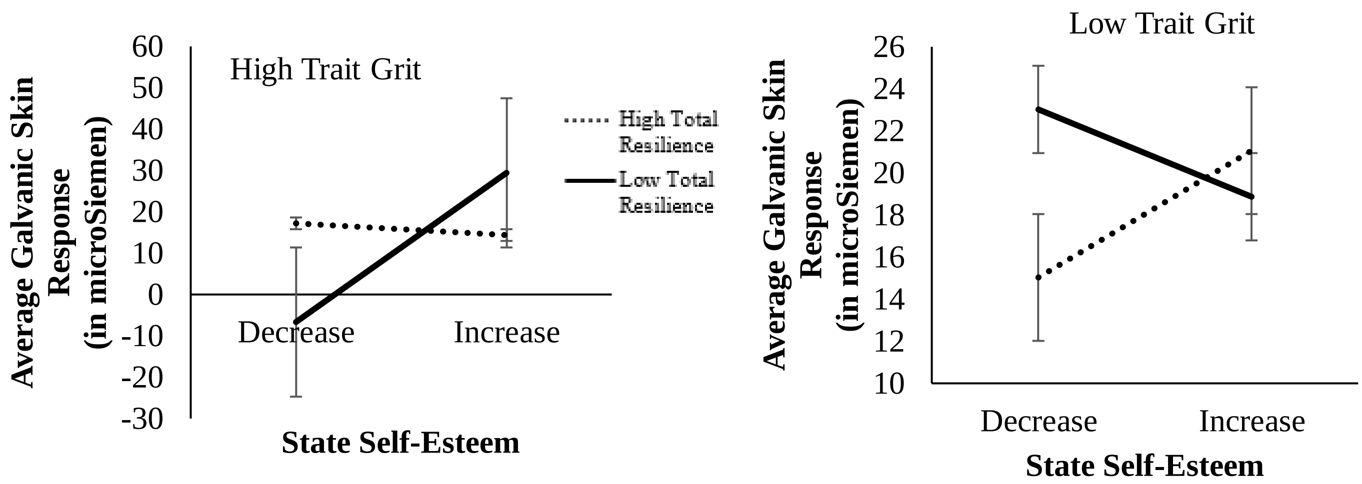

Figure 5. Average galvanic skin response during the monster scene during the entirety of the fear-inducing simulation with high and low trait situational resilience under state self-esteem increase and reduction conditions for high grit individuals. Error bars indicate standard error.

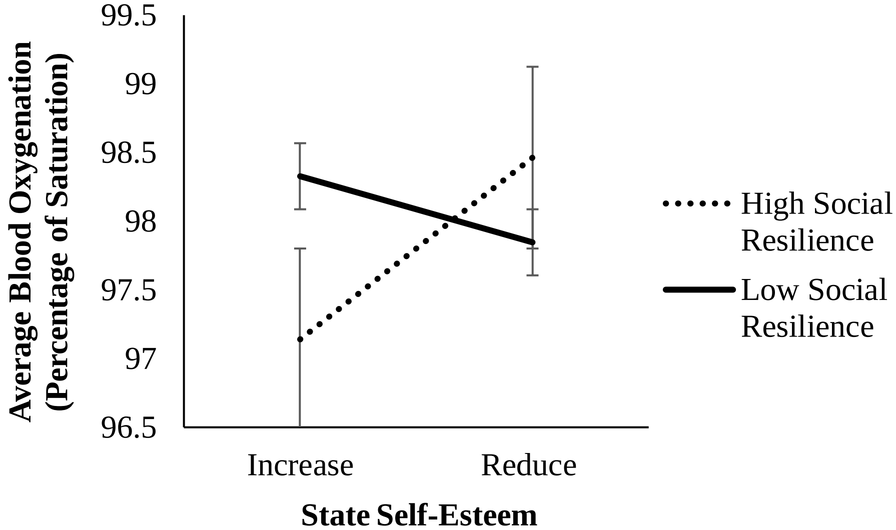

Figure 6. Mean blood oxygenation during the third minute with high and low trait social resilience under state self-esteem increase and reduction conditions. Error bars indicate standard error.

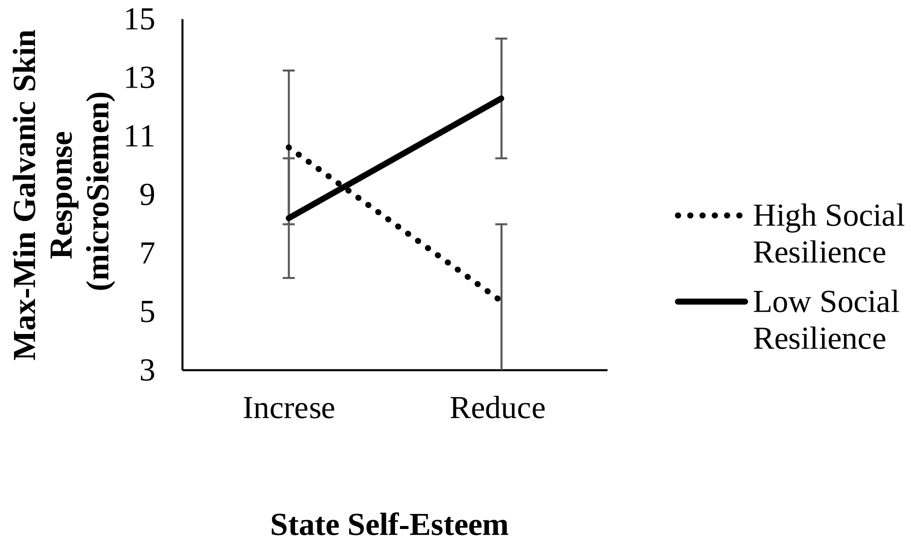

Figure 7. Max-min galvanic skin response conductivity during the third minute with high and low trait social resilience under state self-esteem increase and reduction conditions. Error bars indicate standard error.

Appendix A. Item Grit Scale

Directions for taking the Grit Scale: Here are a number of statements that may or may not apply to you. For the most accurate score, when responding, think of how you compare to most people—not just the people you know well, but most people in the world. There are no right or wrong answers, so answer honestly.

1. I have overcome setbacks to conquer an important challenge.
   - Very much like me
   - Mostly like me
   - Somewhat like me
   - Not much like me
   - Not like me at all

2. New ideas and projects sometimes distract me from previous ones.
   - Very much like me
   - Mostly like me
   - Somewhat like me
   - Not much like me
   - Not like me at all

3. My interests change from year to year.
   - Very much like me
   - Mostly like me
   - Somewhat like me
   - Not much like me
   - Not like me at all

4. Setbacks don't discourage me.
   - Very much like me
   - Mostly like me
   - Somewhat like me
   - Not much like me
   - Not like me at all

5. I have been obsessed with a certain idea or project for a short time but later lost interest.
   - Very much like me
   - Mostly like me
   - Somewhat like me
   - Not much like me
   - Not like me at all

6. I am a hard worker
   - o Very much like me
   - o Mostly like me
   - o Somewhat like me
   - o Not much like me
   - o Not like me at all

7. I often set a goal but later choose to pursue a different one.
   - o Very much like me
   - o Mostly like me
   - o Somewhat like me
   - o Not much like me
   - o Not like me at all

8. I have difficulty maintaining my focus on projects that take more than a few months to complete.
   - o Very much like me
   - o Mostly like me
   - o Somewhat like me
   - o Not much like me
   - o Not like me at all

9. I finish whatever I begin.
   - o Very much like me
   - o Mostly like me
   - o Somewhat like me
   - o Not much like me
   - o Not like me at all

10. I have achieved a goal that took years of work.
   - o Very much like me
   - o Mostly like me
   - o Somewhat like me
   - o Not much like me
   - o Not like me at all

11. I have become interested in new pursuits every few months
   - o Very much like me
   - o Mostly like me
   - o Somewhat like me
   - o Not much like me
   - o Not like me at all

12. I am diligent
   - o Very much like me
   - o Mostly like me
   - o Somewhat like me
   - o Not much like me
   - o Not like me at all

Appendix B. Items from the Resilience Appraisal Scale (RAS)

Item	Subscale
1. If I were to have problems, I have people I could turn to	Social Support
2. My family or friends are very supportive to me	Social Support
3. In difficult situations, I can manage my emotions	Emotional Coping
4. I can put up with my negative emotions	Emotional Coping
5. When faced with a problem I can usually find a solution	Situation Coping
6. If I were in trouble, I know of others who would be able to help me	Social Support
7. I can generally solve problems that occur	Situation Coping
8. I can control my emotions	Emotional Coping
9. I can usually find a way of overcoming problems	Situation Coping
10. I could find family or friends who listen to me if I need them to	Social Support
11. If faced with a set-back, I could probably find a way around the problem	Situation Coping
12. I can handle my emotions	Emotional Coping