A Thesis

entitled

Using the Biopsychosocial Model of Threat and Challenge to understand

the Occurrence of Placebo Effects

by

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Submitted to the Graduate Faculty as partial fulfillment of the requirements for the

Master of Arts Degree in Psychology

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December 2015
An Abstract of
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Placebo effects are the physiological or psychological reactions evoked from the
administration of an inactive substance or procedure (Stewart-Williams, 2004). Recent
research has demonstrated that a key causal mechanism behind placebo effects is an
individual’s expectations. Although expectations have been found to generate placebo
effects in many studies, researchers have revealed that changing expectations do not
always lead to placebo effects. The goal of the present research was to examine the
possibility that a prominent framework of the coping literature, the Biopsychosocial
Model (BPS) of Threat and Challenge, could help account for placebo effects in
performance situations. According to the BPS model, individuals experience more of a
“challenge response” if they view themselves as having enough resources to handle the
task, or a “threat response” if they do not. If a treatment expectation is conceptualized as
an asset, akin to perception of greater resources, then integration of the placebo literature
with the challenge threat model is useful. The present research examined how the
wording of a placebo expectation (gain or loss-framed) about the difficulty of the
performance task determined whether an individual experiences a challenge or threat response to the task. This was tested in the present study using a performance paradigm successfully employed in research on the BPS model. Inconsistent with the BPS Model, task engagement did not increase from baseline through the performance task. In addition, participant’s completion of the performance task did not lead to significant differences between conditions. Consistent with the BPS Model, participants provided with a placebo expectation demonstrated physiological indicators of challenge, whereas no expectation participants displayed physiological indicators of threat ($p<.05$). Implications of these findings and directions for future research are discussed.
# Table of Contents

Abstract iii

Table of Contents v

List of Figures viii

List of Tables ix

List of Abbreviations x

I. Chapter 1: Introduction 1
   A. Placebo Effects 2
   B. Stress and Coping Theory 8
   C. Connecting the Stress and Coping Theory to the Biopsychosocial Model 11
   D. Psychological Processes of the Biopsychosocial Model 12
   E. Physiological Responses of the BPS Model 14
   F. Framing and the BPS Model 18
   G. Integrating Placebo Effects with the BPS Model 20

II. Chapter 2: Methods 24
   A. Participants and Design 24
   B. Materials and Measures 25
      a. Health History Questionnaire and Demographics 25
      b. Cardiovascular Measures 25
      c. Supplementary Questions 26
      d. Manipulation Check Item 26
      e. Mind Clearing Exercise 27
      f. Remote Associates Test (RAT) 28
C. Procedure 29

D. Results 32
   a. Manipulations Check Analysis 32
   b. RAT Performance 33
   c. Physiological Data Acquisition 34
   d. Analysis of Task Engagement 35
   e. Analysis of Threat and Challenge 36
   f. Analysis of Supplementary Questions 38

E. Discussion 39
   a. Manipulation Check Data 40
   b. Hypothesis One: Task Engagement 41
   c. Hypothesis Two: Placebo Expectation Condition versus Control 43
   d. Hypothesis Three: Gain-Framed Expectation versus Loss-Framed Expectation 45
   e. Challenge and Threat: Continuous or Separate 47
   f. Mediators and Moderators of the BPS Model 48
   g. Meaningful Application Outside the Lab 49
   h. Other Stressor/Performance Domains 50
   i. Limitations and Future Directions 51
   j. Conclusion 52

F. Footnotes 54

G. References 55
H. Appendices
List of Figures

Figure 1  Overview of the BPS Model (Seery, 2011)…………………………..62

Figure 2  Expected results depicted as levels of challenge responding……………63

Figure 3  Expected results depicted as levels of correct number of RAT

    word associations solved………………………………………………64

Figure 4  Expected results as depicted as levels of task engagement……………..65

Figure 5. Number of RAT associations answered correct by condition………….66

Figure 6: Mean number of word associations answered correct by difficulty per

    condition……………………………………………………………………67

Figure 7: Mean level of task engagement by condition……………………………68

Figure 8: Mean Challenge responding by condition………………………………69
List of Tables
Table 1: Percent of participants whether or not participants answered the manipulation question correctly.................................................................70
Table 2: Z-Score Mean Task Engagement for HR, PEP and combined across time points.................................................................71
Table 3: Z-Score Mean Threat/Challenge for TPR, CO and combined across time points .................................................................72
Table 4: Mean ratings of participants’ feelings toward the RAT.........................73
Table 5: Mean ratings of whether participants thought clearing their mind would help them to perform better on the RAT.................................74
Table 6: Mean ratings of whether participants felt confident that they would be successful on the RAT.................................................................75
Table 7: Mean ratings of participants perceived difficulty of the RAT.............76
Table 8: Mean ratings of how demanding participants found the RAT to be..........77
Table 9: Mean ratings of whether participants treated the RAT as a challenge to overcome.................................................................78
Table 10: Mean ratings of whether participants felt like they had the resources to successfully perform the RAT.................................................................79
Table 11: Mean ratings of whether participants thought they performed well on the RAT .............................................................................................80
List of Abbreviations

BPS Model ......Biopsychosocial Model

CO..............Cardiac Output

HR..............Heart Rate

PAC...............Pituitary-Adrenal-Cortical

RAT.............Remote Associates Test

SAM..............Sympathetic-Adrenal-Medullary

SCT...............Stress and Coping Theory

SV.................Stroke Volume

TPR..............Total Peripheral Resistance

VC.................Ventricular Contractibility
I. Introduction

The mechanisms underlying placebo effects are just now becoming a hot topic in research, with important theoretical and practical implications for the realm of both social behavior and health care. Although progress is being made in this area, there have been few attempts to integrate this phenomenon with established process models that have already been developed in the psychological literature. The present project represents a preliminary step toward this integration. Specifically, in this defense an argument is made for using a prominent model in the coping literature, called the Threat and Challenge Biopsychosocial Model (BSP), to predict the occurrence of placebo effects. The purpose of the project was to determine if this coping model can explain physiological reactions to placebo treatments in stressor/performance situations. If this model can be used to understand placebo effects, the research may have important practical implications for utilizing placebo effects in real life situations.

The present paper begins with a brief overview of placebo effects to provide the reader with a background of the phenomenon under investigation. From here, discussion shifts to the theories of coping, including Lazarus and Folkman’s Stress and Coping Theory to offer a frame of reference for the coping literature (Lazarus & Folkman, 1984). Next, Blascovich and colleague’s (e.g., Blascovich & Tomaka, 1996) Threat and Challenge Biopsychosocial Model of coping is reviewed, as this model serves as the basis for the proposed study. Finally, the phenomenon of placebo effects is synthesized with the Threat and Challenge BPS Model and an experiment which tested the predictions made from this integration is explained.
Placebo Effects

The reciprocal relationship between social psychology, health and medicine poses many provocative questions. One of the important concepts that appears to link social psychology to health and medicine is that of placebo effects. Historically, placebo effects were viewed as the outcome of administering inert treatments or substances, such as sugar pills, to patients (Geers & Rose, 2011; Benedetti, 2008; Price, Finniss & Benedeti, 2008). More recently, there has been less emphasis on inert treatments themselves and greater emphasis placed on the psychological and neurological processes that underlie the placebo phenomenon. As such, placebo effects are now typically defined as the physiological or psychological reactions evoked from the administration of an inactive substance or procedure (Stewart-Williams, 2004). Some, in the placebo literature, argue that placebo effects encompass more than reactions to inert treatments and that this definition should be broadened such that placebo effects are viewed as the psychologically mediated responses to treatment administration—regardless of whether the treatment contains active or inactive properties (Geers & Miller, 2014). Although this definitional issue is still under debate, to directly investigate placebo effects, researchers rely on inert treatments so as to completely isolate the psychological contributions to a treatment effect from the contributions generated by an active treatment agent.

A placebo response refers to a specific change that occurs to an individual’s symptoms or condition as a result the administration of a placebo (Price, et al., 2008). This change can be captured on a wide variety of dependent measures. For example, placebo effects frequently manifest on subjective measures of mood, pain, depression, headache, and sleep quality (For a review, see Geers, Brinol, Brown, & Petty, in
Placebo effects have been exhibited on measures of cognitive processing such as reaction time, recall, recognition, Stroop interference, and implicit learning (e.g., Gama, Slama, Caspar, Gevers, & Cleeremans, 2013; Geers, Wellman, Fowler, Rasinski, & Helfer, 2011; Colagiuri, Livesev, & Harris, 2011; Wright, Mauro da Costa Hernandez, Sundar, Dinsmore, & Kardes, 2013). Placebo effects also occur on behavioral measures including pain tolerance, completion of puzzle tasks, reduced sleep latency, accuracy on search tasks, weight lifting by competitive lifters, and motor performance in Parkinson patients (e.g., Geers et al., in preparation; Shiv, Carmon, & Ariely, 2005; Wellman & Geers, 2009). Finally, one of the fastest growing areas of placebo research concerns the neurobiological pathways implicated in this effect. For example, brain imaging studies have shown that placebos analgesics work by activating the same neural networks and endogenous opioid pathways as pharmacological pain treatments (for reviews, see Atlas, Wager, Dahl & Smith, 2009; Benedetti, 2009; Enck, Bingel, Schedlowski & Rief, 2013). Additionally, research has revealed that in addition to neurological changes, placebo treatments can modify nociceptive mechanisms in the spinal cord (for reviews, see Eippert, Finsterbusch, Bingel, & Buchel, 2009; Goffaux, Redmond, Rainville, & Marchand, 2007; Matre Casey & Knardahl, 2006). Thus, not only are placebo effects pervasive across many domains, but are highly applicable to health and medical outcomes.

Two primary mechanisms have been theorized to account for placebo effects: classical conditioning and expectancy. In classical conditioning accounts, placebo effects are the conditioned response brought on by unconditioned stimuli or by conditioned stimuli—which in this case are the methods and techniques used in administering
treatments (Voudouris, Peck, & Coleman, 1985; Wickramasekera, 1985). Although conditioning can generate placebo effects, the results of many studies suggest that conditioning is not the only cause of placebo effects (Stewart-Williams & Podd, 2004). A second account for placebo effects is the expectancy explanation. Expectations refer to one’s beliefs about the future and the probability estimates of what will occur (Olson, Roese, & Zanna, 1996). The expectation view of placebo effects asserts that the effect arises from one’s belief that a treatment will have a certain outcome (Bootzin, 1985; Kirsch, 1999; Stewart-Williams & Podd, 2004). According to some expectancy perspectives, anticipating how one will react directly leads to congruent changes in experience (Kirsch, 1999). The key notion is that expectations serve a preparatory function, readying the organism for change. According to other versions of the expectancy perspective, expectations produce placebo effects by changing what sensations and symptoms individuals attend to and how individuals interpret their experience (Geers, Helfer, Weiland, Kosbab, 2006; Lundh, 1987; Moerman, 2002; Price et al., 2008). Although the expectancy mechanism is typically viewed as the most critical in the literature compared to the conditioning explanation, it should be recognized that both correlational and experimental studies have discovered that changes in expectations do not always produce placebo effects (e.g., Hammersley, Finnigan, & Millar, 1998; Laska & Sunshine, 1973; Walach, Schmidt, Dirhold, & Nosch, 2002). Thus, it appears a simple expectation account may not be enough to fully explain placebo effects.

Although researchers have established the occurrence of placebo effects in many symptom and performance domains, much of the placebo research has made use of stressor and pain paradigms. Notably, placebo effects appear to induce stronger changes
in pain and stress responses than in some other domains, such as sleep onset (Levine, Gordan & Fields; 1978; Benedetti, 2009). Several example placebo–pain paradigms include submerging one’s hand in ice cold water for two minutes, listening to aversive noises through headphones, ischemic pain tasks, ingestion of supposed pain reducing pills, and perceived direct cranial stimulation (Geers, Helfer, Kosbab, Weiland, & Landry 2005; Geers, Wellman, Fowler, Helfer, & France, 2010; Geers, Wellman, Helfer, Fowler, & France 2008; Rose, Geers, Rasinski, & Fowler 2012; Rainville, Feine, Bushnell, & Duncan, 1992). In these studies placebo effects are often assessed with online ratings of pain, discomfort, or stress. Important for the present research, prior studies find that providing individuals with a treatment expectation can reduce stress and pain compared to individuals who do not receive a treatment expectation.

As noted earlier, expectations for treatment benefits do not always lead to placebo effects. As such, researchers have begun testing for theoretical moderators. There are many factors that can moderate placebo effects, including suggestibility, optimism, somatic focus, cognitive distraction, and goal congruency (DePascalis, Chiaradia, & Carotenuto, 2002, Hyland & Whalley, 2008, Geers et al., 2006; Gibbons & Gaeddert, 1984, Buhle, Stevens, Friedman, & Wager, 2012, Geers, Kosbab, Helfer, Weiland, & Wellman, 2007). Additionally, placebo effects have recently been shown to be stronger when participants are actively involved in the process of selecting their (placebo) treatment as compared to when the (placebo) treatment has been selected for them by an experimenter (Geers & Rose, 2011; Rose, et al., 2012).

As an example of a study testing for a moderator of placebo effects, consider the research conducted by Geers, Weiland, Kosbab, Landry and Helfer (Study 1; 2005). This
study tested the possibility that nonconscious goals moderate placebo expectation effects. In this study, the researchers employed both a placebo expectation manipulation as well as priming manipulation to activate nonconscious goals. Nonconscious goals were primed using the Scrambled Sentence Test in which 16 of 20 words differed between experimental condition (i.e. cooperation, unrelated to cooperation, independence). Specifically, participants were assigned to one of the following four conditions: no expectation/ no prime, placebo expectation/ no prime, placebo expectation/ cooperation prime, and placebo expectation/ independent prime. After the priming task, participants in the no-placebo condition were asked to evaluate how a four-minute segment of music made them feel. Participants given the placebo expectation were told the music had been scientifically developed by neuropsychologists to increase positive feelings and energy levels and to reduce headaches. In actuality, this piece of music did not have any affect inducing properties. Results revealed that placebo responding was moderated by nonconscious goals (Geers et al., 2005). Specifically, participants provided with the placebo expectation and given the nonconscious goal of cooperation had stronger placebo effects than the expectations participants not primed with a cooperation goal and participants primed with a goal for independence.

In another study looking at moderation, Beedie, Stuart and Coleman (2006) examined how the strength of an expectation alters the strength of placebo responding. Cyclists engaged in three 10-km time trials after being led to believe they received either a placebo capsule, a capsule containing 4.5 mg caffeine, or a capsule containing 9.0 mg.kg caffeine before beginning each trial. No true caffeine was ever received, however, as all cyclists were given an identical placebo capsule on every trial. Results revealed that
mean power output of the cyclists increased in all conditions except when participants were explicitly told the capsule was a placebo. Further, data depicted a linear trend in that more power was exuded when participants had a higher caffeine dose expectation. Here, performance was influenced by the cyclist’s expectations of the effects of caffeine—and the strength of this effect was moderated by the expected dose of caffeine (Beedie et al., 2006).

In summary, placebo effects are a component of treatment effects that are psychologically mediated. The expectancy view of placebo effects accounts for such changes by suggesting that the effects are the consequence of one’s belief that a treatment will have a certain outcome. Placebo research looking at expectancies has most often employed pain and stressor paradigms—although other paradigms are used such as performance tasks. Further, placebo effects do not always result from placebo expectation manipulations and researchers are now exploring different moderating variables.

Although the research described above is beginning to provide important evidence of moderation, the placebo effect literature remains murky and in many cases it is unclear when placebo effects will occur. Thus, additional research and theory is required to enhance our understanding of this phenomenon. One possible method for advancing our understanding of placebo effects is to integrate research on this phenomenon with established theories in the psychological literature. Towards this goal, the present research builds a connection between research on placebo effects and research on stress and coping. This defense focuses on stress and coping because prior work demonstrates that placebo expectations often reduce stress in various paradigms such as those involving pain and difficult performance tasks.
Stress and Coping Theory

Psychology has often focused on how people deal with stress in their lives. Individuals experience stress when internal perceptions or external pressures are perceived as exceeding one’s ability to cope. Stress can cause both physical and mental deteriorations, making healthy functioning difficult or impossible. Although stress is often detrimental, exposure to stressors can also galvanize individuals, leading to increased productivity given the right circumstances. In order to understand how and when stress management leads to distinct outcomes, one must understand the different types of stress as well as the various coping strategies employed to alleviate stress.

Coping refers to the ways individuals respond to stress. More specifically, coping can be defined as the various cognitive and behavioral strategies individuals employ to manage external and/or internal demands that are considered taxing (Folkman, Lazarus, Dunkel-Schtter, DeLongis & Gruen, 1986). Coping is important in handling adversity, stressors, and relationships among a multitude of other factors.

Both behavioral and cognitive strategies can be utilized to cope with stressors. Typical components of the coping process include cognitively judging an event to be stressful, feeling overwhelmed, and causing one to behave in response to the stressful event (Snyder, 1999). Further, coping can be on a large or small scale, rather significant or relatively meaningless in the long run (Snyder, 1999). For example, a behavioral coping strategy could consist of a student who is consistently failing his math test changing his studying behavior to studying by increasing the amount of time he spends in the evening learning course material. Studying, in this case, could lead to less stress when taking the test and consequences of failure. A cognitive coping strategy, on the other
hand, might look more like cognitive restructuring. Here, the student could recognize his negative thoughts in regards to taking the exam and modify them in order to do better. Knowing that a single exam does not determine if the student will pass or fail can improve mood and may even improve performance.

To provide the backdrop for the present focus on coping, one of the major coping theories is explained: Lazarus and Folkman’s Stress and Coping Theory (SCT; 1984). SCT draws together two psychological processes: cognitive appraisal and coping. This theory accounts for the relationship between stressful person-environment encounters as well as the long and short-term consequences mediated by cognitive appraisal and coping (Folkman et al., 1986), explained in detail below.

Cognitive appraisal, a key aspect of this theory, is a process by which an individual determines the relevance of one’s environmental encounters to one’s welfare. Cognitive appraisal is further broken down into primary and secondary appraisal. These two forms of appraisal are not meant to occur sequentially, but rather can occur simultaneously. During primary appraisal, the individual determines if s/he has anything to lose in this situation (e.g. harm). In this primary appraisal individuals assess stressors, gauging if they present a threat. Secondary appraisal goes beyond answering the initial questions, such as “will harm come to me?” During secondary appraisal, one determines if there is any way in which harm to one’s well-being can be avoided or one could be benefitted instead. Here, coping enters the equation.

Coping strategies involve adapting to the situation by seeking more information or holding back from acting impulsively (Folkman et al., 1986). Primary and secondary appraisals determine together if the stressful person-environment encounter is relevant to
one’s well-being and if one has the resources to surpass the stressor. When this occurs, the person-environment relationship is evaluated as challenging or threatening. Threat here could result in “harm or loss”, while challenge is positive and can lead to success or other benefits (Folkman et al., 1986). These appraisals can occur a priori to stressful situations as anticipation builds (Takoma, Blascovich, Kelsey, & Leitten, 1993). Compared to challenge appraisals, appraisals of threat are associated more with negative emotions (Fischer, Shaver, & Carnochan, 1990; Folkman and Lazarus, 1985; Kobasa, 1982).

For example, consider a study by Folkman and Lazarus (1985) in which they investigated emotion and coping during a college examination. In this study, participants completed measures at Time 1 (two days before the midterm), at Time 2 (five days after the midterm), and at Time 3 (two days before grades were announced). Participants completed a stress questionnaire that used Likert scales to assess appraisal, emotion, and coping at each time point. The 15 emotions rated by participants were grouped into appraisal categories by researchers as anticipatory (threat or challenge emotions) or outcome (harm or benefit). Participants reported many more emotions related to threat and challenge at Times 1 and 2 than at Time 3. Harm and benefit emotions, however, were lower at Time 1, higher at Time 2, and similarly high at Time 3. Both anticipatory and outcome emotions were high at Time 2 as participants had experienced the stress of taking the exam, but were still sustaining the stress of awaiting grade reports. Overall, these results conform to Lazarus and Folkman’s SCT (1984) in demonstrating the separation of threat and challenge and the use of threat and challenge reactions in earlier
stages of a stressful encounter and more outcome-focused coping reactions at a later part of the stressful encounter.

In summary, stress and the resulting coping mechanisms engaged to deal with this stress have been a focus of much theory and research. Coping includes cognitive or behavioral strategies individuals make use of to handle difficult internal and/or external demands. Lazarus and Folkman’s SCT (1984) utilizes cognitive appraisals and coping to account for the consequences of stressful person-environment encounters. Threat and challenge are cognitive appraisals by which the person-environment relationship is evaluated.

**Connecting the Stress and Coping Theory to the Biopsychosocial Model**

A more recent model in the literature that developed from Lazarus and Folkman’s Stress and Coping Theory (SCT; 1984) is Blascovich’s Biopsychosocial Model (BPS Model; 1996). The BPS Model starts from the SCT perspective in that it distinguishes between two key reactions to stress: challenge and threat. Further, the BPS model also views challenge as more affectively positive and threat as more affectively negative. In discriminating between the two, the creators of the BPS Model use the term “evaluation,” rather than “appraisal” to describe affective processes (i.e., feelings of threat or challenge; Seery, 2011). Appraisals refer to intervening processes, involving primary and secondary appraisals, for SCT whereas challenge and threat evaluations are the output event for the BPS Model. A pictorial representation of this model is presented in Figure 1.

Seery and colleagues (2011) extend the SCT (Lazarus & Folkman, 1984) in several key ways. To begin with, in the BPS Model (Blascovich & Tomaka, 1996),
challenge and threat evaluations are the key end product of the primary and secondary appraisal processes. A difference between theories lies in when one perceives feelings of threat or challenge: SCT focuses on feelings occurring alongside appraisal and the BPS Model focuses on feelings occurring after appraisal. Second, the BPS Model and SCT focus their attention on different outcomes. The predictions of the SCT are focused on psychological and behavioral outcomes. The BPS model emphasizes the importance of physiological reactions. Here, psychological states of challenge and threat are thought to result in predictable patterns of physiological reactions. Finally, divergent challenge and threat reactions only occur in the BPS Model if a motivated performance situation is self-relevant. In comparison, Lazarus argues that the threat/challenge perception influences whether a circumstance is judged as self-relevant (Seery, 2011).

**Psychological Processes of the Biopsychosocial Model**

Broadly speaking, the BPS Model (Blascovich & Tomaka, 1996) was developed to explain how individuals respond to motivated performance situations. Motivated performance situations refer to self-relevant tasks or other performances that require an individual to be highly engaged and invested (Blascovich & Mendes, 2000; Elliot, 2008). Examples of prototypical self-relevant tasks include test taking, competitive sports, negotiations between two people, playing a game, giving a speech, or word association tasks.

Additionally, when a task is self-relevant, participants believe that a satisfactory or unsatisfactory performance means something about themselves—academic ability, social skills, etc. Further, task relevance is enhanced when individuals believe that their performance in the task is under evaluation by others, such as a peer or experimenter, or
by the participant if the task is highly self-relevant (Blascovich & Mendes, 2000). When tasks are self-relevant and thus individuals are highly engaged, there are different psychological outcomes: challenge and threat evaluations. Challenge evaluations encompass positive reactions which lead to superior task performance whilst one is being monitored (Chalabaev, Major, Cury & Sarrazin, 2009). Threat reactions, however, tend to yield negative outcomes that do not increase task performance. For example, students who perceive themselves as unprepared may feel threatened and anxious before an exam thus performing worse. Students who feel prepared, on the other hand, do better as they are more likely to feel confident and challenged.

As depicted by Figure 1, this model suggests that when engaged in a self-relevant task, people respond differently based on perceived resources and situational demands. According to this model, resources can be internal, such as knowledge, skills, and abilities. Resources can also be external, including components such as social support, opportunities for practice, and instrumental provisions/assets. Situational demands refer to the physical or mental taxes that are caused by the situation, consist of necessary effort, and include greater levels of danger and uncertainty (Blascovich, Seery, Mugridge, Norris, Weisbuch, 2004). When resources are perceived to exceed situational demands, the model says that an individual believes he or she can overcome the situation and exhibits more of a challenge response. However, when situational demands exceed resources then more of a threat response is typically displayed. Thus, according to the model, self-relevant tasks can lead to threat or challenge-style responses based on the perceived situational demands generated for the self-relevant task coupled with one’s perception of resources to accomplish that task. Notably, situational and resource
appraisals are not meant to be conscious. Rather, these appraisals are thought to occur primarily below one’s conscious awareness (Seery, 2013; Quigley, Barrett & Weinstein, 2002). Further, challenge and threat are not meant to be dichotomous evaluations, but instead are viewed as the end points of a continuum.

**Physiological Responses of the BPS Model**

The BPS model does suggest that threat responses are often associated with different psychological and behavioral consequences than challenge responses. For example, challenge engages more confidence and better performance. One notable aspect of BPS Model, however, is that it focuses more on physiological than psychological outcome measures. Physiological responding encompasses important mechanisms by which researchers can investigate how an individual responds to psychological perceptions and environmental stimuli. In prior research on the BPS model, physiological responses have been validated as measures of challenge and threat which can be supplemented by self-report measures and manipulation checks (Blascovich & Tomaka, 1996).

As depicted in Figure 1, threat and challenge responses were hypothesized to result in distinct physiological responses. The cardiovascular pattern exhibited by challenge differs from threat and is akin to responses seen in physical exercise (Seery, 2013). In challenge, one has confidence and continues to pursue a desired goal. On the other hand, the cardiovascular pattern of threat involves readying the body for both movement and physical inhibition (e.g., not moving to avoid being caught as an animal might do if a threat were near). An individual facing threat must be alert as the cardiovascular pattern results in continued goal pursuit progress, but also physiological
readiness to hinder goal pursuit at any moment (Seery, 2013). Physiological changes can be measured in performance situations when the body is preparing for metabolically demanding physical activity (which may or may not follow).

The physiological challenge pattern depicts increased activity in the sympathetic-adrenal-medullary (SAM) axis. Dienstbier (1989) asserted that SAM activation was a bodily reaction to motivated performance situations in the short term only (few minutes). SAM activity is in contrast with pituitary-adrenal-cortical activation (PAC), which accounts for cortisol release and break down for over an hour (Seery, 2013; Dienstbier, 1989). Challenge is marked by a decrease in total peripheral resistance (TPR; compares net values of constriction and dilation of arterial pressure; Blascovich et al., 2004) and an increase in cardiac output (CO; measurements record the total number of liters of blood the heart pumps per minute; Seery, 2013) similar to that which occurs in aerobic exercise. An increase in ventricular contractibility (VC; a measurement of the contracting force of the left ventricle) and heart rate (HR) signal task engagement for both challenge and threat. Additionally, blood pressure remains relatively stable during challenge conditions (Blascovich & Mendes, 2000).¹

The physiological markers of threat differ from that of challenge. When both the SAM axis and the PAC axis increase in activity, the threat pattern is evidenced. Threat is accounted for by no (or very little) change in both CO and TPR as PAC activity restrains SAM responses (mobilization inhibition; Seery, 2013). Large changes in blood pressure are typically recorded in the threat condition (Blascovich & Mendes, 2000).

The physiological measures of threat and challenge have been validated through both correlational and experimental means (e.g., Tomaka et al., 1993; Tomaka,
For example, across three studies (Tomaka et al., 1993), and in line with the BPS model, researchers discovered that reactions to stressors in subjective, physiological, and behavioral domains could be predicted by an individual’s evaluation of the stressful events threat levels and coping ability. In the first study, active coping task performance was assessed while physiological responses and cognitive appraisal (threat and challenge) were recorded. Between receiving instructions and performing a mental arithmetic task, participants’ primary and secondary appraisals were measured. Participants then reported experienced stress levels caused by the task. Following the initial task and appraisal, a second similarly stressful task was completed in order to assess secondary appraisal. During these tasks, participants were asked to subtract aloud for a short period of time. Results indicated that subjective and physiological reactions to active coping stressors were predicted by cognitive appraisals. Subjective reactions were in line with the predictions of Lazarus and Folkman’s SCT (1984). Physiological reactions on the other hand were not in line with SCT; physiological activity was greater for participants who expressed challenge than those who viewed the task as threatening (Tomaka et. al, 1993). These physiological results were directly in line with BPS Model predictions.

Given the results of Study 1, a second study was conducted in which researchers updated primary appraisal assessment to include a specific question of task threat and ability to cope and also included cardiac and vascular measures. Study 2 used a mental arithmetic task extremely similar to the main task used in Study 1. Similar to Study 1, the results of Study 2 revealed that subjective stress is greater when participants perceive the task as a threat rather than a challenge. Further, cardiac responses, but not TPR, were
higher for those who perceived the task as a challenge than those who viewed the task as a threat (Tomaka et. al, 1993). Moreover, challenge was more associated with greater pre-ejection period (PEP; a measure of cardiac contractibility), CO, and HR. These physiological patterns were in line with the predictions of the BPS Model (Blascovich & Tomaka, 1996).

Tomaka and colleagues (1993) conducted one final study to test if there was a difference between active versus passive coping and the vascular effect found in Study 2. Cardiac, vascular, and electrodermal physiological measures were recorded among all participants across two conditions. Participants in the active coping condition engaged in the mental arithmetic task used in previous studies. Participants counted aloud for the first 30 seconds of each task and finished the task in silence. The other half of participants who were assigned to the passive coping task viewed graphic pictures of car accident victims, as well as graphic images of head, throat and neck surgeries of cancer patients. Similar images were viewed in the second task. Results of the third study replicate and extend previous findings as threat was associated with greater task related stress than challenge evaluations. Results reaffirmed the finding that cardiac reactivity was higher and vascular resistance was lower when participants appraised the tasks as challenging. Overall, these three studies depict, using the BPS Model (Blascovich & Tomaka, 1996), that cognitive appraisals and resulting coping behavior predict physiological, behavioral and subjective reactions to stressors.

In summary, the BPS Model (Blascovich & Tomaka, 1996) depicts that physiological responses differ between threat and challenge. Measures of HR, VC, CO, TPR and BP all converge to distinguish between threat/challenge and determine task
engagement. Challenge is marked by low TPR and high CO, whereas threat is marked by high TPR and low CO. Task engagement is high if VC and HR are increased. These measures were validated across several studies.

**Framing and the BPS Model**

Pertinent to the present research is a recent study on the BPS model by Seery, Weisbuch and Blascovich (2009). This study is very relevant as the paradigm used serves as the basis for the study that is proposed in this thesis. Seery and colleagues drew together the concept of message framing (for reviews see Updegraff & Rothman, 2013; Gallagher & Updegraff, 2012) with the physiological markers used to assess threat and challenge. At the start of the study, baseline cardiovascular measures were recorded. These measures included a Minnesota Impedance Cardiograph and a Cortronics Blood Pressure Monitor which was continuously inflated. After baseline measures were recorded, participants were given instructions on the Remote Associates Test (RAT; McFarlin & Blascovich, 1984) and a message framing manipulation. The RAT is a standard cognitive performance task which was described as a “reasoning ability” test. The RAT consists of naming a word in an allotted amount of time that connects three other words together. For example, “widow, bite, and monkey” were all correctly connected by the word “spider” (Mednick, Mednick & Mednick 1964). Seery and colleagues presented twelve sets of these words to participants in fifteen second intervals for a total of 3 minutes. After fifteen seconds, participants began working on the next word association. The cardiovascular measures used at baseline were recorded throughout the task.
Prior to the main RAT performance, the researchers employed a message framing manipulation. For the framing manipulation, gain condition participants were told, “in order to encourage your best performance, we are offering a $5 incentive. You will begin with no money, but you will win $.50 for each item that you answer correctly” (Seery, et al., 2009, pp. 310). In contrast, participants in the loss condition were instructed “…you will begin with $5, but you will lose $.50 for each item that you skip or answer incorrectly” (Seery et. al, 2009, pp. 310). Finally, in addition to the gain and loss frame conditions, this study also contained a control condition in which participants were given no incentive for performance.

Results demonstrated that the framing conditions differed from the control in that participants had larger increases in HR and larger decreases in pre-ejection period from baseline. This signals high task engagement in the framing conditions regardless of whether the gain or loss frame of the monetary incentive was employed. These results also indicate that the framing participants were engaged in the task, a necessary component of the BPS Model (Blascovich & Tomaka, 1996). Importantly, the cardiovascular measures of threat and challenge were found to be sensitive to the framing manipulation. Specifically, this study found that the gain frame resulted in higher CO and lower TPR (i.e., markers of challenge) than the loss frame. This indicates participants provided with a positively framed message evaluated the task as more challenging, whereas those provided with a loss frame evaluated the task as more threatening. The results indicate that how task instructions are framed and be a critical determinant of whether individuals respond with a threat or challenge. Gain (positive) frames appear to
lead to more challenge responses, whereas loss (negative) frames appear to lead to more threat responses.

**Integrating Placebo Effects with the BPS Model**

Here it is hypothesized that combining research on coping and placebo effects can benefit these two largely disparate lines of research. Few attempts have been made to join together coping processes and the placebo phenomenon. The goal of the present study was to point to one potential interface between these lines of work and then to test several novel predictions for placebo effects that can be derived from the threat/challenge perspective. A benefit for the coping literature is that this work may show how coping processes are involved in treatment expectation situations.

First, it is theorized here that in placebo paradigms, the administration of the placebo manipulation is akin to providing an individual a resource to cope with a stressor. That is, the expectation of a treatment (placebo or active) can be conceptualized as a resource that allows one to make a challenge rather than threat evaluation. To illustrate this point, consider the following example. A research participant is working on a stressful performance test in an experiment. In the language of the BPS model, the individual would have a threat evaluation if s/he perceives that the current situation demand (the difficult performance test) exceeds her/his resources. However, imagine a participant in a different condition of the experiment is given a drink said to aid task performance. From the BPS model perspective, this energy drink could be viewed as increasing the participants perceived resources—and this increases the chances that s/he would have a challenge evaluation instead of a threat evaluation. Now consider this same example as if it was a placebo paradigm. If this was a placebo paradigm, the participant
without the energy drink would be in a no-placebo control condition. In the second condition, however, when the energy drink is ingested, this would be the placebo expectation group (e.g., if the energy drink is not actually beneficial). As we can see here, giving a treatment expectation is analogous to increasing one’s perceived resource. In placebo studies, which tend to rely on pain and performance tasks, the placebo effect (the difference between a control group and a group given a placebo) may in fact be the difference between challenge or threat responses. The belief that one now has a beneficial treatment leads to the changes for the placebo participants.

In the present study, all participants performed the same stressful task used successfully by Seery et al. (2009). Based on the above theorizing, we compared control participants (no expectation) with placebo expectation participants. It is expected that control participants (those not given the placebo expectation) would display a threat pattern of physiological reactions. Participants in the placebo expectation condition, however, were expected to now have greater perceived resources. As such, it was predicted that participants would display more of a challenge pattern of physiological and performance reactions. If these results were found, it would provide preliminary evidence that placebo effects in performance situations can be the result of differences in challenge and threat evaluations.

Second, in the present study a framing manipulation was also used to alter how participants perceive the placebo expectation. As will be recalled, Seery et al. (2009) found that gain (positive) frames can result in more challenge responses than loss (negative) frames. Following this finding, a framing manipulation would be employed here. A gain frame expectancy (e.g., you will perform better) was hypothesized to lead to
more of a challenge response and better performance on the RAT, whereas loss frame expectancy (e.g., you will not perform as poorly) was expected to lead to more of a threat response and worse performance on the RAT. Using loss frame language thus reduced the challenge response and promotes more of a threat-like response. Therefore, it was predicted that gain-framed expectation participants would have the greatest challenge response. In the language of the placebo literature, these individuals were expected to show the largest placebo effect. As participants given the loss-framed expectation received the expectation of resources they have shown less challenge than those in the gain frame, but more than those in the control group. The expected results were for a linear trend, with the gain-framed expectation group on one end and the control group on the other. These predictions are displayed in Figure 2. The addition of the framing manipulation was valuable as it would provide evidence of a case when placebo expectations can lead to placebo effects (gain frame) and not (loss frame). Thus, it would offer evidence of a theoretically-derived moderating variable of placebo effects from the BPS Model framework.

Finally, it must be noted that the threat/challenge model predictions were not expected to account for all placebo effects. Rather, this is a complex phenomenon that is likely multi-determined depending on the situation or context. The focus here is on how the coping processes described in the threat/challenge model can explain some of the variance in stressor and performance placebo situations. However, this model may not be able to account for responses in other situations such as some nocebo contexts, when treatment responses were due to conditioning, or when the treatment event involves no stress.
In summary, two key predictions were made. First, participants in the control condition would show less challenge responding than participants in either placebo expectation conditions (gain-framed expectation or loss-framed expectation). These differences were expected on both cardiovascular measures as well as measures of task performance. Second, participants in the gain frame expectation condition were expected to show more challenge responding and perform better on the RAT than those in the loss frame expectation condition. Again, these differences ought to be observed on both cardiovascular measures as well as measures of task performance. Finally, all conditions were expected to show higher levels of task engagement during the RAT from baseline.
II. Methods

The methodology of this project is modeled after that used by Seery and colleagues (2009) as described above. The present research manipulated the framing of a placebo expectation to test the predictions that the BPS Model (Bascovich et al., 1996). The primary difference between the current study and the Seery et al. research is that the monetary incentive is no longer used for the framing manipulation. Rather, an expectation manipulation—more appropriate for the study of placebo effects—is used. This manipulation is described in detail below.

Participants and Design

One hundred forty (63 male, 77 female) University of Toledo undergraduate students 16 years of age or older were recruited from the Department of Psychology human participant pool. After filtering for participants whose language was not English or if there was an equipment malfunction during data collection we were left with a final sample size of 106 for data analysis. As can be the case with physiological data collection, some additional points of data were lost during recording for specific participants. As a result, some analyses involving physiological data have a reduced sample size. Participants ranged in age from 16 to 33. Sixty-nine were White, 26 were African American, 4 were Asian, 1 was Native American/Pacific Islander, and 6 did not specify race. All procedures were approved in advance by the Institutional Review Board of the University of Toledo. All participants received partial course credit in return for their participation.

In this study there was a control group (no expectation) and two expectation groups. One expectation group received a gain-framed expectation and the other a loss-
framed expectation manipulation. Following this manipulation, participants in all conditions completed the RAT as the main stressor. Throughout participant’s time in the lab, physiological measures of threat and challenge were recorded.

Materials and Measures

Health History Questionnaire and Demographics At the beginning of the experiment, participants were asked to answer a series of personal health history questions (Appendix A). The questions included height and weight, use of prescription medications, and recent injury. Additional questions assessed whether the participant had a cardiac illness, took cardiac or allergy medication, or medication that could affect alertness. Participants who responded affirmative to these questions were not permitted to participate in the study. Standard demographic questions including date of birth, ethnicity and GPA were also on the health history questionnaire.

Cardiovascular Measures Testing the main hypothesis of threat and challenge required the use of an impedance cardiograph (ZKG), electrocardiograph (ECG), blood pressure monitor, non-invasive spot electrodes, and a BioPac machine. BioPac is a data acquisition and analysis system utilized for research across science domains involving living beings.

Five specific physiological measures were used to distinguish between threat and challenge in research on the BPS model. These include HR, VC, CO, TPR, and BP (Blascovich et al, 2004). VC is a measurement of the contracting force of the left ventricle. CO measurements record the total number of liters of blood the heart pumps per minute. TPR compares net values of constriction and dilation of arterial pressure (Blascovich et al, 2004). These five measures were calculated differently to account for
task engagement, challenge, and threat. All cardiovascular measures were non-invasive and recording strategies followed accepted guidelines as per typical practice in the field (Sherwood, Allen, Fahrenberg, Kelsey, Lovallo, & van Doornen 1990).

**Supplementary Questions** Participants were asked to complete a series of dependent measures after the RAT in order to supplement the physiological and performance measures. Participants rated how the RAT made them feel on seven nine-point scales (tense to calm, bored to excited, sad to happy, anxious to relaxed, bad to good, negative to positive, unpleasant to pleasant). These seven feelings were averaged with high internal consistency and were used to assess affective reactions to the RAT ($\alpha=.873$). Other supplementary questions included how demanding participants found the word task (RAT) to be, how difficult the study tasks were, how well participants think they performed, if participants felt they had the resources to successfully perform the task, and if the participants treated the word task as a challenge to overcome (Appendix B). These items were incorporated as self-report measures to assess perceived threat and challenge. These items were exploratory, as prior research on the BPS model often does not find self-report measures to mirror the findings on the physiological measures (see Seery, 2013).

**Manipulation Check Item** To assess the effectiveness of the experimental manipulation, the following question was asked at the end of each study session: “At the beginning of the experiment, the experimenter may have explained to you the purpose of completing the Mind Clearing or Baseline task. Please verify that you were told the purpose of this study by selecting the correct reason from the options listed below:” (Appendix B). Control participants were expected to have selected the answer that the
experimenter did not provide any explanation. Participants in the gain-framed expectation group were expected to have selected the answer that the purpose was to increase cognitive performance and help them do better on the word task. Finally, participants in the loss-framed expectation group were expected to have chosen that the purpose was to increase cognitive performance and help them to not do as poorly on the word task.

**Mind Clearing Exercise** In the first exercise of this study, all participants were asked to clear their minds. Those in the control condition were told that clearing their mind was a necessary part of physiological baseline recording used to obtain good baseline measures. For the two experimental conditions, participants were asked to engage in “Mind Clearing.” In the positive expectation condition, participants were told:

Before taking part in this cognitive performance task today, we would like you to try a mental relaxation technique that has been found to enhance cognitive functioning and mental flexibility. This task, called Mind Clearing, is very effective in reducing mental distractions. While lowering blood pressure, Mind Clearing boosts creativity, increases memory and improves attention. Physiologically, this task lowers the levels of blood lactate (reducing anxiety), boosts your energy level and increases serotonin production (improving mood and behavior). Finally, Mind Clearing sharpens the mind by improving focus and expands the mind through relaxation. Clearing your mind, given all the clear benefits of the task, will help you *to do better* on the difficult cognitive task later in the study. During this time it really is up to you to clear your mind of
distractions. You must spend time relaxing and being present in the moment.

In the loss-framed expectation condition, participants were given the same instructions, except that clearing their mind would help participants *not do as poorly* on the difficult cognitive task later in the study. This mind clearing exercise serves as a basis for the expectation manipulation. That is, as described below, expectation participants were told that engaging in this task would alter their performance on the next task—the RAT.

**Remote Associates Test (RAT)** The RAT was the main performance task used in this study and was described to participants as a “test of reasoning ability” (Mednick, Mednick & Mednick, 1964; Appendix F). The RAT, successfully employed in the study by Seery et al. (2009), presented participants with a series of three related words and participants had to generate a single word that links these words together. For example, “flood, hot, and photography” were all correctly associated by the word “flash.” Although this measure can consist of up to 68 items, only 12 were used in this study. This version of the RAT is short, and time-pressured. For 3 minutes, participants had 15 seconds to verbally announce their answer to each set before being forced to move on to the next question. If the participant spoke too softly, the experimenter prompted participants to enunciate and speak louder to ensure accurate results.

Additionally, cardiovascular responses tend to peak during the first few minutes one is engaged in a task, and threat is more likely to occur when the test is difficult enough to cause frustration (Blascovich & Tomaka, 1996; Steele, Spencer & Aronson, 2002). In the proposal, the analyses were detailed as having the cardiovascular measures focus in on the first minute of this timed task like Seery et al. (2009). However, as
preliminary data analyses revealed that changes in threat and challenge emerged in both the first and second minute, we used the first two minutes of the RAT as described below in the results section.

The RAT was selected as it fits certain characteristics required by the BPS Model (Blascovich & Tomaka, 1996). First, the BPS suggests that for threat–challenge differences to emerge, participants should be engaged in a personally relevant task. Requiring participants to tell the experimenter of one’s final answer here with the RAT was expected to have helped participants want to perform well as the experimenter was able to evaluate their performance. As noted earlier, the BPS Model suggests that evaluated performances are much more likely to be self-relevant than non-evaluated performances (Blascovich & Tomaka, 1996). Therefore, one advantage of this task is that it required participants to verbalize their answers—and this was expected to have made the performance self-relevant. Second, the task used a time-pressure situation so as to increase the momentary stress on participants.

To assess participant performance on the RAT, an individual’s score on the task was calculated and analyzed. The score on the RAT was determined by totaling the number of correct responses on the 12 trials (Mednick, Mednick, & Mednick, 1964).

Procedure

Upon arrival, participants entered a physiological laboratory and were asked to complete an informed consent document (Appendix F). This form stated that the study involves a laboratory stressor task. The consent form also indicated that participants could discontinue their participation in the study at any time.
After participants agree to take part in the study, they completed the standard health history questionnaire described above (Appendix A). At this point physiological recording measures were fitted to the participants. To measure Impedance Cardiography, small surface electrodes were applied non-invasively to participants. Electrodes were placed at the upper neck, lower back, right wrist, and left ankle. Blood pressure was measured using a Dinamap blood pressure monitor which recorded blood pressure twice per minute.

Participants rested during an initial 10 minute baseline period of mind clearing. The two expectation conditions differed from the control by the framing of this expectation information. Specifically, participants in the gain-framed expectation condition were told that Mind Clearing would enhance their mental abilities and help them to do better on the following RAT task (Appendix D). However in the loss-framed expectation condition, participants were told that Mind Clearing would help them to not do as poorly on the RAT task.

After the Mind Clearing exercise, but before the RAT, participants were taught how to complete the word task and again heard the expectation presented before the Mind Clearing task. For example, participants in the gain-framed expectation condition were told:

You will now engage in a highly challenging cognitive performance task that will assess your aptitude. Performance on this task has been found to predict key indicators of student success at UT, including student GPA, graduation status, and starting career salaries after graduation. For us to study this task, it is very important that you give it your best effort.
Remember, Mind Clearing, is very effective in reducing mental distractions. While lowering blood pressure, Mind Clearing boosts creativity, increases memory and improves attention. Physiologically, this task lowers the levels of blood lactate (reducing anxiety), boosts your energy level and increases serotonin production (improving mood and behavior). Finally, Mind Clearing sharpens the mind by improving focus and expands the mind through relaxation. Having cleared your mind, given all the clear benefits of the task, will help you *to do better* on the difficult cognitive task.

Finally, participants in the Mind Clearing exercise were reminded of the potential influence of this task on RAT performance.

Next, all participants performed the RAT for 3 minutes. Participants were not told during the trials if the answer they gave was right or wrong. Afterwards, participants answered questions about the tasks and the manipulation check item (Appendix B). At this point, all cardiovascular sensors were removed. Finally, at the end of the study, participants were thanked for their participation and debriefed using funnel debriefing (Appendix E). This specific type of debrief is used to assess participants’ suspicion of the expectation manipulation, what they thought the study was about, and prior knowledge of the study. Responses to these questions provide a better understanding of the data obtained.
Results

A set of fixed effect, omnibus, one-way ANOVA, ANCOVAs, and a repeated measure ANCOVA with three levels (control, gain-framed expectation, and loss-framed expectation) were the primary means of analysis for these data. These ANOVAs and ANCOVAs were followed up with planned contrasts when needed to test the specific hypotheses. The two planned contrasts were (1) directly comparing the expectation conditions (gain and loss) versus the control condition and (2) and analyzing for a linear trend across the three conditions (with the anticipated pattern being for more evidence of challenge in the following order: gain-framed expectation, loss-framed expectation, and then no expectation). All tests were set as two-tailed, alpha <.05.

Manipulation Check Analysis

A chi-square test of independence was conducted on the manipulation check question. A variable was created to test whether participants answered the manipulation question correct or not as based on condition where 1 was coded as incorrect and 2 was correct. The outcome of the chi-square test of independence revealed that answering the manipulation check question correctly was significantly related to condition \( X^2 (2, N = 106) = 65.95, p < .001, \Phi = .79 \). Of the 33 participants in the control condition, 32 (97%) answered the manipulation check question incorrectly; of the 37 participants in the loss-frame expectation condition, 34 (91.9%) answered the manipulation check question incorrectly and 6 (16.7%) answered the manipulation check question incorrectly in the gain-framed expectation condition. For percentages, see Table 1. Most excluded participants answered the manipulation check question incorrectly as well., \( X^2 (2, N = 34) = 20.24, p < .001, \Phi = .72 \). Of the 13 participants in the control condition and 12
participants in the loss-framed conditions, 100% of participants answered the manipulation check question incorrectly. Of the 9 participants in the gain-framed conditions 3 (33.3%) participants answered the question incorrectly. These data indicate that there were unanticipated condition differences on the manipulation check, with participants in the control and loss-frame expectation conditions answering incorrectly more than participants in the gain-framed expectation condition. This was surprising, as participants in all three conditions were expected to answer the manipulation check correctly.

**RAT Performance**

To analyze mean performance on the RAT, total correct RAT scores was subjected to the one-way ANOVA described above. It was expected that this ANOVA would yield a significant effect of condition. This hypothesis was not supported. There was not a significant main effect of condition on the number of RAT words correctly stated, $F(2,102)=1.676, p=.192$ (Figure 5). A linear planned comparison indicated that there was no significant linear trend across conditions $t(102) = .173, p = .678, 95\% \text{ CI} [-.850, .555]$. Further a planned comparison found no significant difference between the control and placebo conditions $t(102) = .224,95\% \text{ CI} [-.332, 1.402]$. The RAT measure includes items set to have different levels of difficulty. As such, a secondary analysis was run to assess whether there was a significant effect of condition on RAT performance at the four levels of RAT question difficulty: very easy, easy, medium and hard. These tests did not yield any significant effects ($ps > .08$). Finally, this analysis was conducted on the excluded participants. No significant difference was found for number of RAT words answered correct $F(2,32) .07, p=.935$. 

33
Physiological Data Acquisition

Next, the physiological data were examined. BioPac software was used to conduct an Impedance Cardiography analysis for each participant. First, a dZ-dt classifier was run. Here, the dZ-dt channel and ECG channel were selected. Next, a representative cycle is highlighted within the dZ-dt data. An entire single cycle was selected as necessary for use in template matching. A single cycle was consistently selected from the last 10 seconds of baseline recording across participants. The ICG analysis was then conducted. Within this, channels were designated for raw Z, dZ-dt, d²Z-dt², and arterial blood pressure (mean 80mmHg). From this analysis, an excel file was generated for each participant.

In order to make sense of the excel file data, the data was transferred into SPSS and then computed into minute one through minute ten of baseline, as well as, minute one through three of RAT variables. Before creating these variables, cycles were removed based on the following filter: CO ≤ 36 & PEP ≤ .42 & LVET ≤ .42 & SV ≤ 131 & SV ≥ 50. The range 50 to 131 was used for SV as it is the range a person can reach while exercising. As threat and challenge exhibit cardiac like responses, the normal resting range would lose the threat/challenge response if cycles were filtered out using a resting range. For CO, the exercise max range of 36 was used as CO can be up to four times the highest normal range (i.e., 8) when exercising.

Cardiovascular reactivity of all measures were captured by subtracting the measurement taken at the final minute two minutes of baseline from the measurement taken during the first two minutes of the RAT, the point at which participants were most
likely to display the threat/challenge reaction. These change scores were used in all further analyses as people vary greatly on their set point on physiological indices.

**Analysis of Task Engagement**

In testing for physiological differences in threat and challenge, participants were first assessed for evidence of task engagement. To evaluate whether or not participants were engaged the task, a repeated measures ANCOVA was conducted using HR and PEP (indicators of engagement), with height and weight used as a covariates. Missing values were replaced in the weight variable by the median score as there were 4 participants who did not report their weight. Height and weight were included as covariates in all physiological analyses because preliminary analyses revealed that both were significantly related to scores on the physiological measures. As HR and PEP are both measures of task engagement, these measures were combined into a single index of task engagement by following the procedures of Seery et al. (2009). To do so, HR and PEP baseline and task scores were converted into z-scores for each participant. Next, PEP scores were reverse scored so that on both measures higher scores equate to greater task engagement. Finally, the HR and PEP scores were summed separately for baseline and task. To analyze task engagement, the summary engagement score from the final two minutes of baseline and the first two minutes in the RAT task was subjected to a repeated measure ANCOVA. It was expected that participants all in three conditions would show an increase from baseline on this dependent measure (Figure 4). Thus, a within-subject effect of time was expected. No condition main effect or interaction was anticipated, as all groups were expected to display task engagement. These hypotheses were not supported. Specifically, engagement did not increase from baseline during the RAT task.
as was anticipated, $F(2,83) = 1.14$, $p = .32$. Surprisingly, an unanticipated effect of condition was found, $F(2,83) = 8.00$, $p = .001$ (Figure 7). Pairwise comparisons yielded a significant difference between the control and loss-framed conditions $p = .017$, 95% CI [.27, 3.54], as well as between the control and gain-framed conditions $p = .001$, 95% CI [.96, 4.31]. No significant difference was found between the gain-framed and loss-framed conditions. $p = .88$, 95% CI [-.96, 2.43]. For task engagement, when controlling for participant sex, height and weight, there is still a significant effect of condition $F(2,82) = 7.96$, $p < .001$, however participant sex is not significant, $F(1,82) = 1.95$, $p = .167$.

To follow-up on these analyses that used the combined HR and PEP dependent variable, we also analyzed HR and PEP separately. When analyzed separately, HR, $F = .99$, $p = .37$ and PEP, $F = .38$, $p = .69$, yielded the same results as the combined engagement variable. For means, see Table 2. Further, task engagement using height in inches and weight as covariates was not significant for the excluded participants, $F(2,27) = .854$, $p = .44$. Additionally, there was no significant effect when including participant sex as a covariate, $F(2, 26) = .822$, $p = .45$, nor was participant sex significant, $F(2,26) = .002$, $p = .96$.

**Analysis of Threat and Challenge**

A one-way ANCOVA was conducted to analyze markers of threat and challenge: TPR and CO. TPR was calculated by dividing mean arterial pressure (MAP) by CO. CO was calculated by HR x SV. Because changes in CO and TPR are both indicators of SAM versus HPA activation, TPR and CO was converted into z-scores and summed. This created a challenge/threat index used by Seery et al. (2009). Prior to summing, CO
scores were reversed scored so that TPR and CO responses share the same directionality: higher scores equal greater challenge and less threat.

To analyze this threat/challenge index, scores on this measure were subjected to the one-way ANCOVA and planned contrasts. Results were predicted to show that the gain-framed expectation group display the greatest challenge followed by the loss-framed expectation group and finally, the control group would show the least amount of challenge (Figure 2). Consistent with this hypothesis, there was a significant effect of condition on threat/challenge responding after controlling for height in inches and weight, $F(2, 88) = 3.37, p = .039$ (Figure 8). Planned contrasts revealed a significant difference between the control and placebo expectation conditions, $p = .013$, 95% CI [-3.28, -.402]. Linear planned contrasts revealed a significant difference between conditions, $p = .016$, 95% CI [.284, 2.650]. Means depict that the conditions lined up with predictions. Specifically, the control condition had the lowest challenge response ($M = -1.51$), then the loss-framed expectation showed more challenge responding than the control condition ($M = .23$) however the gain-framed expectation condition yielded the most challenge responding ($M = .56$).

To follow-up on the threat/challenge analyses that used the combined CO and TPR dependent variable, we also analyzed CO and TPR separately. When analyzed separately, CO, $F = .844, p = .43$ and TPR, $F = 1.82, p = .17$ were not significant. Degrees of freedom for these analyses are 2, 92. This differs from the combined CO and TPR analysis, suggesting that loss of error causes the separate analyses to be insignificant. For means, see Table 3. For CO and TPR, no significant planned contrasts were found. Further, controlling for participant sex alongside height and weight makes the model less
significant, $F(2,92)=3.12$, $p=.049$. Controlling for baseline values of challenge responding, however, makes the model more significant, $F(2,87)=3.95$, $p=.023$. Linear planned contrasts yield a significant difference, $p=.008$, CI [0.342, 2.248]. Further, planned contrasts depict a significant difference between the control and placebo expectation conditions $p=.008$, CI [-2.71, -0.423]. Challenge responding was not significant for excluded participants when controlling for height and weight, baseline challenge responding, or participant sex ($p > .58$).

**Analysis of Supplementary Questions**

All supplementary questions were analyzed. First, an additional ANOVA of how participants felt about completing the RAT task was investigated. Although trending toward significance, no significant effect of condition on task feelings was found, $F=2.489$, $p = .088$. Also, no significant linear planned contrast was found, $p = .24$. Further planned contrast did not yield a significant contrast between the gain-framed and loss-framed expectation conditions, $p = .07$, or between the control and expectation conditions, $p = .91$. For means, see Table 4. Next, univariate analyses tested for differences on the RAT via beliefs about performance (Table 5), confidence of performance (Table 6), perceived difficulty (Table 7), demandingness (Table 8), whether the task was treated as a challenge to overcome (Table 9), perceived availability of resources for success (Table 10) and whether participants thought they performed well (Table 11). None of these analyses yielded any significant effects ($F_s < 1.42$, $ps > .25$).

For excluded participants, there was a significant difference of task feelings, $F(2,33)=3.72$, $p=.036$. Planned linear comparisons yielded a significant effect $p=.038$, CI [-1.405, -0.042]. Further, there was a significant difference between the control and placebo
expectation conditions $p=.01$, CI [.258, 1.83]. Means depict that the control (M=6.06) condition showed greater enjoyment of the task than the loss-framed (M=4.99) and gain-framed (M=5.03) conditions. A significant effect was found for whether excluded participants expected that clearing their mind would help them to perform better on the word task $F(2,31)= 5.37$, $p= .008$. The gain-framed group differed from the control $p=.03$, CI [.13, 2.49], and loss-framed group $p=.01$, CI [.32, 2.63]. No significant difference for Mind Clearing effort, motivation, task completion effort, confidence, rating of experience, task liking, difficulty, treating the task as a challenge, perception of resources to be successful was found ($Fs > .24$, $ps > .15$).

**Discussion**

Can the Biopsychosocial Model (BPS) of Threat and Challenge help explain the occurrence of placebo effects? The present research was conducted to combine the literature on stress and coping with that of placebo effects in order to answer this question. Participants arrived to the lab, were connected to physiological equipment and then engaged in the Mind Clearing placebo task. From here, participants completed a difficult performance task (RAT) and answered supplementary questions before they were debriefed. Consistent with the BPS model, during the RAT, participants given a gain-framed placebo expectation displayed more of a challenge response. Participants given a loss-framed placebo expectation or no expectation displayed more of a threat response. Although these findings are encouraging, the results on the manipulation check question and the other dependent variables did not line up with hypotheses. Below the findings are reviewed in greater detail.
Manipulation Check Data

Participants were asked to verify the purpose of completing the Mind Clearing or Baseline task to assess the effectiveness of the experimental manipulation. Control participants were expected to confirm that no explanation was provided. Participants in the gain-framed expectation condition were expected to remember that the purpose was to increase cognitive performance and help them do better on the word task. Participants in the loss-framed expectation condition were expected to have chosen the purpose was to increase cognitive performance and help them to not do as poorly on the word task.

After coding for whether participants had answered the manipulation check question correctly or not, a chi-square revealed that participants in the gain-framed expectation condition did best at recalling the instructions they received (16.7% incorrect) as compared to the loss-framed expectation condition (91.9% incorrect) and control condition (97% incorrect). Percentages depict that the loss-framed expectation and control conditions largely answered the manipulation question incorrectly. When choosing a response, most participants marked that the purpose of having engaged in the Mind Clearing/Baseline task was to increase cognitive performance and help them to perform better on the word task. When participants were incorrect, the tendency to choose the gain-framed expectation explanation was substantial. This clearly raises some concern for the data collected.

Participants were expected to recall the expectation told to them as it was carefully repeated throughout the study. The wording of the manipulation question, however, may have been unclear or confusing to participants. One reason most participants failed this manipulation check may be that they found it difficult to
remember the precise message they heard. Thus, they may have been influenced by the message, yet not know what precisely influenced them (Nisbett & Wilson, 1977).

Further, participants in the study may not have been able to fully recall what instructions this question was referring to. As there were many instructions throughout the study (e.g., about using the physiological measures, about the RAT task), participants could have found this question too vague. If this is the case, why were most errors made by selecting the “increases cognitive performance” explanation? One possibility is that, in order to choose a response, participants may have decided that this gain-framed expectation explanation sounded like the best response option for a research study. That is, this explanation might have seemed like the “right” choice in the psychology experiment—as participants may have held the default belief that psychologists are most likely to want to improve student performance. As such, participants may not have remembered why they engaged in the Mind Clearing or Baseline task, but it may have seemed reasonable that the study was about increasing performance. This explanation is clearly speculative, but, does make sense with the pattern of results obtained on this measure.

**Hypothesis One: Task Engagement**

Based on the BPS model and the results of Seery et al. (2009), all three conditions were expected to show an equal increase in task engagement. Inconsistent with this hypothesis, differences in task engagement between baseline and RAT were not found for the groups. Instead of this predicted within-subject increase in engagements for all conditions, a repeated measure ANCOVA yielded a significant effect of condition. Thus, unexpectedly, there were differences in task engagement amongst conditions.
Contrary to the hypothesis, the control condition was more engaged than the expectation groups resulting in differences across baseline and RAT scores. The difference started at baseline and continued through the RAT. Expectations changed the engagement level, of participants in the placebo expectation conditions, from the beginning of the study and may have caused them to relax more. Further, participants in the control condition did not receive any expectation, instead they were provided with a more medical/physiological explanation. This could have caused the control condition participants to be more vigilant in attending to the RAT. Control participants could have been doing something physiologically during baseline which influenced responses during the RAT as well.

A second explanation for the control condition being more engaged than the placebo expectation conditions a failure of randomization. Although rare, the control group could have had higher physiological scores from the beginning. A significant difference was found between the control and placebo expectation conditions for task engagement. No significant difference was discovered between the two placebo expectation groups, however. The level of engagement differences between conditions may be most easily explained by focusing in on the perspective of the two expectation groups. Participants in the expectation conditions could have been less engaged than the control participants as they were given the expectation of performing well on the RAT. These participants may have relied too heavily on the expectation to boost performance and thus did not engage in the task as much as control participants. Placebo expectation participants had already engaged in Mind Clearing, which previously provided participants with an edge to overcome the RAT challenge. Having this edge could have
allowed placebo expectation participants to believe they would not have to work as hard to do well. This belief could lead to less engagement. One complication to this explanation is that placebo expectation participants did physiologically differ from the control (through challenge responding). The control condition did not have an expectation to draw from for help in completing the RAT. Control participants lacked a tool (expectation) to help complete the RAT, and thus may have become more engaged to perform well on the challenging task.

The results of the task engagement analysis do not align with the predictions of the BPS Model. The BPS Model states that task engagement must occur for threat/challenge differences to be found. The present study did not yield a main effect of task engagement, however differences in challenge responding were found. Perhaps these results depict that increased task engagement does not happen all the time. Different environments and manipulations may cause differences in the amount of task engagement one could have. Future research needs to discover in which situations and through which manipulations challenge and threat can occur with various levels of task engagement.

**Hypothesis Two: Placebo Expectation Conditions versus Control**

Hypothesis two stated that participants in the control condition would show less challenge responding than participants in either placebo expectation conditions (gain-frame expectation or loss-frame expectation). Specifically, the control condition had the lowest challenge response and the loss-framed expectation showed more challenge responding than the control condition. The gain-framed expectation condition, however, yielded the most challenge responding of all three conditions.
The impact of the expectation provided is depicted by differences in challenge responding across conditions. The placebo effect was produced through the way participants physiologically responded to their experience. As hypothesized, placebo expectation framing (gain and loss) resulted in lower TPR and higher CO in combined analyses (consistent with relative challenge) than the control condition. Providing an expectation resulted in these subsequent changes. The placebo expectations allowed participants to rely on a tool, thought to increase performance, which yields more challenge responding. The BPS model can be used to understand placebo effects, and therefore the present research may have important practical implications for utilizing placebo effects in real life situations.

The difference in challenge responding, between the placebo expectation framed conditions and control condition, extends the work of Seery et. al, (2009) that the markers of challenge/threat are sensitive to the framing of performance results. The use of framing allowed for the discovery that differently framed messages (gain and loss) can yield specific results both physiologically and psychologically. Participants, given different message expectations, became more or less challenged physiologically. This simultaneously resulted in psychological differences in evaluating performance from the control condition through placebo responding. Participants provided with a placebo message frame evaluated the task as more challenging whereas those provided with a no message frame (control) evaluated the task as more threatening. The expectancy account of placebo effects explains such changes by suggesting that the effects are the consequence of one’s belief that a message frame will yield a certain outcome on performance.
Although not fully, this work demonstrates that placebo expectations do have an impact on stress and coping as depicted by physiological reactions. The BPS coping model can explain physiological responses to placebo treatments in stressor/performance situations. Anticipating how one will react (based on an expectation) directly leads to congruent changes in experience. The coping processes described in the threat/challenge model helps explain some of the variance in stressor and performance placebo situations, as marked by physiological measures.

**Hypothesis Three: Gain-Framed Expectation versus Loss-Framed Expectation**

Hypothesis three was that there would be a linear trend among the three conditions on the challenge/threat and performance dependent measures. Participants in the gain-framed expectation condition were expected to have shown more challenge responding and perform better on the RAT than those in the loss-framed expectation condition. The control condition was expected to show the least amount of challenge responding.

For measures of RAT, this hypothesis was not supported. None of the conditions was significantly ordered in a specific way. The RAT task required participants to name a word that associates three other words together. These associations varied in difficulty: very easy, easy, medium and hard. A secondary analysis, assessing the effect of condition on RAT performance via question difficulty was conducted to discover if specified difficulty of associations resulted in differences for task performance amongst conditions. This test was also not significant.

One reason no significant difference was found in the RAT difficulty analyses could be that the RAT is, overall, simply too hard for participants—even the questions
previously judged to be easy—causing a decrease in motivation to engage in the task and perform well. A floor effect may have occurred where participants were unable to do any better on the task. Relatedly, challenge and threat responses likely alter performance through engendering greater or lesser motivation. As such, for performance to be altered, performance outcomes need to be sensitive to effort expenditures. It may be that performance on the RAT is more ability based and might not be sensitive enough to capture motivation differences. It is important to further note that Seery and colleagues (2009) did not find RAT performance differences in their study on framing. As such, it might be that this task is not ideally suited for detecting performance differences due to challenge and threat differences. 

Coping processes typically include cognitively judging an event to be stressful, feeling overwhelmed, and causing one to behave in response to the stressful event (Snyder, 1999). In the present study, participants may not have adequately coped with the stressful RAT task, leading to poor performance. Further, as participants were generally not engaged, their coping strategy may simply have been to disengage from the task. Not being motivated about the task might have seemed like the best behavioral coping mechanism as poor performance would not reflect on the participant. Following poor performance, an external attribution could be made for not doing well so that the performance could not be attributed to the participants’ true abilities—rather, they were not motivated to try. Participants may have believed that only if they did engage in the task could their performance actually say something about their intelligence levels.

Participants may have adjusted what it meant to do well or not do as poorly on the word task to combat initial feelings of threat in terms of persistence. If participants began
the task believing that they would not perform very well, the message frames provided may not have been enough to push participants from the “I will fail” mindset to “I will do okay.” Instead, participants may have thought “I will fail, but not fail as much as I could have” (loss-framed expectation) or “I would have failed much worse if I had not engaged in Mind Clearing” (gain-framed expectation). The individual goal may have become answering a few questions correctly rather than striving to answer every question correctly.

Failure to find effects in RAT performance might also indicate that differences in threat and challenge responding could have been stronger. The attempt here to create threat and challenge responding could have been less than ideal because the placebo expectation may not have been strong enough. As a lot of information was given in the study, perhaps participants did not catch on to the placebo expectation manipulation. This is supported by the fact that the manipulation check question was not significantly different between the control and expectation groups. If a stronger expectation had been used, perhaps the results on the RAT would have come out as predicted. Future studies should have a clear, yet concise and believable expectation manipulation.

**Challenge and Threat: Continuous or Separate**

One discussion point regarding the BPS model that has been raised in the past regards whether or not challenge and threat reactions are continuous. The BPS model suggests that challenge and threat is not dichotomous, but rather exists on a continuum. A person could be more or less challenged at anytime. Given the results of this study, research points to a continuous model of threat and challenge. Specifically this research depicts that there is a range of challenge responding differences between conditions as described
above. The linear trend conducted supports the idea of a continuous model of threat and challenge. If the model was not continuous, the data would not have revealed three different levels of challenge responding by condition.

**Mediators and Moderators of the BPS Model**

Within the BPS Model there are a series of psychological processes linked together which are proposed to cause specific physiological responses. The psychological processes begin with recognizing a motivated performance situation, becoming engaged in the task, evaluating one’s resources and situational demands, and finally end with experiences of challenge or threat. Physiological responses of the model occur as the outcome of the previous psychological processes. As the BPS model is packed with different steps in a causal chain, this model is in effect a mediational model.

An interesting issue for the BPS model is whether more can be said regarding the links between the processes already proposed. For example, the link between recognizing a motivated performance situation and task engagement could be mediated by a person’s perception of a performance situation as important. While some might view some tasks as important, others could view the same task as unimportant. The perception of a situation as important may thus be a key mediator. Further, the perception of importance may be further still mediated by attention shifts. One’s attention would have to shift to the situation at hand, and not other tasks, to be able to determine if the situation is important. In addition, attention shifts could, even further, be mediated by situational cues. If situational cues are not perceived as signaling a change or requiring attention then none of the other steps (attention shifts, perception of importance, task engagement) could
occur. Thus, although not fully depicted in the BPS model, there are many interesting possible linkages to still be uncovered.

In addition to looking more deeply into mediators, future work on the BPS model might also look into moderating variables. For example, after becoming engaged in a task, the next step in the model is to evaluate one’s resources and situational demands. Evaluation of resources and demands could be moderated by one’s level of dispositional optimism. Optimists are most likely to persist in the face of an obstacle, thus exhibiting more of a challenge response. This would be the case as optimists may be more likely to evaluate resources as abundant or helpful in face of the situation. Optimists may have an added resource than pessimists do not. The added resource could be optimism in itself. Optimists are able to believe that they are more likely to succeed, therefore increasing one’s challenge responding.

**Meaningful Application Outside the Lab**

As with all research there should be meaningful application. The present research occurred in a single session, laboratory environment. This research covers only a thin slice of how a person copes with stress and only explores one bit of larger processes that occur in someone’s lifetime. The question remains, however; what is the long term, cumulative effect of threat and challenge? What happens when someone consistently experiences multiple stressors and has a threat or challenge response? One example outcome is that a person learns to typically exhibit threat responses to daily stressors. If this occurred chronically over time, threat responses could lead to unhealthy cardiovascular health, can cause disease, or mental illness.
Threat and challenge can also positively connect to life outside the lab. For instance, generalized anxiety disorder patients can focus on gain-framed expectations in order to feel more challenged when faced with stressful situations. As depicted, loss-framed expectations hinder physiological readiness to succeed. Overtime, changing one’s mindset to feel challenged, and not view situations as threatening, could help to positively change physiological responding and one’s mentality.

Additionally, this research has discovered that the short-term consequences of placebo expectations with threat and challenge may be helpful in improving ones physiological states given diverse cognitive tasks. While differences were not shown on this difficult performance task (RAT), a more engaging or self-selected task may strengthen the relationship.

Other Stressor/Performance Domains

Differences between threat and challenge have been discovered on a variety of performance tasks (e.g. cognitive word tasks, sports an academic performance, etc.). Threat and challenge responding can occur in any situation in which one is stressed by a difficult situation. Applying a placebo expectation to an already engaging task could beneficially help someone in a stressful performance situation. This performance task could be something other than a cognitive performance task. For instance, telling an athlete that some sort of specific exercise may help performance or may help one to not perform as poorly, could lead to differences in the threat/challenge response. Further, providing students with a gain-framed expectation before an exam could lead to greater challenge responding. In sum, placebo expectations could benefit a variety of other performance domains. There are some situations in which placebo effects occur, but there
are also situations in which placebo effects are absent. If one engages in a challenge response to stressors then placebo effects can arise. If the situation is not stressful, then one will not be engaged and no experience of threat and challenge or placebo responding will occur.

Limitations and Future Directions.

Message framing is one way in which this study was able to depict the relationship between placebo effects and the BPS model. As the initial bridge between stress, coping and placebo effects has been built, future research can now work to piece together other moderating factors. For instance, how would nocebo effects influence threat and challenge responding? Can participants generate expectations through self-persuasion that influence BPS Model outcomes? Finally, what other types of performance tasks yield the placebo BPS Model connection: or is the relationship context dependent?

The present research was limited to a US college student sample. As such, the findings detailed may not generalize to other populations or age groups. The results may also be subject to cultural differences as what is perceived as a resource or viewed as a resource might differ in individualistic and collectivist cultures. For example, those in individualistic cultures may view Mind Clearing as more of a resource as it is a tool designed to promote individual achievement. Another limitation is that this research only looked at one placebo paradigm. Additional research must assess in which other placebo paradigms the BPS Model applies.

Future research should consider using a stronger expectation manipulation. A stronger expectation manipulation could serve to increase the differences amongst conditions, further allowing for threat/challenge differences. The expectation
manipulation provided to participants was specific. For example, those in the gain-framed manipulation condition were provided with the expectation that having previously engaged in Mind Clearing “would help you do better.” Additional studies could use a less specific expectation, allowing participants to self-generate how Mind Clearing could help them on later performance tasks. Future studies should also include an “unsure” answer option for the manipulation check. This would allow for participants to mark if they could not remember an expectation rather than simply choosing one. Further research must additionally utilize a better performance task. The RAT worked well to cause stress and the need for coping, but the lack of differences in word association completions may change if the task was not so difficult.

Finally, present research focused in on the influence of a single stressor. Unfortunately, life outside the lab rarely involves facing a single stressor at a time. Instead the pressures from several different aspects of life tend to require attention and coping strategies. Future research should assess how multiple stressors influence the placebo/ BPS Model connection in order to apply better to real life situations.

Conclusion

The current project examined the possibility that the BPS Model of Threat and Challenge can explain how and when placebo expectations benefit task performance. According to the BPS model, individuals experience more of a “challenge response” when they perceive themselves as having enough resources to handle a task, or a “threat” response when they do not. Here it was theorized that placebo expectations increase perceptions of resources and thus prompt more challenge responding, which benefits performance outcomes. To test this idea, student participants were given a placebo
expectation (gain or loss-framed) or no expectation prior to a difficult performance task. Consistent with the BPS model, participants given a placebo expectation displayed physiological indicators of challenge, whereas no expectation participants displayed physiological indicators of threat ($p<.05$). Further, and consistent with prior BPS model research, gain-framed placebo expectations produced stronger challenge responding than loss-framed placebo expectations. Ultimately, the BPS model can help explain placebo effects.
Footnotes

1. BP is required to measure TPR, but is not a specific threat/challenge marker (TPR x CO – mean arterial pressure; Seery, 2011). BP cannot account for challenge or threat solely, as BP changes could reflect both based on the TPR/CO equilibrium. High BP can occur with either high TPR or high CO (Seery, 2011).
References


Figure 1: Overview of the biopsychosocial model (Seery, 2011).
Figure 2: Expected results depicted as levels of challenge responding.
Figure 3: Expected results depicted as levels of correct number of RAT word associations solved.
Figure 4

Expected Task Engagement

<table>
<thead>
<tr>
<th>Levels of Task Engagement</th>
<th>Control</th>
<th>Positively Framed</th>
<th>Negitively Framed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Figure 4: Expected results as depicted as levels of task engagement.
Figure 5. Number of RAT associations answered correct by condition.
Figure 6: Mean number of word associations answered correct by difficulty per condition.
Figure 7: Mean level of task engagement by condition.
Figure 8: Mean challenge responding by condition.
Table 1: Percent of participants whether or not participants answered the manipulation question correctly.

<table>
<thead>
<tr>
<th></th>
<th>Condition</th>
<th>Loss-Frame</th>
<th>Gain-Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard Deviation</strong></td>
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<td>.28</td>
<td>.38</td>
</tr>
<tr>
<td><strong>Count</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Incorrect</td>
<td>1</td>
<td>34</td>
<td>6</td>
</tr>
<tr>
<td>Correct</td>
<td></td>
<td>3</td>
<td>30</td>
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<tr>
<td><strong>% Within Condition</strong></td>
<td>97.0%</td>
<td>91.9%</td>
<td>16.7%</td>
</tr>
<tr>
<td>Incorrect</td>
<td>3.0%</td>
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<tr>
<td>Correct</td>
<td>8.1%</td>
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<td>83.3%</td>
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Table 2

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<th>Condition</th>
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<th>PEP</th>
<th>SD</th>
<th>Combined</th>
<th>SD</th>
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<tr>
<td>Control</td>
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<td>1.01</td>
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<tr>
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<td>.16</td>
<td>1.05</td>
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<td>Control</td>
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<td>1.12</td>
<td>.42</td>
<td>1.36</td>
<td>-1.23</td>
<td>3.65</td>
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Table 2: Z-Score Mean Task Engagement for HR, PEP and combined across time points.
Table 3

<table>
<thead>
<tr>
<th>Condition</th>
<th>TPR</th>
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<th>CO</th>
<th>SD</th>
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<td></td>
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<td>Control</td>
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<td>.01</td>
<td>.26</td>
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<td>.32</td>
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<td>4.38</td>
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<td>1.12</td>
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<td>.32</td>
<td>-.49</td>
<td>3.71</td>
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<td><strong>RAT</strong></td>
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<td>.97</td>
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<td>3.51</td>
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<td>-.08</td>
<td>1.07</td>
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<td>3.89</td>
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<td>-.11</td>
<td>1.01</td>
<td>.56</td>
<td>4.43</td>
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Table 3: Z-Score Mean Threat/Challenge for TPR, CO and combined across time points.
Table 4

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
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Table 4: Mean ratings of participant’s feelings toward the RAT.
### Table 5

<table>
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<tr>
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<th>Mean</th>
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<td>Loss-Frame</td>
<td>4.72</td>
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Table 5: Mean ratings of whether participants thought clearing their mind would help them to perform better on the RAT.
Table 6

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<td>Loss-Frame</td>
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<td>1.81</td>
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Table 6: Mean ratings of whether participants felt confident that they would be successful on the RAT.
Table 7

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Standard Deviation</th>
</tr>
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<tr>
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<tr>
<td>Loss-Frame</td>
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<td>1.75</td>
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Table 7: Mean ratings of participants perceived difficulty of the RAT.
Table 8

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<td>Loss-Frame</td>
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Table 8: Mean ratings of how demanding participants found the RAT to be.
### Table 9

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Table 9: Mean ratings of whether participants treated the RAT as a challenge to overcome.
Table 10: Mean ratings of whether participants felt like they had the resources to successfully perform the RAT.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>Standard Deviation</th>
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<tbody>
<tr>
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Table 11

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</tbody>
</table>

Table 11: Mean ratings of whether participants thought they performed well on the RAT.
Appendix A.

Personal Health History

Height______________Weight______________Date of Birth______________

Ethnic Background: _____Caucasian   _____Black   _____Asian
   _____Hispanic   _____Native American
   _____Other—please specify ________________________________

Gender (please circle one)       MALE       FEMALE
What is your GPA?
What year are you in college?
Are you currently under a doctor’s care? ______________________________
   If so, for what? ______________________________

Are you currently taking any prescription medication? __________________
   If so, what? ______________________________

Have you had any physical injuries in the past 48 hours? If so, explain?________
Do you have a cardiac illness?
   If so, what?
Do you take any cardiac medications?
   If so, what?

Do you take any blood pressure medications?
   If so, what?
Do you take any allergy medications?
   If so, what?
Do you take any medication that can affect alertness?
   If so, what?

Tacked on Questions:
I expect the upcoming task to be demanding
1 2 3 4 5 6 7
not at all very much

   I expect to have the resources to perform the upcoming task successfully.
1 2 3 4 5 6 7
not at all very much
Appendix B
Supplementary Questions

Please answer the following questions as accurately as possible.

1) How unpleasant did it feel to engage in the word task?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>extremely unpleasant</td>
<td>extremely pleasant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

2) How anxious did you feel during the word task?

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<tr>
<th></th>
<th>1</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>not at all anxious</td>
<td>very anxious</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3) How anxious did you feel during the word task?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>not at all anxious</td>
<td>very anxious</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4) How would you rate your experience of the word task?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>extremely negative</td>
<td>extremely positive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5) On the following scales, please rate how you felt during the word task:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>uncomfortable</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>tense</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>bored</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>sad</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>anxious</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>bad</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>negative</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>unpleasant</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>comfortable</td>
<td></td>
<td></td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
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<tr>
<td>calm</td>
<td></td>
<td></td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
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<tr>
<td>excited</td>
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<td></td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
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<tr>
<td>happy</td>
<td></td>
<td></td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>relaxed</td>
<td></td>
<td></td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>good</td>
<td></td>
<td></td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>positive</td>
<td></td>
<td></td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>pleasant</td>
<td></td>
<td></td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

6) How much did you like or dislike completing the word task?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dislike</td>
<td>like</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>very much</td>
<td>very much</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7) Would you be willing to participate in another study using the word task in the future?

1  2  3  4  5  6  7
not at all  very much

8) During the study, did you feel as if you wanted to please, or help out, the experimenter?

1  2  3  4  5  6  7
not at all  very much

9) Prior to having physiological measures collected, how at ease did you feel about your participation?

1  2  3  4  5  6  7
not at all  very much
at ease

10) At the beginning of the experiment, the experimenter may have explained to you the purpose of completing the Mind Clearing or Baseline task. Please verify that you were told the purpose of this study by selecting the correct reason from the options listed below:

A. To increase cognitive performance and help me do better on the WORD TASK
B. To increase cognitive performance and help me not do as poorly on the WORD TASK
C. The experimenter did not provide me any explanation

11) How hard was the word task?

1  2  3  4  5  6  7
not at all very hard
all hard

12) How hard was the word task?

1  2  3  4  5  6  7
not at all very hard

13) Did you find the word task to be demanding?

1  2  3  4  5  6  7
not at all very much

14) Did you treat the word task like a challenge to overcome?

1  2  3  4  5  6  7
not at all very much
15) How well do you think you did on the task?

1 not good at all
2
3
4
5
6
7 very good

16) I felt comfortable performing the word task.

1 not at all
2
3
4
5
6
7 very much

17) I had the resources to perform the word task successfully.

1 not at all
2
3
4
5
6
7 very much
Appendix D
Remote Associates Task (RAT)

Write participant answers in the blanks below. Circle final answers if necessary. Compare answers to correct ones in **BOLD** and write number of correct responses at bottom along with time remaining.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Falling - Actor - Dust</td>
<td>STAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Broken - Clear - Eye</td>
<td>GLASS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Widow - Bite - Monkey</td>
<td>SPIDER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Time - Hair - Stretch</td>
<td>LONG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Bald - Screech - Emblem</td>
<td>EAGLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Rabbit - Cloud - House</td>
<td>WHITE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Salt - Deep - Foam</td>
<td>SEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Square - Cardboard – Open</td>
<td>BOX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Lick - Sprinkle - Mines</td>
<td>SALT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Chocolate - Fortune - Tin</td>
<td>COOKIE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Mouse - Sharp - Blue</td>
<td>CHEESE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Sandwich - Golf - Foot</td>
<td>CLUB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL CORRECT:**

**TIME LEFT (in seconds):**
Appendix E
Funnel Debriefing

1. Were all the directions clear and easy to understand?  Yes  No
   If no, what was confusing?

2. Did a friend or classmate tell you anything about this study?  Yes  No
   If yes, what did they tell you?

3. Was there anything you think might have altered your responses in some way?  Yes  No
   If yes, what do you think may have influenced your responses and in what way?
Appendix F
Consent Form

ADULT RESEARCH SUBJECT - INFORMED CONSENT FORM
Evaluations of Challenge

Principal Investigator: Dr. Andrew Geers, Associate Professor (419) 530-8530

Purpose: You are invited to participate in the research project entitled, Evaluations of Challenge which is being conducted at the University of Toledo under the direction of Dr. Andrew Geers. The purpose of this study is to learn more about subjective experience and cognitive performance as it pertains to different methods and tasks.

Description of Procedures: Procedures: This research study will take place in the Psychology Research Laboratory in University Hall. First, you will be asked to complete several questionnaires that ask you about your daily behaviors, health history, and feeling states. Next, you will be asked to take part in a task in which you will have surface electrodes placed on your lower back, the back of your neck, right wrist and left ankle. These electrodes monitor physiological reactions only and will not cause any harm to you. If you wish to discontinue your participation in this task at any time, you may do so. Then you will complete two cognitive tasks, one of which is a laboratory stressor task. Finally, you will be asked to complete another set of questionnaires about your experience in this study. This participation will take about 60 minutes.

After you have completed your participation, the research team will debrief you about the data, theory and research area under study and answer any questions you may have about the research.

Potential Risks: There are minimal risks to participation in this study, including loss of confidentiality. Also, some of the aspects of the project, such as the physiological measures, may cause minor psychological uneasiness, discomfort, or stress. You may stop your participation at any time without penalty.

Potential Benefits: Participants will receive 1 experimental credit to partially satisfy their PSY 1010 research exposure requirement for participating in this research. The only other direct benefit to you if you participate in this research is that you will learn about psychology research and you may learn more about aspects of stress and perception. Others may benefit by learning about the results of this research.

Confidentiality: The researchers will make every effort to prevent anyone who is not on the research team from knowing that you provided this information, or what that information is. The consent forms with signatures will be kept separate from responses, which will not include names and which will be presented to others only when combined with other responses. Although we will make every effort to protect your confidentiality, there is a low risk that this might be breached.

Voluntary Participation: Your refusal to participate in this study will involve no penalty or loss of benefits to which you are otherwise entitled and will not affect your relationship with The University of Toledo or any of your classes. In addition, you may discontinue participation at any time without any penalty or loss of benefits. If you decide not to participate or wish to discontinue your participation at any point you will still receive 1 research credit.

University of Toledo IRB Approved
Approval Date: 10/17/14
Expiration Date: 19/16/13

Adult Informed Consent Revised 11.05.10 Page 1 of 2
**Contact Information:** Before you decide to accept this invitation to take part in this study, you may ask any questions that you might have. If you have any questions at any time before, during or after your participation or experience any physical or psychological distress as a result of this research you should contact a member of the research team Dr. Andrew Geers, (419) 530-8530; or Fawn Caplandies, (845) 836-4401.

If you have questions beyond those answered by the research team or your rights as a research subject or research-related injuries, the Chairperson of the SBE Institutional Review Board may be contacted through the Office of Research on the main campus at (419) 530-2844.

Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

**SIGNATURE SECTION – Please read carefully**

You are making a decision whether or not to participate in this research study. Your signature indicates that you have read the information provided above, you have had all your questions answered, and you have decided to take part in this research. It also indicates that you are at least 18 years old or that you have provided the researcher with a signed parental permission form.

The date you sign this document to enroll in this study, that is, today’s date must fall between the dates indicated at the bottom of the page.

<table>
<thead>
<tr>
<th>Name of Subject (please print)</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Person Obtaining Consent</td>
<td>Signature</td>
<td>Date</td>
</tr>
</tbody>
</table>

This Adult Research Informed Consent document has been reviewed and approved by the University of Toledo Social, Behavioral and Educational IRB for the period of time specified in the box below.

Approved Number of Subjects: 300

---

Adult Informed Consent

Revised 11.05.10
Page 2 of 2
Greet participants outside of the experiment room.
Hello, are you here for “Evaluation of Challenges?” And your name is ________? My name is _________. I will be conducting the study. Thank you for helping us today.
Before we begin, I need you to complete an informed consent. It is a requirement of the University that we have participants read and sign a consent form before they take part in a study. Read it over carefully and when you are finished, sign it on the second page. Behind the consent is a survey I need you to fully complete.

Give participants consent form, survey and somewhat close the door. While participant reads the consent form, make sure to set-up Media Labs – Evaluation of Challenge. When they finish, take the papers into the lab room and check to see if they have answered yes to any questions that may influence physiological responding. If they do, we cannot run them in the study. Please tell participants that we have a problem with our equipment malfunctioning or that we do not have enough electrodes.

Please follow me into the lab so we can get started.

Remind participants to put away food or beverages, and to stop chewing gum if they have any. Ask participants to place their cell phone (turned off) and any bracelets or necklaces in the bucket on the corner of the table. Ask the participants to take a seat in the recliner.

In the study today you will have a non-invasive surface electrode attached to your lower back, neck, wrist and ankle in order to record physiological measures of impedance cardiography. Impedance cardiography is a safe and easy way to measure physical functions of the heart. As the term implies, impedance cardiography measures total impedance, or resistance to the flow of electricity in the chest. I will be measuring heart rate, ventricular contractibility, cardiac output, and total peripheral resistance. It will also be necessary to continuously measure your blood pressure during both baseline and the task. These recording procedures are painless and just require that I attach these small sticky patches to your skin (SHOW THE PARTICIPANT AN EXAMPLE ADHESIVE). Are you ready to get started?

Great! Now I need you to take off any sweaters, scarves or jackets that could make application difficult.

Also ask participants to put their hair in a pony tail if it covers their neck.
Place two spot electrodes on the back of the neck, and two on the lower back (ask them to stand when applying to lower back) as shown below. Show and describe the electrodes to participants. Talk them through what you are doing. Wipe the skin with an alcohol pad before applying. You may need to use the gel to remove hair.

**Color Lead EL506 Position** –

1. The 4 wires attached to one hub will attach to the participants back and neck.
   - **white** I+ Neck, top
   - **red** V+ Neck, bottom
   - **green** V- Back, top
   - **black** I- back, bottom

2. Measure the vertical distance (in centimeters) between the upper and lower voltage sensing electrodes and note this value as "L" for later use in the Expression for Stroke volume. (Distance between red and green).

3. Place one EL503 electrode on the right wrist (white inside) and one above the left ankle (red inside)(Lead II without ground).
   a. The 3 wires attached to a different hub will attach to the participant’s wrist and ankle.
      - **white** - right wrist
      - **red** + left ankle
      - **black** ground DO NOT CONNECT!
Calibration Procedure:
Calibration consists of modifying the SV equation (C3) to account for “L” as measured in Setup Step 8.
1. Navigate to the Stroke Volume (C3) calculation channel Expression dialog as follows (Figure 11):
   a. Select “Set Up Channels...” from the MPxx menu.
   b. From the “Input channels setup” dialog, select the Calculation tab.
   c. Select “C3” (Stroke Volume) by clicking on the line item, and then click the “Setup” button.
   d. Select the first line item, Stroke Volume (C3.0) in the “Metachannel setup” dialog and click “Setup Subchannel.”
2. Change the Length (L) value (in cm) in the SV expression, as shown in Figure 12, to reflect that measured in Setup Step 7.
3. Click OK to close the Expression dialog, then close
the other two channel setup dialogs.

Attach BP to non-dominant. We will record twice a minute during baseline and the word task. Make sure the monitor is set to silent.

2. Click Start to begin the recording.
3. Record for 60 seconds, and then click Stop.

Say to all participants:
Today you will be taking part in a study using a cognitive performance task that is currently under development by the University of Toledo in collaboration with the University of Michigan. The research focuses on how performance on cognitive aptitude tasks predicts future outcomes. As such, in this experiment, you will be asked to engage in a highly challenging cognitive performance task that will assess your aptitude. Performance on this task has been found to predict key indicators of student success at UT, including student GPA, graduation status, and starting career salaries after graduation. For us to study this task, it is very important that you give it your best effort.

1: Control
Clearing your mind is a necessary part of physiological baseline recording. By clearing your mind we will be able to obtain good baseline measures. During this time it really is up to you to clear your mind of distractions. You must spend time relaxing and being present in the moment. During this phase, it will help us out if you try not to move too much—as that will affect recordings. Also, please try not to rest electrodes against the chair—so it would be best if you could sit straight up and not put a lot of pressure on your back.

2: Positive Expectation
Before taking part in this cognitive performance task today, we would like you to try a mental relaxation technique that has been found to enhance cognitive functioning and mental flexibility. This task, called Mind Clearing, is very effective in reducing mental distractions. While lowering blood pressure, Mind Clearing boosts creativity, increases memory and improves attention. Physiologically, this task lowers the levels of blood lactate (reducing anxiety), boosts your energy level and increases serotonin production (improving mood and behavior). Finally, Mind Clearing sharpens the mind by improving focus and expands the mind through relaxation. Clearing your mind, given all the clear benefits of the task, will help you to do better on the difficult cognitive task later in the study. During this time it really is up to you to clear your mind of distractions. You must spend time relaxing and being present in the moment. During this phase, it will help us out if you try not to move too much—as that will affect recordings. Also, please try not to rest electrodes against the chair—so it would be best if you could sit straight up and not put a lot of pressure on your back.

3: Negative Expectation
Before taking part in this cognitive performance task today, we would like you to try a mental relaxation technique that has been found to enhance cognitive functioning and mental flexibility. This task, called Mind Clearing, is very effective in reducing mental distractions. While lowering blood pressure, Mind Clearing boosts creativity, increases memory and improves attention. Physiologically, this task lowers the levels of blood lactate (reducing anxiety), boosts your energy level and increases serotonin production (improving mood and behavior). Finally, Mind Clearing sharpens the mind by improving focus and expands the mind through relaxation. Clearing your mind, given
all the clear benefits of the task, will help you to not do as poorly on the difficult cognitive task later in the study. During this time it really is up to you to clear your mind of distractions. You must spend time relaxing and being present in the moment. During this phase, it will help us out if you try not to move too much—as that will affect recordings. Also, please try not to rest electrodes against the chair—so it would be best if you could sit straight up and not put a lot of pressure on your back.

1. Press the Start button on biopac and BP.
2. Insert a marker and label it “Baseline.”
3. After 10 minutes, press Stop within the PRO software.
4. To save recorded data, choose File menu > Save As... > file type: BSL PRO files (*.ACQ) File name: (Evaluation of Challenges-Participant Number) > Save button

After 10 minutes, stir the participant and say:

In this study, we are measuring physiological responses during tests of reasoning ability. You are about complete a word task. This test will be made up of a series of items. Each item will appear on the screen for 15 seconds. You must say your answers aloud so that the experimenter can record them. Please click continue to see a sample item.

Your task is to generate the single word that links the three given words. In this example, the correct answer is “sick”, as in “seasick”, “homesick”, and “sick to your stomach”, so you would say the word “sick” aloud. Sometimes the answer goes with prompt words to form a phrase, like “seasick” and “homesick”. However, sometimes the answer is linked to prompt words only conceptually, like in “sick to your stomach”. Test items may include either or both kinds of relationships.

Does this sample item make sense? (Pause for response)

Once the test starts, you will have only 15 seconds to answer each item. After 15 seconds have passed, the computer will automatically move on to the next item. You cannot go back, so it is important that you say an answer aloud if you think you have one. The experimenter will only record the last answer you give for each item, but you must respond before 15 seconds are up. The experimenter cannot tell you if you have answered an item correctly or what the correct answer is.

Before the computer moves on to the next item, it will briefly show the words “next item in the middle of the screen. Press continue to see this message and advance to the last sample item.

In this example, the correct answer is “bar”. “Gold” is a type of bar, you can sit on a “barstool”, and can be waited on by a “bartender.” Answers can be related to prompt words in many different ways, as can be seen in this example.
Does this sample item make sense? (Pause for response)

During the test, you can click continue as seen here. If you answer an item and wish to move on to the next item before 15 seconds go by, you can press the space bar to advance. Please be careful: once you press continue, you cannot go back. Also, you will not gain extra time for the next item by advancing; the time limit for each item will always be 15 seconds.

Please press continue to advance to the next screen.

1: Control Condition:
You will now engage in a highly challenging cognitive performance task that will assess your aptitude. Performance on this task has been found to predict key indicators of student success at UT, including student GPA, graduation status, and starting career salaries after graduation. For us to study this task, it is very important that you give it your best effort.

2: Gain-Framed Expectation Condition:
You will now engage in a highly challenging cognitive performance task that will assess your aptitude. Performance on this task has been found to predict key indicators of student success at UT, including student GPA, graduation status, and starting career salaries after graduation. For us to study this task, it is very important that you give it your best effort. Remember, Mind Clearing, is very effective in reducing mental distractions. While lowering blood pressure, Mind Clearing boosts creativity, increases memory and improves attention. Physiologically, this task lowers the levels of blood lactate (reducing anxiety), boosts your energy level and increases serotonin production (improving mood and behavior). Finally, Mind Clearing sharpens the mind by improving focus and expands the mind through relaxation. Having cleared your mind, given all the clear benefits of the task, will help you to do better on the difficult cognitive task.

3: Loss-Framed Condition:
You will now engage in a highly challenging cognitive performance task that will assess your aptitude. Performance on this task has been found to predict key indicators of student success at UT, including student GPA, graduation status, and starting career salaries after graduation. For us to study this task, it is very important that you give it your best effort. Remember, Mind Clearing, is very effective in reducing mental distractions. While lowering blood pressure, Mind Clearing boosts creativity, increases memory and improves attention. Physiologically, this task lowers the levels of blood lactate (reducing anxiety), boosts your energy level and increases serotonin production (improving mood and behavior). Finally, Mind Clearing sharpens the mind by improving focus and expands the mind through relaxation. Having cleared your mind, given all the clear benefits of the task, will help you to not do as poorly on the difficult cognitive task.

Do you have any last questions before you begin? (pause)
Then begin recording all measures, and ensure functioning.

Remember, you will have only 15 seconds for each item, and you must say your answers aloud so that the experimenter can record them. Are you ready to start? (pause)

Click continue and begin.

Add a marker to the data to alert me where the RAT data collection began. Record all participant responses and circle their final answers. Use your phone to see how long of the three minutes they have left—mark on answer sheet. After the RAT is complete, you stop recording and remove the blood pressure cuff. Direct participants attention to the tablet where they will complete a final set of questionnaires and debrief.

To complete the study, I just need you to complete a final set of questionnaires on the tablet. Please let me know when you are finished and I will remove all the electrodes and wires.

Finally, remove all electrodes and wires from participants (they can peel off electrodes after you unattach the wires, if they wish). Thank participants for their time and tell them that the study is officially over.