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The Role of Nature in Physiological Recovery from Stress: A Critical Examination of Restorative Environments Theory

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by

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Dedication

I dedicate this work to my family, whose unwavering support was the scaffolding upon which I stood as I strove to accomplish this longstanding dream. I would especially like to thank my husband. Your commitment to me and our family did the work of this achievement. Without you, my dream to become a clinical psychologist would be nothing more than the stuff of fairy tales. I would also like to thank my Mom and my Dad, whose decision to be the kind of parents that every child should have paved the road toward a level of fulfillment that I could never have imagined. To my brother, thank you for sharing the bond of siblinghood that gives the kind of support you cannot obtain from anyone else. Our random talks and support sessions got me through some of the most challenging times of this process. Thank you also to the other members of my family, who championed my successes and let me know that they were in my corner every step of the way. To my Grandma, thank you for exhibiting the kind of strength and resilience that helped me carry on when I questioned my purpose. Finally, I dedicate this dissertation to the two people who book-ended its existence. My sweet daughter, who was born five days after it was proposed; and my dear Grandpa who passed away as it was coming to an end. Thank you, for your continuous excitement in the remaining months of this project about mommy becoming a “green doctor.” Thank you, Gramps, for your patience in awaiting my return from graduate school. I know you always wondered when I was coming back home. I’m back. I only wish it had been sooner.

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Abstract

Recently, health researchers have become interested in “eco-friendly” or “green” healthcare. One of the current trends in the green healthcare movement involves incorporating natural elements into health care settings to promote the health of patients and healthcare workers. Research based on Restorative Environments Theory (RET) provides insight into the rationale behind incorporating nature into the healthcare setting. RET posits that pleasant natural environments help promote stress recovery by increasing positive affect, decreasing negative affect, and reducing physiological arousal. However, the components of this theory have not been sufficiently tested using a controlled laboratory environment. The purpose of the present study was to provide a more rigorous test of RET than what is currently found in the literature by using a controlled laboratory-based design. Undergraduates from the University of South Florida were randomly assigned to view 1) no images, 2) neutral, non-nature images, 3) pleasant, non-nature images, or 4) pleasant, nature images during recovery from an anger recall task. Overall, the results of the present study did not demonstrate support for RET. There were no group differences in recovery time for any of the physiological variables with the exception of TPR. Those in the pleasant, non-nature condition took longest to recover. Further, there were no group differences in affect ratings with the exception of positive affect, which was higher for those in the no-image control condition. From an evidence-based practice framework, this study suggests that additional empirical support is needed

before RET is used as a foundation to justify widespread adoption of nature-based interventions using media presentation to represent the natural environment.

The Role of Nature in Physiological Recovery from Stress: A Critical Examination of Restorative Environments Theory

Background and Organization of Introduction

Growing awareness of the current sustainability crisis has led many health researchers to become interested in "eco-friendly" or "green" healthcare. The U.S. Green Building Council (USGBC) is an organization whose primary focus is on incorporating sustainability into the built environment. In a collaboration between the USGBC and the Green Guide for Healthcare Project, a rating system has emerged for healthcare facilities, called LEED for Healthcare (USGBC, 2010). This rating system enables facilities to earn credits toward certification based on the degree to which they meet certain standards. As the green healthcare movement is grows in popularity, many health care settings are beginning to use the LEED for Healthcare standards to guide their building design. While green building has significant environmental implications, it is possible that the benefits extend beyond sustainability to human health and well-being.

One component of the LEED for Healthcare's green building guidelines includes providing a connection to the natural world. The rationale behind this guideline is based in part on research from Restorative Environments Theory (Parsons, 2007; Parsons & Hartig, 2000), which assumes that exposure to the natural environment can promote the health of patients and healthcare workers via stress reduction. However, the existing literature on RET is limited. Thus, the validity of using exposure to the natural environment for stress-reduction purposes is open to question.

Research on RET has followed two approaches. One approach focuses on the deleterious effects of cognitive fatigue on attentional capacity. This approach posits that exposure to pleasant natural environments can promote cognitive recovery and restore attention to pre-fatigue levels. The second approach focuses on physiological recovery from stress and posits that exposure to pleasant natural environments can promote recovery from stress by eliciting positive affect, decreasing negative affect, and returning physiological arousal to pre-stress levels. For the purposes of the current proposal, the second approach—that of physiological recovery from stress—will be the primary focus. The following section will begin with a brief review of the negative effects of psychological stress on physical well-being, followed by the positive effects of stress reduction. The current research on RET as means to promote stress recovery will then be presented. Finally, a brief description of the present study design will be provided, which will include how the present study addresses the limitations of the current research on RET.

Deleterious Effects of Stress

It is well established that psychological stress has deleterious effects on physical health. Stress requires the body to adapt using various mechanisms. It has been posited that repeated adaptation to stress can lead to abnormal activation of various systems, a process which is termed "allostatic load," and which can lead to disease progression (McEwen, 1998). Research has shown that stress can directly lead to immune dysfunction, which puts an individual at increased risk for illness (Cohen, Tyrrell, & Smith, 1994; Glaser & Kiecolt-Glaser, 2005; Kiecolt-Glaser, Marucha, Malarkey, Mercado, & Glaser, 1995). In addition to immunosuppression, stress has been implicated in chronic disease states such as cardiovascular disease (CVD). For example, research has indicated that factors such as psychological stress, employment burdens, and socioeconomic difficulties are highly related to CVD (Lee & Lip, 2003). Chronic stress such as significant job strain has been shown to predict sub-clinical atherosclerosis in non-symptomatic men (Hintsanen et al., 2005). Additionally, acute life stressors such as bereavement, natural disasters, and trauma are associated with increases in cardiac events (Rozanski, Blumenthal, & Kaplan, 1999). Cardiovascular responses to psychological stress may be one mechanism through which psychological stress is associated with increased CVD risk. Increased cardiovascular reactivity to and prolonged recovery from laboratory stressors has been shown to be associated with CVD symptoms, some of which include atherosclerosis, hypertension, and left ventricular mass (Gianaros et al., 2002; Jennings et al., 2004; Manuck & Krantz, 1986; Murdison et al., 1998; Steptoe & Marmot, 2005). With psychological stress being implicated in the disease process of CVD—the annual economic impact of which is estimated at $297.7 billion (Roger, et al., 2012)—it is important to pinpoint effective stress reduction techniques.

Salutary Effects of Stress Reduction

To date, much research has focused on establishing the deleterious effects of stress. Yet, it is equally important to investigate the effects of stress reduction. If stress has such negative effects on health, then reducing stress should presumably be associated with positive effects on health. Research has suggested that stress reduction is associated fewer cardiac deaths, fewer cardiac incidents, and fewer hospitalizations (Dusseldorp, Van Elderen, Maes, Meulman, & Kraaij, 1999; Frasure-Smith, 1985; van Dixhoorn &

Duivenvoorden, 1999). Some researchers have also suggested that stress reduction can enhance immune function (Goldrosen & Straus, 2004).

The term “stress reduction” encompasses a wide variety of techniques, many of which vary in their consistency. These techniques include relaxation, guided imagery, breathing exercises, leisure activities, among others. Because there are so many varied techniques used to reduce stress, establishing the validity of such techniques can be difficult. Fortunately, the emergence of manualized stress reduction therapies has offered the opportunity to evaluate their efficacy. Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1990) is one example of manualized stress reduction that has received much attention in the literature. There is substantial evidence for the efficacy of MBSR across multiple populations in reducing stress, improving mood, and improving health symptoms (Baer, 2003; Grossman, Niemann, Schmidt, & Walach, 2004). Another manualized form of stress-reduction is Cognitive Behavioral Stress Management (CBSM; Antoni, 2003). CBSM has been primarily used in populations with HIV, and has demonstrated efficacy in improving mood and immune parameters (e.g., Carrico et al., 2005). Thus, evidence from research on standardized stress reduction procedures is consistent with the theory that reducing stress can improve health. This evidence has implications for healthcare and speaks to the importance of complementary and alternative medicine practices.

Despite the benefits of manualized stress reduction therapies, there are some drawbacks, the most predominant of which is the time commitment required by the patient. Both MBSR and CBSM are structured similarly to traditional psychotherapy, with a typical duration of approximately 10 weeks. For hospitalized patients, this commitment can be very difficult to maintain, especially for those with limited hospital stays. Thus, an alternative, less time-intensive form of standardized stress-reduction may be appropriate for these populations.

Restorative Environments Theory

A new approach to stress reduction has emerged from Restorative Environments Theory (RET). RET originated from the fields of Environmental Psychology and Landscape Architecture. Essentially, RET states that visually pleasant physical surroundings have positive effects on mental and physical well-being. RET posits that exposure to restorative environments—specifically pleasant natural environments—reduces the negative impacts of cognitive fatigue and psychological stress (see Parsons & Hartig, 2000 for a review). RET proposes some mechanisms through which pleasant natural environments exert their positive effects. These mechanisms include: 1) increasing positive affect, 2) decreasing negative affect, and 3) reducing physiological arousal from acute stress (Parsons & Hartig, 2000).

Two primary lines of research have emerged from RET. The first focuses on cognitive restoration from prolonged focused attention. Research from this area has suggested that when an individual is cognitively fatigued, exposure to pleasant natural environments can help restore attention and cognitive functioning to more optimal levels. The second line of research from RET focuses primarily on the arousal-reducing effects of exposure to pleasant natural environments post stress. The present study focused solely on this second line of research to examine more specifically the stress recovery benefits of exposure to pleasant natural environments (see Parsons & Hartig, 2000 and Parsons, 2007 for reviews).

Evidence in Support of Restorative Environments Theory

Correlational research has provided preliminary support for RET. For example, it has been demonstrated that proximity to green space is associated with better perceptions of overall health (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). Additionally, in a consumer satisfaction study, visitors to a hospital healing garden reported increased positive emotions and reduced stress after their visit (Whitehouse et al., 2001). In a classic archival study, Ulrich, 1984 retrospectively examined whether patients assigned to a hospital room with a view of nature would show more restorative benefits than patients assigned to a room with a view of a brick wall. Forty-six patients who underwent gall-bladder surgery were matched on a variety of demographic and health characteristics. The results showed that patients with the natural view were discharged sooner, had fewer negative chart notes, took fewer analgesic medications, and had fewer post-surgery complications than those with the brick wall view.

Intervention-oriented research has also provided initial support for RET, primarily in the domain of pain control and management. One study suggested that exposure to pleasant natural stimuli can be used as an effective pain control intervention during flexible bronchoscopy (Diette, Lechtzin, Haponik, Devrotes, & Rubin, 2003). Another study found that exposure to natural stimuli reduced pain-related anxiety and pain intensity during burn dressing changes (Miller, Hickman, & Lemasters, 1992). Finally, an experimental laboratory study demonstrated that those who viewed natural scenery during a pain induction procedure showed higher pain threshold and tolerance than those who saw no scenery (Tse, Ng, Chung, & Wong, 2002).

Other experimental research has provided support for RET as well. In the realm of environmental psychophysiology, exposure to pleasant natural stimuli has demonstrated physiological arousal-reducing effects. For example, data have shown that participants who are exposed to pleasant natural environments post-stress show greater and faster returns to baseline physiological levels than those who are exposed to urban environments post-stress (Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998; Ulrich, Quan, Zimring, Anjali, & Choudhary, 2004; Ulrich et al., 1991; Ulrich, Simons, & Miles, 2003). It has also been found that those who go on a nature walk show more restorative effects than those who go on an urban walk of equivalent duration (Hartig, Evans, Jamner, Davis, & Gärling, 2003; Hartig, Mang, & Evans, 1991). In another study, researchers investigated the effects of "green exercise" on various mental and physical health outcomes (Pretty, Peacock, Sellens, & Griffin, 2005). All participants engaged in 20-minutes of exercise on a treadmill while viewing different scenes, and the level of intensity was consistent across participants. The results showed that only those who viewed rural pleasant scenes exhibited significant decreases in mean arterial pressure (MAP), systolic blood pressure (SBP), and diastolic blood pressure (DBP) following the exercise session. Overall, the preliminary research on RET is consistent with the suggestion that exposure to pleasant natural stimuli increases positive affect, decreases negative affect, and reduces physiological arousal post-stress.

The Need for Further Research on Restorative Environments Theory

Although preliminary research on RET is promising, there are other explanations that may account for the positive effects found thus far. For example, the function of the parasympathetic nervous system has been largely ignored in this line of research. In contrast to the sympathetic nervous system, which is responsible for increases in metabolic output and the classic "fight-or-flight" response, the parasympathetic branch of the autonomic nervous system is responsible for slowing of metabolic energy and is associated with the promotion of restorative processes (Porges, 1995). Thus, it is possible that exposure to pleasant natural stimuli promotes restoration through the influence of the parasympathetic nervous system (PNS). Initial research demonstrating greater heart rate recovery in those exposed to pleasant natural stimuli points to the possibility that the PNS may play an important role in stress recovery, which can be reliably measured using estimates of respiratory sinus arrhythmia (RSA; the variability in the timing of heart beats that coincides with inspiration and expiration).

Another limitation of the current research on RET includes the manipulations that have been used in the existing literature. The most common method for evaluating the effects of nature on physiological arousal has been using nature versus urban exposures as the between-subjects factor. While this manipulation demonstrates the benefits of exposure to pleasant natural stimuli over urban stimuli, it is unknown what aspects of the natural stimuli are responsible for the positive outcomes. There are a number of differences between natural and urban environments that could explain the effects. For example, urban and natural environments may differ in the extent to which they elicit positive affect. Positive affect has been shown to promote physiological recovery post-stress (Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000). Similarly, positive affect has been found to be associated with lower heart rate and cortisol throughout the day (Steptoe, Wardle, & Marmot, 2005). Thus, it is possible that pleasant natural environments elicit more positive affect than urban environments, which may explain why they have shown more physiological arousal reduction than urban environments. Another possible explanation is that urban and natural environments may be different in the degree to which they distract individuals from stress. Distraction has been found to promote physiological recovery post-stress (Gerin, Davidson, Christenfeld, Goyal, & Schwartz, 2006; Glynn, Christenfeld, & Gerin, 2002; Neumann, Waldstein, Sollers III, Thayer, & Sorkin, 2004). Thus, it is possible that pleasant natural environments are more effective at distracting participants than urban environments, which may also explain why they have shown more arousal reducing effects than urban environments. Teasing apart these effects would help to further the current understanding of the benefits of restorative environments.

No studies thus far have compared the efficacy of exposure to pleasant natural stimuli to other stimuli that are known to be efficacious in reducing physiological arousal post-stress (e.g., distraction, pleasant non-nature stimuli). Thus, additional research is needed to further elucidate the currently proposed components of RET. Results from this study have implications for public health by informing clinical practice regarding the components of RET that are necessary for physiological recovery post-stress. Additionally, identifying the necessary and sufficient components of restorative environments will help refine RET and has implications for more focused and effective RET interventions.

Purpose of Study and Overview of Design

The purpose of the present study was to provide a more rigorous test of Restorative Environments Theory than research has to date. This study was conducted in a laboratory setting using a between-subjects experimental design. This study was designed to directly test the currently proposed components of RET (i.e., increasing positive affect, decreasing negative affect, and reducing physiological arousal). Another goal of this study was to refine RET by investigating other explanations for the salutary effects of exposure to pleasant natural stimuli. Specifically, this study investigated the role of distraction and the role of the parasympathetic nervous system in promoting physiological recovery from stress.

All participants were exposed to a psychosocial laboratory stressor and were randomly assigned to one of four recovery conditions. The recovery conditions were defined as follows: 1) no-image control, 2) neutral, non-nature, 3) pleasant, non-nature, and 4) pleasant, nature (henceforth referred to as control, neutral, pleasant, and nature, respectively). An additive method was used to assess key components of each recovery condition including 1) distraction, 2) positive affect, and 3) elements of the natural environment. Each subsequent recovery condition contained an additional element such that any differences between subsequent conditions would be attributable to that particular element. That is, any differences in recovery between the control and neutral conditions would be due to distraction, any differences in recovery between the neutral and pleasant conditions would be due to positive affect, and any differences between the pleasant and nature conditions would be due to the addition of nature. Figure 1 provides a graphical depiction of the study design.

Hypotheses

Four hypotheses were proposed. First, consistent with previous research, it was hypothesized that participants in the neutral condition would demonstrate shorter

	Control	Neutral, Non-Nature	Pleasant, Non-Nature	Pleasant, Nature
Distraction	–	+	+	+
Positive Affect	–	–	+	+
Nature	–	–	–	+

Figure 1. Graphical depiction of study design. Any differences between control and neutral, non-nature were presumably due to the presence of distraction, any differences between neutral and pleasant were presumably due to the presence of positive affect, and any differences between pleasant and nature were presumably due to the presence of nature.

recovery times for sympathetically-mediated cardiovascular responses than those in the control condition (H_1). Second, consistent with previous research and RET, it was hypothesized that participants in both the pleasant and nature conditions would demonstrate shorter cardiovascular recovery times than those in both the neutral and control conditions (H_2). Third, consistent with RET, it was hypothesized that participants in the nature condition would demonstrate shorter recovery times than those in the pleasant condition (H_3). Finally, the role of parasympathetic activity was evaluated by examining differences in RSA among recovery conditions. It was hypothesized that each additional visual element would correspond to greater increases in RSA levels and shorter recovery times during the recovery period. That is, it was hypothesized that those in the neutral condition would have greater increases in RSA and shorter RSA recovery than those in the control condition, those in the pleasant condition would have greater increases in RSA and shorter RSA recovery than those in the neutral condition, and those in the nature condition would have greater increases in RSA and shorter RSA recovery than those in the pleasant condition; H_4). Figures 2 and 3 provide graphical depictions of the study hypotheses.

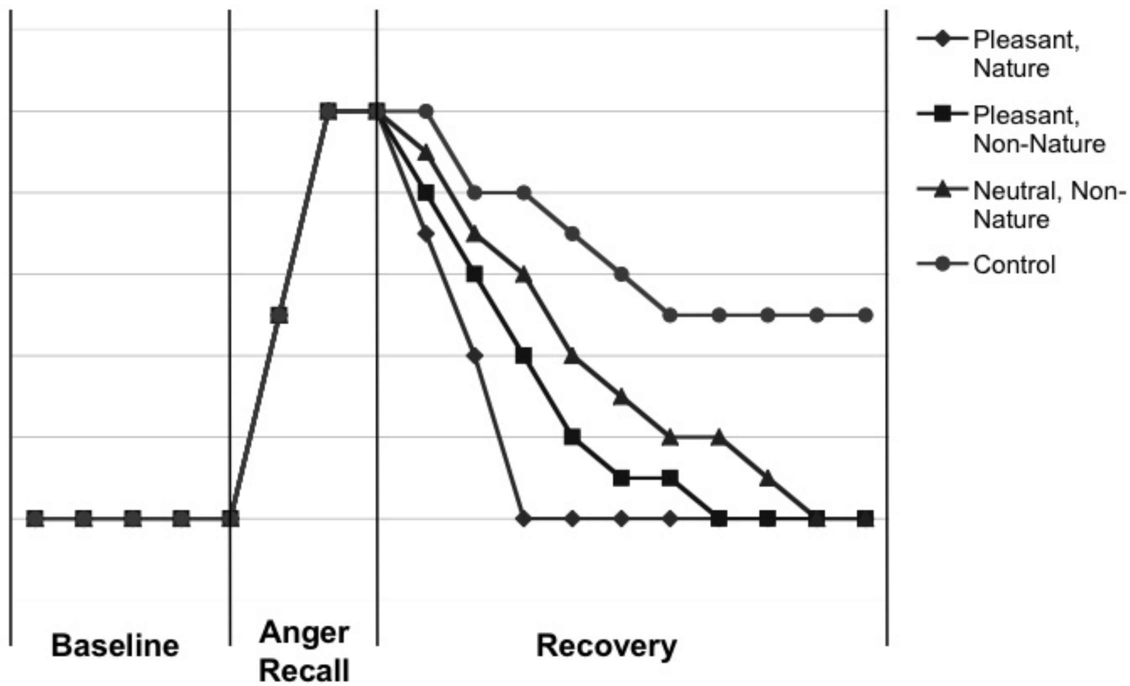

Figure 2. Graphical depiction of hypotheses for time to recovery for sympathetically mediated variables.

Method

Design Overview

The present study used a between-subjects experimental design. Recovery condition was the independent variable and sympathetically-mediated cardiovascular recovery from stress was the dependent variable. Parasympathetic nervous system activity was an additional dependent variable. Operational definitions of the independent and dependent variables are provided in greater detail in the **Procedure** section. Participants were randomly assigned to recovery condition.

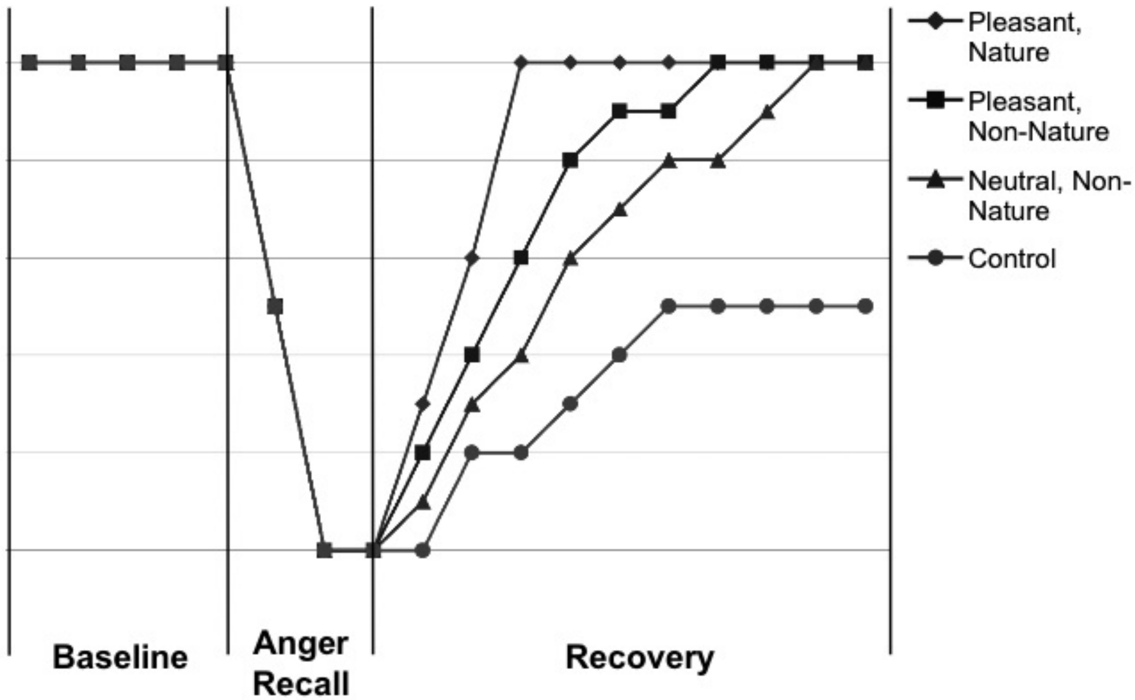

Figure 3. Graphical depiction of hypotheses for time to recovery for RSA.

The lab procedure lasted 90 minutes. Participants received course extra credit as compensation.

Power Analysis

Multiple a priori power analyses were conducted to investigate the requirements for analyzing the data in different ways. Each analysis yielded a different sample size requirement. The data analysis that required the largest sample is explained in detail below.

Version 3.1.2 of the G*Power computer software package (Faul, Erdfelder, Lang, & Buchner, 2007) was used to conduct an a priori power analysis for a one-way between-subjects ANOVA. The number of groups was set to 4 (corresponding to the four recovery conditions), the overall effect size was set to f = .25 (corresponding to a medium effect size according to published standards; Cohen, 1992), and the alpha level was set to .05. The analysis revealed that an overall sample size of 180 participants would yield a power of .80 at the .05 significance level using the aforementioned estimated parameters.

Participants

Participants were 186 undergraduate volunteers aged 18 to 50 years (*M* = 21.42, *SD* = 4.58) who were enrolled in psychology courses at the University of South Florida. Overall, the sample consisted of primarily Caucasian, female upperclassmen who were educated in the U.S. (see Table 1 for complete demographic data). One participant was dropped from the overall study due to missing questionnaire data in which she declined to answer the majority of the items, resulting in a final sample size of 185. Participants were recruited via Sona Systems (the university's online participant pool), and received course credit as compensation for their participation. Anyone who reported being pregnant, having heart disease, having hypertension, having a cardiac arrhythmia, or taking medication that affects the cardiovascular system were excluded from the study because these factors can artificially influence cardiovascular functioning.

Materials

Images from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) were utilized as neutral, pleasant, and nature stimuli for the recovery conditions. The IAPS is a database of images that has norms for arousal and valence. The IAPS has been widely used to elicit various emotions and research has suggested that the images in the IAPS have demonstrated highly reliable psychophysiological and emotion self-report data (Bradley & Lang, 2007; Greenwald, Cook, & Lang, 1989; Lang, Greenwald, Bradley, & Hamm, 1993).

Table 1. *Sample Demographics*

	M (SD)	Min	Max
Age	21.42 (4.58)	18	50
	Frequency	Percent	
Gender			
Female	147	79.5	
Male	37	20	
Race/Ethnicity			
Arab/Middle Eastern	3	1.6	
Asian/Asian-American	14	7.6	
Black/African-American	30	16.2	
Hispanic/Latino	29	15.7	
White/Caucasian	103	55.7	
Other/None Describe Me	4	2.2	
Class			
Freshman	43	23.2	
Sophomore	39	21.1	
Junior	50	27.0	
Senior	49	26.5	
Post-Bachelors	3	1.6	
U.S. Citizen?			
Yes	165	89.2	
No	20	10.8	
K-12 Education in U.S.?			
Yes	153	82.7	
No	32	17.3	

Using a system such as the IAPS allowed for greater experimental control across the recovery conditions. In addition, a small pilot study was conducted in which the selected IAPS images were rated on restorative quality using the Restoration Scale (Han, 2003). The results of the pilot study suggested that the nature images were perceived as most restorative (*M* = 5.06, *SD* = 1.22), followed by the pleasant images (*M* = 4.17, *SD* = 1.12), and followed by the neutral images (*M* = 2.91, *SD* = .72). A between subjects ANOVA with post hoc analyses using a Bonferroni adjustment showed that there were significant differences in ratings between the neutral and nature images ($F(2, 14) = 5.35$, $p < .05$). Figure 4 provides a graphical depiction of the restoration ratings. The Restoration Scale is described below.

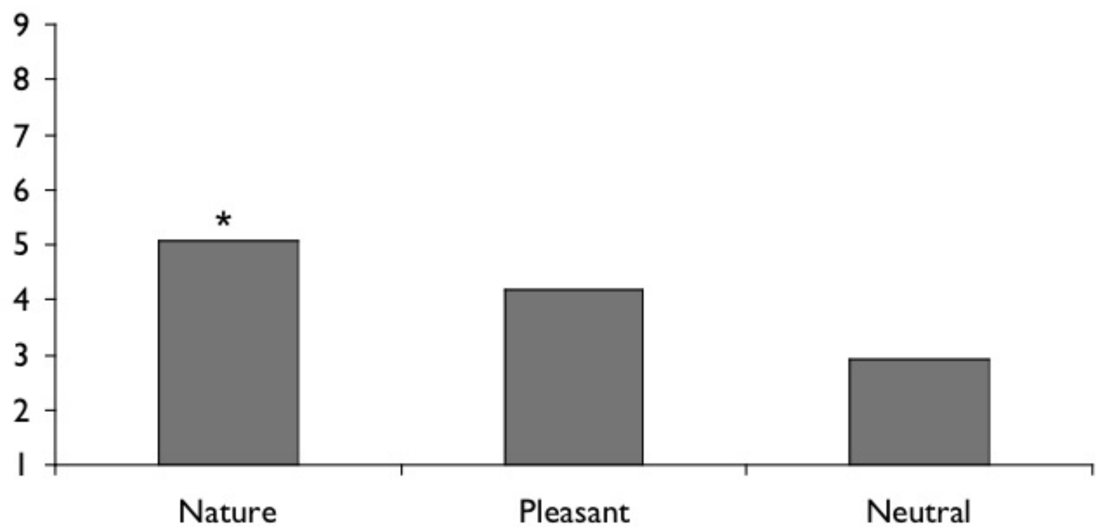

Figure 4. Differences in restoration ratings by slideshow condition for small pilot study. *Significantly differs from neutral condition.

Measures

Pre-screening questionnaire. Participants completed a pre-screening questionnaire, which was used to assess for exclusion criteria. The questionnaire included items regarding English fluency as well as cardiovascular health (see Appendix A).

Demographics. A brief demographic questionnaire was administered online using mass testing through Sona Systems to record participants' age, gender, race, ethnicity, and socioeconomic status (including years of education and annual income). This questionnaire was used to collect sample characteristic data (see Appendix B).

Arousal Predisposition Scale (APS; Coren, 1988). The APS was administered online using mass testing through Sona Systems to assess participants' dispositional tendency to become emotionally and physiologically aroused. This measure has demonstrated strong psychometric characteristics (Chronbach's $\alpha = .84$) and has also shown utility when using APS scores to predict psychophysiological responses to laboratory stressors (Coren & Mah, 1993). This measure was used as a random-assignment check to verify that equivalent groups were established across the four recovery conditions.

Health Status Questionnaire. The Health Status Questionnaire is a baseline health behavior measure, which assesses factors that may influence cardiovascular function. Participants reported their caffeine consumption, their smoking behavior, any current medications, when they ate their most recent meal, and whether they were aware of having any heart condition. The Health Status Questionnaire was used as an additional screening tool for exclusion criteria once participants arrived at the lab (see Appendix C).

Pre and Post-Task Appraisal Questionnaires. These questionnaires were used to assess participants' subjective appraisal to the stress task before and after task completion to ensure that the stress task was adequately demanding. These questionnaires are modeled after those used in a previous study of challenge and threat appraisal (Tomaka, Blascovich, Kelsey, & Leitten, 1993) and include 4 items with a 5-point Likert response scale. The four items ask participants to appraise the extent to which the upcoming (or just completed) stress task is/was demanding, threatening, and stressful as well as how able they are/were able to cope with the task (1 = not at all, 5 = very).

Restoration Scale (RS; Han, 2003). The RS was used in the pilot phase and in the main study to rate the restorative qualities of the images presented in the recovery conditions. The RS is an 8-item self-report measure in which participants were asked to rate each image on 4 domains: emotional response, physiological response, cognitive response, and behavioral response. This measure asks participants to imagine that they are in the depicted scene and use a 9-point Likert scale to rate each image on all 4 domains. An example item from the emotional domain is as follows: "Imagine you are in the projected scene. How would you describe your emotional response?" Participants then respond on a scale from 1-9 with 1 = very anxious and 9 = very relaxed. The RS has been shown to be a reliable (Chronbach's α = .92) and valid measure of the restorative qualities of environments.

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS was used to measure participants' self-reported pre- and post-recovery affective states, to assess for changes in affective states after the recovery phase. The PANAS is a widely used 20-item measure of positive and negative affect. Participants rate the extent to which they experience different feelings and emotions (e.g., interested, distressed, excited, upset, etc.) on a 5-point Likert scale (1 = very slightly or not at all, 5 = extremely). There are two scales, ten items reflect positive affective states and 10 items reflect negative affective states. The PANAS has demonstrated sound psychometric characteristics for both the positive affect (Chronbach's α = .89) and negative affect (Chronbach's α = .85) scales (Crawford & Henry, 2004). It was expected that all participants who viewed images would report a decrease in negative affect from pre- to post-recovery. It was also expected that participants in the pleasant and nature conditions would report greater increases in positive affect than participants in the neutral and control conditions.

State-Trait Anger Expression Inventory-2, State Anger Scale (STAXI-2, SAS; Spielberger, 1999). The SAS from the STAXI-2 was used to measure participants' pre- and post-recovery anger levels as a self-report verification of stress-related anger. The SAS is a 15-item measure of anger experienced in the present moment. Participants rate statements about their current state of anger (e.g., "I am mad," "I feel frustrated") on a 4-point Likert scale (1 = not at all, 4 = very much so). The SAS has demonstrated appropriate psychometric characteristics (Chronbach's $\alpha = .90$; Bishop & Quah, 1998).

Relaxation Inventory (RI; Crist, Rickard, Prentice-Dunn, & Barker, 1989). The RI was used to assess the extent to which participants were relaxed at the end of each recovery condition. The RI is a 45-item, internally valid (Chronbach's $\alpha \geq .81$) self-report measure of relaxation. The RI contains items that measure three separate domains of relaxation, physiological tension (e.g., "My forehead feels tense."), physical assessment (e.g., "My whole body is at rest."), and cognitive tension (e.g., "I am thinking about my problems."). Participants respond to each item using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Only the physiological tension and physical assessment scales were used for this study. The RI was used in addition to the PANAS to examine the effect of recovery condition on affect.

Distraction efficacy. Two measures—implicit and self-report—were used to assess the extent to which the recovery conditions were efficacious in distracting participants from thinking about the anger recall task. First, a word completion task was administered following a similar procedure to Anderson, Carnagey, and Eubanks (2003). Participants were presented with a series of word fragments and were instructed to fill in the missing letters to make a complete word. Some words had both neutral and anger-related completions (e.g., O F F _ _ _ = OFFEND, OFFSET, OFFERS, OFFICE), whereas others had only neutral completions (e.g., D _ _ R = DEAR, DEER, DOOR). Theoretically, the more efficacious the recovery conditions were at distracting participants from ruminating about the anger recall task, the less likely participants would be to generate anger-related completions.

Additionally, a three-item measure was administered to assess participants' perception of distraction during the recovery period. The first question read, "While you were sitting quietly/viewing the pictures, how much (in percentage of time) did you think about the situation that made you angry?" The response was provided as fill-in-the-blank and read "________% of the time." The second item read, "While I was sitting quietly/viewing the pictures, I was thinking about the situation that made me angry." Participants responded to this item using a 4-point Likert scale, which ranged from 0 (not at all true) to 3 (completely true). The final question read, "While I was sitting quietly/viewing the pictures, I felt distracted from thinking about the situation that made me angry." Participants responded to this item using the same 4-point Likert scale as in item 2 (see Appendix D).

Procedure

Operational definitions of the independent and dependent variables.

Recovery conditions (IV). Each recovery condition was 10 minutes in duration. No stimuli were presented in the control condition. Participants in the control condition were instructed to sit quietly and await further directions. All images presented in the neutral, pleasant, , and nature recovery conditions were taken from the IAPS. A slideshow of the selected images was presented on a large computer monitor in the recording room. In the nature condition, participants viewed images of nature that received positive ratings (e.g., waterfalls, vistas, flowers, etc.). Likewise, in the pleasant condition, participants viewed images that received positive valence ratings (e.g., happy couples, musical instruments, abstract art, etc.). In the neutral condition, participants viewed images that received neutral valence ratings (e.g., pencil, stapler, light bulb, etc.). It was assumed that all three image-viewing conditions provided distraction because stimuli were presented. Additionally, the images in each condition were selected such that there were minimal differences among the conditions on arousal ratings. While a one way ANOVA revealed significant differences among the conditions on arousal ratings ($F(2, 119) = 16.57$, $p < .001$), the available images that fit each category did not make it possible to completely eliminate differences on arousal ratings. Additionally, the differences in arousal ratings were small (e.g., the largest difference occurred between the neutral and pleasant conditions and equaled .81). To provide a more rigorous test of Restorative Environments Theory (RET) the images in the nature and pleasant recovery conditions were selected such that there were no significant differences on positive valence ratings, but also such that they had higher valence ratings than the neutral, non-nature condition ($F(2, 119) = 269.79$, $p < .001$). Thus, the only difference between the two pleasant conditions was whether the images in the slideshow depicted nature. Table 2 provides the descriptive statistics for the arousal and valence ratings of the slideshow images. Figure 5 provides a graphical summary of the arousal and valence ratings.

Table 2. *Valence and Arousal Ratings of IAPS Images Used in Recovery Conditions*

	Recovery Slideshow		
	Nature *M (SD)*	Pleasant *M (SD)*	Neutral *M (SD)*
Mean Valence Rating	6.92 (.41)†	6.70 (.54)†	5.02 (.16)
Mean Arousal Rating	3.85 (.83)†	3.97 (.62)†	3.16 (.55)

† = significantly differs from the neutral condition

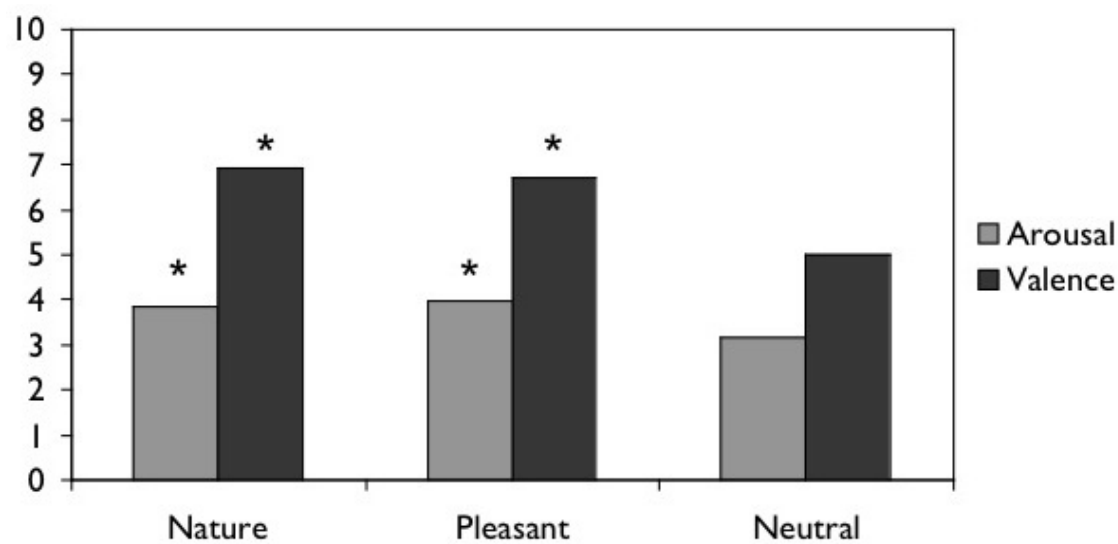

Figure 5. Differences in arousal and valence image ratings by slideshow condition.
*Significantly different from neutral condition.

Cardiovascular recovery from stress (DVs_{1-7}). Sympathetically-mediated cardiovascular recovery from stress was measured using systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and impedance cardiography (ICG). ICG provides assessment of stroke volume (SV; The amount of blood in milliliters ejected by the heart on an average heart beat), cardiac output (CO; The amount of blood in liters ejected by the heart in a minute in L/min), and pre-ejection period (PEP: The time between ventricular depolarization and ejection of blood from the heart, which provides a measure of cardiac contractile force in milliseconds). BP and CO were used to calculate total peripheral resistance (TPR). TPR provides quantification of the vascular resistance component of blood pressure. For each of these measures, time-to-recovery was used to index the degree to which a participant returns to baseline levels (i.e., recovers) after the stress task. The use of these measures provides a comprehensive and detailed picture of sympathetically-mediated cardiovascular recovery. Further, specific measures provide details on the hemodynamics underlying the function of this system (e.g. cardiac versus vascular performance). The formula for TPR and the method for calculating time-to-recovery are provided in the **Data quantification, reduction, and analysis** section.

Consistent with H_1, it was expected that participants in the neutral condition would demonstrate shorter recovery times for SBP, DBP, HR, SV, CO, PEP, and TPR than those in the no-image control condition. Consistent with H_2, it was expected that participants in both pleasant conditions (nature and pleasant) would demonstrate shorter recovery times for SBP, DBP, HR, SV, CO, PEP, and TPR than those in both the neutral, non-nature and no-image control conditions. Consistent with H_3, was expected that participants in the nature condition would demonstrate shorter recovery times for SBP, DBP, HR, SV, CO, PEP, and TPR than those in the pleasant condition.

Parasympathetic cardiac function (DV_8). Parasympathetic cardiac function was measured using respiratory sinus arrhythmia (RSA). RSA is a measure of the variability in the timing of heart beats that coincides with inspiration and expiration. RSA has been proposed as a reliable measure of parasympathetic cardiac function (e.g., Berntson, Cacioppo, & Quigley, 1993) . Again, time-to-recovery was used to index the degree to which a participant returns to baseline levels (i.e., recovers) after the stress task. Additionally, RSA level across the 10-minute recovery period was used as an overall measure of parasympathetic cardiac function during recovery.

Consistent with H_4, it was expected that those in the neutral condition would exhibit greater post-task increases in RSA and shorter RSA recovery than those in the control condition It was also expected that those in the pleasant condition would have greater increases in RSA and shorter RSA recovery than those in the neutral condition. Finally, it was expected that those in the nature condition would have greater increases in RSA and shorter RSA recovery than those in the pleasant condition.

Laboratory stress task. Scientists within the field of cardiovascular psychophysiology have identified a number of methodological issues that are common to research in CVR (Kamarck & Lovallo, 2003; Steptoe & Vögele, 1991). One methodological issue involves problems with the reliable and valid assessment of CVR arising from stress tasks low in ecological validity. Additionally, because the recovery period represented the point at which the IV was manipulated during the experimental protocol, it was important to use a stress task that has shown sufficient variability in time to recovery from the task. Therefore, the anger recall task was used because it has increased personal relevance over other laboratory stress tasks (Ironson et al., 1992; Waldstein et al., 2000), because recovery after the anger recall task is slower due to prolonged perseverative cognitive processes that occur post-task (see Brosschot, Gerin, & Thayer, 2006 for a review), and because distraction has been shown to promote cardiovascular recovery from the anger recall task (Neumann et al., 2004).

Consistent with the protocol outlined by Ironson et al., (1992), participants engaged in a 3-minute anger recall interview in which they were asked to recall and discuss a situation in which they became very angry. A research assistant instructed participants to recall an anger-evoking incident they experienced within the last 6 months. After participants identified the situation, they were instructed to describe it in great detail. In order to encourage participants to recreate the situation as best they could, they were asked to describe what happened, what they did, how they responded, how others in the situation responded, and how they felt during the anger-evoking situation. Additionally, participants were probed to elaborate if they stopped discussing the situation before 3 minutes has elapsed (e.g., "tell me more about that," "please continue," "then what happened?). See Appendix E for all instructions provided throughout the laboratory protocol.

Physiological recording apparatus. An Accutorr Plus non-invasive blood pressure monitor (Datascope, Corp., Mahwah, NJ) was used to measure SBP and DBP. Repeated blood pressure measurements were taken at 2-minute intervals in accordance with published guidelines (Shapiro, et al., 1996). Electrocardiogram (EKG) was measured using silver-silver chloride electrodes in a modified lead II configuration. EKG was measured continuously to obtain values for HR and RSA according to published guidelines (Berntson et al., 1997; Jennings et al., 1981). ICG was collected using electrode mylar tape with two bands encircling the neck and two bands encircling the torso. ICG was measured continuously to obtain values for SV, CO, and PEP in accordance with published guidelines (Sherwood et al., 1990). EKG and ICG data were collected using a PC as well as equipment and software provided by Biopac Instruments Inc. (Goleta, CA) including the AcqKnowledge 3.7.2 data acquisition software, an EKG amplifier (Biopac ECG100) and an ICG amplifier (Biopac NICO100C).

Experimental protocol. Participants completed preliminary questionnaires online using Sona Systems. The preliminary questionnaires were administered online using Sona System's Mass Testing feature and included a questionnaire that assessed exclusion criteria, the Demographic Questionnaire and the Arousal Predisposition Scale. Upon arrival to the laboratory, participants completed informed consent. Next, participants completed the Health Status Questionnaire. Participants then had the EKG electrodes and disposable mylar tape placed on their skin. A research assistant then escorted participants to the recording chamber in which they were seated in a comfortable chair and connected to the physiological equipment. Then, participants engaged in a 10-minute resting baseline where they watched an instructional video from the television show, "How it's Made" to facilitate physiological acclimation to the laboratory setting. Physiological measures were taken during the last 5 minutes of the resting baseline.

After the baseline period, participants were given the instructions for the anger recall stress task (Appendix E). After the instructions, they completed the Pre-Task Appraisal Questionnaire on the computer in front of them. Then participants were instructed to complete the anger recall stress task (Appendix E). After the first 90 seconds, participants completed the SAS and the PANAS on the computer to obtain in-the-moment assessments of anger and affect. Then, participants continued engaging in the anger recall stress task for an additional 90 seconds. Participants were notified when the stress task was finished and were instructed to direct their attention to the computer monitor (Appendix E). At this point, participants were randomly assigned to recovery condition. For those who were assigned to an image-viewing condition, the slideshow for the recovery condition began. For those who were assigned to the control condition, a blank screen was shown. After the 10-minute recovery, participants completed the Word Completion Task, the three-item self-report distraction measure, the SAS, the PANAS, the Relaxation Inventory, the Post-Task Appraisal Questionnaire, and the RS (for those who were in a slideshow viewing condition) on the computer. Once participants completed the final questionnaire, they were disconnected from the physiology equipment and the EKG electrodes and mylar tape were removed. Participants' anthropometric measurements were then taken (i.e., height, weight, waist circumference, and hip circumference). Participants were then be fully debriefed and compensated. The entire lab procedure took approximately 90 minutes per participant. Figure 6 provides a graphical depiction of the experimental protocol.

Data quantification, reduction, and analysis. BP readings were taken every 2-minutes across the laboratory procedure such that baseline, stress task, and recovery condition phases each had 2 BP readings. BP readings were then averaged to create an aggregate BP reading for each of the baseline, stress, and recovery phases.

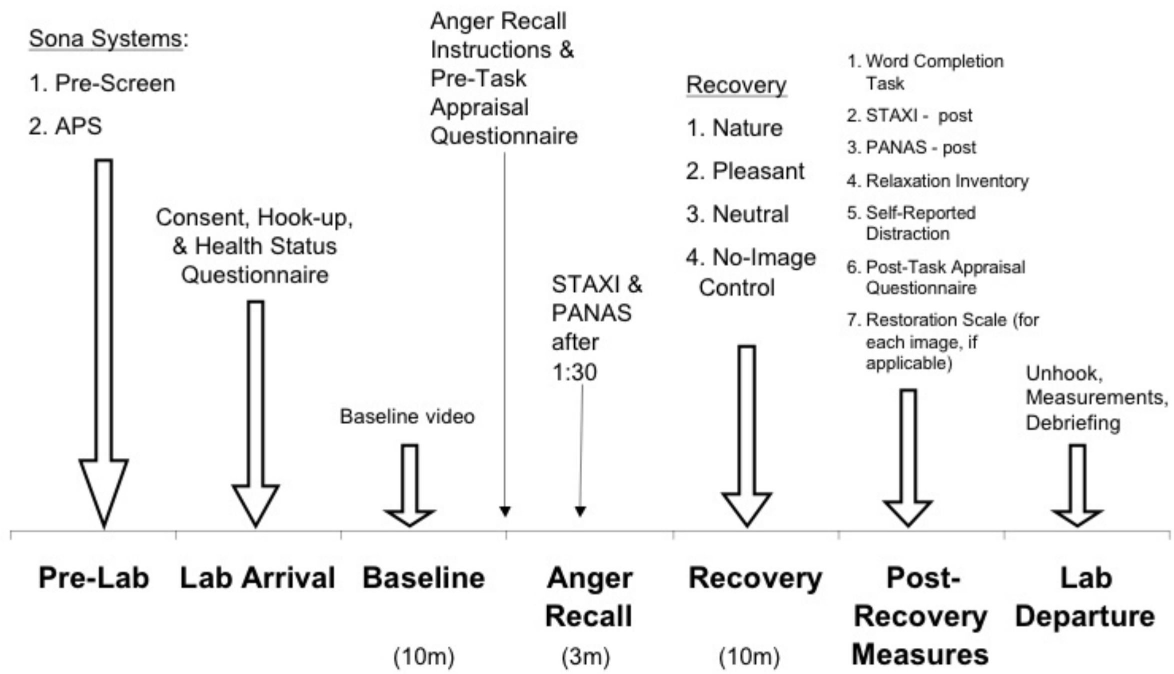

Figure 6. Graphical depiction of experimental protocol.

ICG and EKG values were measured continuously and were averaged on a minute-by-minute basis using MindWare IMP 2.56 and HRV 2.56 software (MindWare Technologies, Ltd., Gahanna, OH). Minute-by-minute averages for EKG and ICG were combined to create aggregate values for HR, RSA, SV, CO, and PEP for each of the baseline, stress, and recovery phases. TPR was calculated using the formula: TPR = (MAP/CO) * 80 in arbitrary units, where MAP is mean arterial pressure (SBP + (2 * DBP))/3.

To calculate reactivity, a change score was calculated for each participant associated with the baseline-to-stress phase. The difference between participants' composite baseline and stress task values was used to calculate change scores. For recovery, each participant's recovery score was compared to the corresponding baseline value. Participants were considered "fully recovered" if their physiological levels returned to baseline levels during the recovery period. First, a percentage of overall recovery was calculated as baseline values divided by recovery values for each of the 10 minutes. The percentage values were then used to calculate time to recovery for each participant. If a participant did not reach “full recovery” by the end of the 10-minute recovery period, that participant received a time-to-recovery value of 10 minutes.

Data were analyzed using the SPSS statistical software program. To address hypotheses 1-3, a series of between-subjects ANOVAs were conducted with recovery condition as the between-subjects factor and time-to-cardiovascular recovery as the dependent variable. Although this resulted in a fair number of statistical tests (7), it is standard procedure in the cardiovascular reactivity and recovery literature to examine each DV independently. If a significant effect was found, post hoc analyses using Bonferroni adjustment were conducted to investigate differences in cardiovascular recovery among the recovery conditions. To address the fourth hypothesis, two between-subjects ACNOVAs with RSA reactivity covaried (see corresponding section in Results for an explanation) were conducted to examine differences in RSA recovery by condition. Again, condition was entered as the between-subjects factor, change in RSA levels was entered as the dependent variable for the first analysis, and time-to-recovery was entered as the dependent variable for the second analysis. Similar to the above analysis, post hoc analyses with Bonferroni adjustment were conducted to further investigate differences in RSA among the recovery conditions.

Results

Random Assignment Checks

There were no significant differences among the groups on Arousal Predisposition

Scale scores ($F(3, 179) = .56$, $p > .05$) and pre- ($F(3, 180) = .85$, $p > .05$) or post-task ($F(3, 181) = .71$, $p > .05$) appraisal scores, suggesting that random assignment produced equivalent groups on these measures, which assessed constructs that occurred before the independent variable manipulation. Table 3 provides a summary of these analyses.

Table 3. *Descriptive Statistics for Arousal Predisposition Scale and Pre- Post-Task Appraisals*

	Recovery Condition			
	Nature *M (SD)*	Pleasant *M (SD)*	Neutral *M (SD)*	Control *M (SD)*
Arousal Predisposition	37.02 (6.62)	36.07 (5.37)	36.84 (5.80)	35.52 (7.02)
Pre-Task Appraisal	8.33 (2.81)	9.02 (2.78)	8.84 (3.08)	8.26 (2.27)
Post-Task Appraisal	7.78 (2.67)	8.27 (2.81)	7.89 (2.57)	7.45 (2.86)

Manipulation Checks

Anger recall. A series of repeated measures ANOVAs was conducted to examine change in physiological levels from baseline-to-anger recall. The analysis revealed a significant change from baseline-to-anger recall for all physiological measures (all *ps* < .05). There were no group by phase interactions for degree of reactivity with the exception of RSA reactivity ($F(3, 181) = 3.66$, $p < .05$). Figure 7 provides a graphical depiction of these analyses for the sympathetically mediated physiological measures. A follow-up one way ANOVA with reactivity score as the DV confirmed group differences on RSA reactivity ($F(3, 183) = 3.65$, $p < .05$). Post hoc analyses revealed that those in the no-image control condition ($M = -.64$, $SD = .74$) exhibited greater reductions in RSA

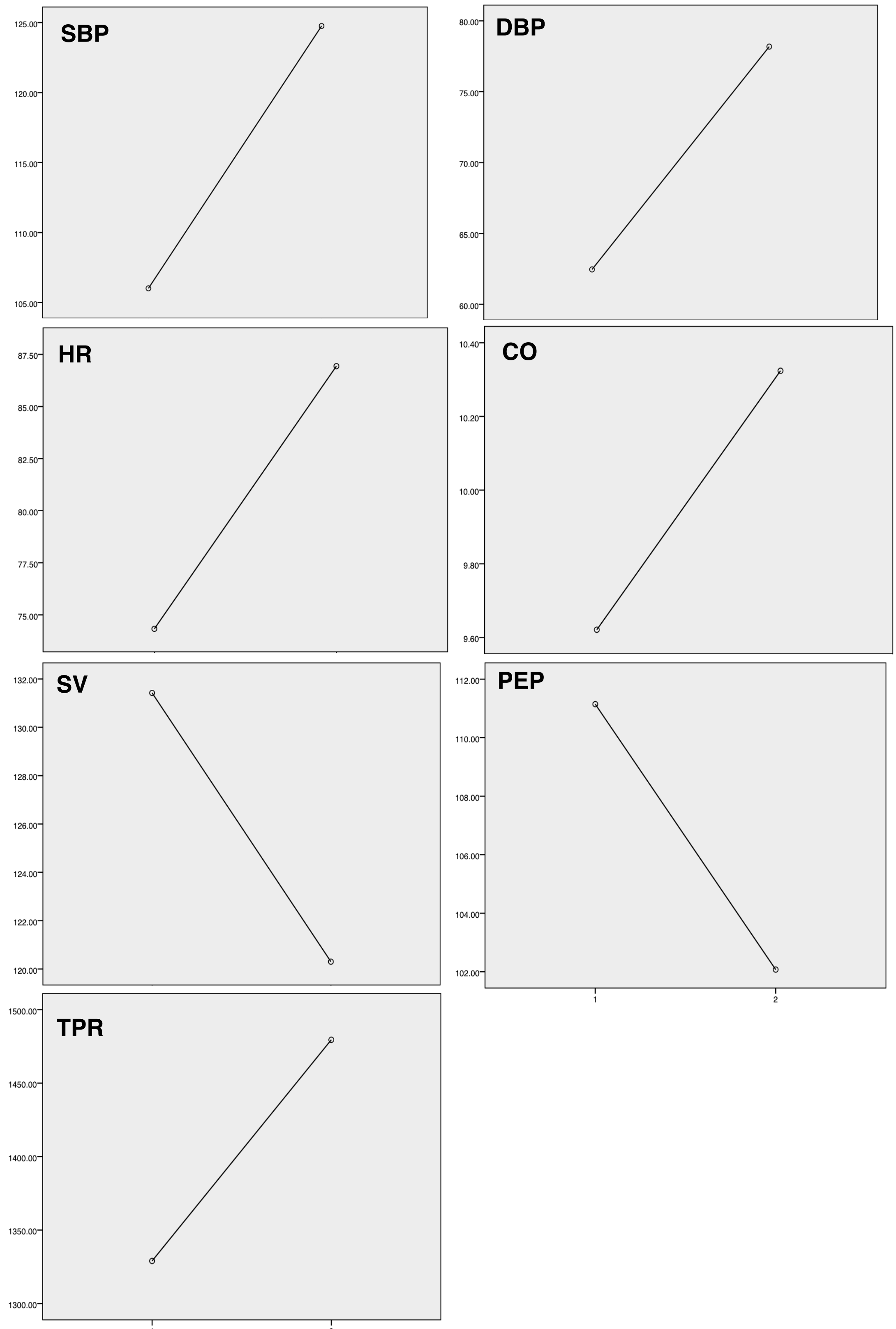

Figure 7. Change from baseline-to-anger for sympathetically mediated variables.

during the anger recall task than those in the pleasant condition (*M* = .01, *SD* = .92; $p <$ .01). Figure 8 provides a summary of the group by phase interaction for change in RSA from baseline-to-anger recall. Additionally, although no baseline measure of anger was taken, a repeated measures ANOVA revealed that participants reported a significant decrease in anger between the anger recall task and after the recovery period ($p < .05$). Taken together, these results suggest that the anger recall task produced sufficient physiological arousal and produced higher feelings of anger than after the recovery. Table 4 provides a summary of these analyses.

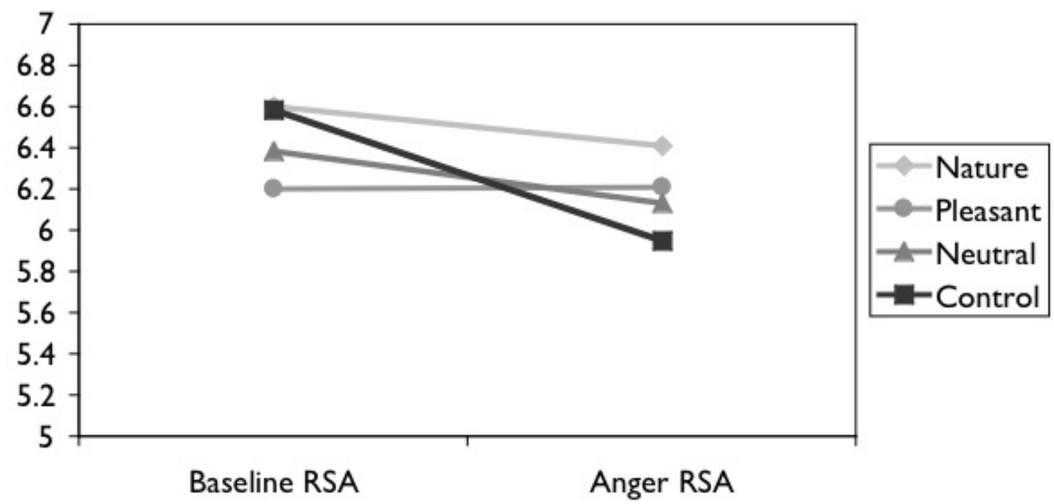

Figure 8. Change in RSA from baseline to anger recall task. Change significantly differed between pleasant and control conditions.

Distraction. There were no significant group differences on the Word Completion Task ($F(3, 183) = .77, p > .05$) or self-reported distraction ($F(3, 183) = 1.13$, $p > .05$). As expected, these results suggest that the slideshow viewing conditions were equivalent in their ability to distract participants. However, unexpectedly, these results also suggest that the slideshow viewing conditions were no more effective at distracting participants than the control condition. Table 5 provides the descriptive statistics for these analyses. A follow-up series of Pearson's correlations was conducted to examine whether there was a relationship between self-reported distraction and recovery time. Contrary to previous studies, there was no relationship between distraction and recovery time (all *ps* > .05). Table 6 summarizes the correlations among distraction and recovery time for each of the physiological variables.

Table 4. *Summary of Anger Recall Manipulation Check*

Systolic Blood Pressure (mmHg)		
	Phase	
	Baseline *M (SD)*	Anger Recall *M (SD)*
Recovery Condition		
Control	106.35 (8.31)	126.28 (9.74)
Neutral	105.66 (9.86)	123.72 (13.49)
Pleasant	106.38 (7.52)	123.76 (10.73)
Nature	105.66 (8.87)	125.27 (11.43)
Overall	106.01 (8.61)	124.77 (11.43)
$F(1, 182) = 806.74$, $p < .001$		
Diastolic Blood Pressure (mmHg)		
	Phase	
	Baseline *M (SD)*	Anger Recall *M (SD)*
Recovery Condition		
Control	62.13 (5.33)	78.26 (7.35)
Neutral	63.07 (5.72)	78.48 (10.11)
Pleasant	62.46 (5.59)	78.59 (8.64)
Nature	62.18 (6.12)	77.39 (9.48)
Overall	62.46 (5.66)	78.17 (8.89)
$F(1, 182) = 720.43$, $p < .001$		

Heart Rate (bpm)		
	Phase	
	Baseline *M (SD)*	Anger Recall *M (SD)*
Recovery Condition		
Control	74.53 (9.26)	88.76 (12.46)
Neutral	76.31 (11.08)	88.47 (11.47)
Pleasant	75.06 (10.95)	86.37 (11.89)
Nature	71.42 (12.05)	84.15 (14.43)
Overall	74.33 (10.93)	86.95 (12.65)
$F(1, 181) = 668.26$, $p < .001$		

Cardiac Output (L/min)		
	Phase	
	Baseline *M (SD)*	Anger Recall *M (SD)*
Recovery Condition		
Control	9.88 (2.62)	10.78 (3.09)
Neutral	8.95 (2.43)	9.72 (2.38)
Pleasant	10.36 (3.04)	10.78 (2.69)
Nature	9.30 (3.42)	10.02 (3.80)
Overall	9.63 (2.93)	10.33 (3.04)
$F(1, 179) = 31.19$, $p < .001$		

Stroke Volume (mL/beat)		
	Phase	
	Baseline *M (SD)*	Anger Recall *M (SD)*
Recovery Condition		
Control	134.39 (39.00)	123.11 (36.91)
Neutral	118.21 (28.84)	111.51 (31.50)
Pleasant	140.89 (43.02)	127.25 (35.18)
Nature	132.20 (49.63)	119.33 (43.14)
Overall	131.51 (41.31)	120.37 (37.06)
$F(1, 179) = 51.15$, $p < .001$		

Pre-Ejection Period (msec)		
	Phase	
	Baseline *M (SD)*	Anger Recall *M (SD)*
Recovery Condition		
Control	110.03 (13.97)	101.12 (16.75)
Neutral	108.81 (15.72)	100.88 (16.90)
Pleasant	112.07 (13.46)	101.45 (15.57)
Nature	113.67 (13.76)	104.86 (16.07)
Overall	111.14 (14.25)	102.06 (16.28)
$F(1, 179) = 192.13, p < .001$		

Respiratory Sinus Arrhythmia		
	Phase	
	Baseline *M (SD)*	Anger Recall *M (SD)*
Recovery Condition		
Control	6.58 (0.86)	5.95 (0.82)†
Neutral	6.38 (1.11)	6.13 (0.91)
Pleasant	6.20 (0.93)	6.21 (0.90)
Nature	6.60 (1.37)	6.41 (1.21)
Overall	6.44 (1.09)	6.17 (0.98)
$F(1, 181) = 14.36, p < .001$		

† = Change from baseline to anger significantly differs from pleasant condition

STAXI Scores		
	Phase	
	Anger Recall *M (SD)*	Post-Recovery *M (SD)*
Recovery Condition		
Control	24.91 (8.64)	17.67 (6.59)
Neutral	25.64 (7.07)	18.60 (7.86)
Pleasant	23.38 (5.46)	16.49 (2.80)
Nature	26.10 (7.83)	17.18 (3.38)
Overall	25.05 (7.31)	17.51 (5.60)
$F(1, 148) = 198.16, p < .001$		

Table 5. *Descriptive Statistics for Distraction Measures*

	Recovery Group			
	Nature *M (SD)*	Pleasant *M (SD)*	Neutral *M (SD)*	Control *M (SD)*
Total number of angry words	2.64 (1.50)	2.18 (1.32)	2.38 (1.54)	2.36 (1.50)
Self-reported distraction	1.62 (1.03)	1.38 (1.05)	1.44 (.97)	1.23 (1.05)

Table 6. *Correlations Between Self-Reported Distraction and Recovery Time*

	SBP	DBP	HR	SV	CO	PEP	TPR	RSA
r	-.03	.03	-.05	-.11	-.06	.10	.06	-.01
p	.74	.73	.50	.15	.43	.20	.43	.90

Tests of Restorative Environments Theory

Restorative qualities of images. As expected, a between-subjects ANOVA revealed that the full sample replicated the findings of the pilot study on image ratings (F (2, 130) = 32.68, $p < .001$). Those in the nature condition rated their images the highest on qualities of restoration. Post-hoc analyses revealed that the images in the 2 pleasant conditions were rated as more restorative than the images in the neutral condition. Table 7 provides the descriptive statistics for this analysis and Figure 9 provides a graphical summary of this analysis.

Increased positive affect. Inconsistent with RET, there were no group differences on Relaxation Inventory scores post-recovery (F(3, 156) = .25, $p > .05$). There were significant differences among the groups on positive affect after recovery

Table 7. *Descriptive Statistics for Image Ratings on Restorative Qualities – Full Sample*

	Recovery Group			
	Nature *M (SD)*	Pleasant *M (SD)*	Neutral *M (SD)*	Control *M (SD)*
Image Ratings on Restorative Qualities	4.69 (1.15)†	4.48 (.96)†	3.05 (.97)	--

† = significantly different from neutral condition

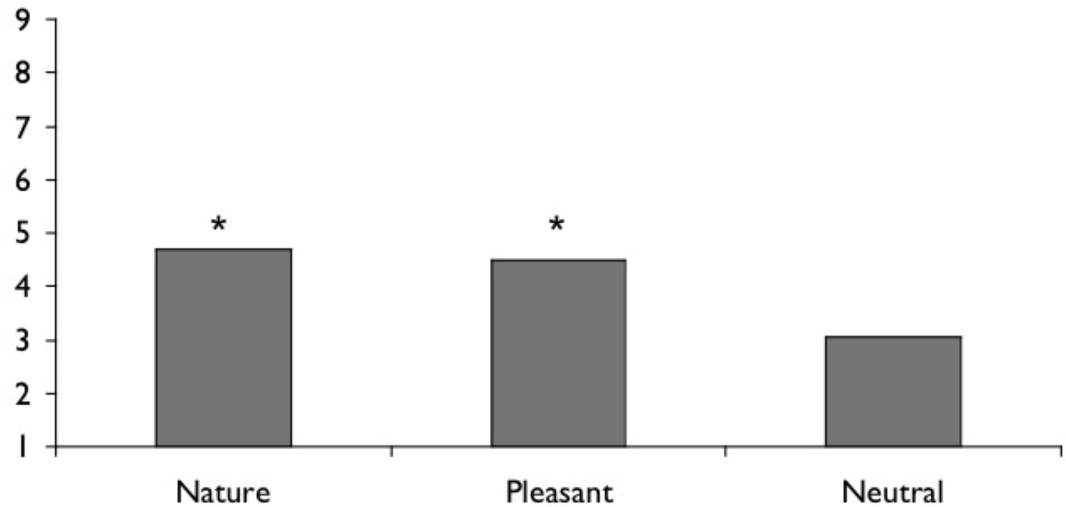

Figure 9. Differences in restoration ratings by slideshow condition for full sample.
*Significantly differs from neutral condition.

(F (3, 170) = 4.74, $p < .01$) as well as change in positive affect from anger-to-post-recovery (F (3, 170) = 2.98, $p < .05$) as measured by the PANAS. The effect of condition was in the opposite direction of what was expected. For positive affect after recovery, those in the control condition had the highest values, followed by those in the nature condition, followed by those in the pleasant condition, and finally those in the neutral condition. Post-hoc analyses revealed that the only significant difference was between the control and neutral conditions ($p < .01$). For change in positive affect from anger-to-post-recovery, the effect of condition was again in the opposite direction as expected. Participants in all groups experienced a decrease in positive affect from anger-to-post-recovery. Those in the neutral condition experienced the greatest decrease in positive affect, followed by those in the control condition, followed by those in the nature condition, and finally those in the pleasant condition. Post-hoc analyses revealed that the only significant difference was between the neutral and pleasant conditions such that those in the neutral condition experienced a greater decrease in positive affect than those in the pleasant condition ($p < .05$). Table 8 provides the descriptive statistics for the positive affect analyses.

Table 8. *Descriptive Statistics for Positive Affect Analyses*

	Recovery Group			
	Nature *M (SD)*	Pleasant *M (SD)*	Neutral *M (SD)*	Control *M (SD)*
Relaxation Inventory Scores	131.20 (22.99)	132.06 (23.07)	127.85 (23.02)	130.85 (23.08)
Positive Affect After Recovery	22.32 (8.19)	22.71 (6.98)	20.00 (7.02)	25.74 (7.03)†
Change in Positive Affect from Anger-to-Post Recovery	-1.46 (7.21)	-.60 (5.58)†	-4.40 (7.01)	-2.04 (4.51)

† = significantly different from neutral condition

Decreased negative affect. Contrary to what was expected, there were no significant differences among the groups on STAXI scores post-recovery ($F(3, 152) = 1.07$, $p > .05$) or change in STAXI scores from anger-to-post-recovery ($F(3, 150) = .775$, $p > .05$). A follow-up between-subjects ANOVA was conducted to examine whether there were group differences on self-reported anger during the anger recall task, which could influence post-recovery scores. The analysis revealed no significant differences among the groups on self-reported anger during the anger recall task ($F(3, 181) = 1.13$, $p > .05$). Although there were no significant differences among the groups on change in STAXI scores from anger-to-post recovery, all groups reported a decrease in anger, and those in the nature condition reported the greatest decrease in self-reported anger (see **Anger recall** section above for a discussion of the analysis for anger-to-recovery differences on STAXI scores). Additionally, there were no significant differences among the groups in negative affect after recovery ($F(3, 169) = .49$, $p > .05$) or change in negative affect from anger-to-post-recovery as measured by the PANAS ($F(3, 168) = .18$, $p > .05$). Again, a follow-up between-subjects ANOVA was conducted to examine whether there were group differences on self-reported negative affect during the anger recall task, which could influence post-recovery scores. The analysis revealed no significant group differences in self-reported negative affect during the anger recall task ($F(3, 183) = .53$, $p > .05$). Table 9 provides the descriptive statistics for the negative affect analyses.

Main hypotheses: physiological recovery. Contrary to hypotheses 1-3, there were no significant differences in recovery time among the groups, with the exception of TPR recovery time ($F\ (3, 175) = 3.54$, $p < .05$). For TPR, those in the pleasant condition took longest to recover, followed by those in the nature condition, followed by those in the control condition, and finally those in the neutral condition. Given that preliminary analyses revealed a significant difference among the groups in RSA reactivity, the recovery analyses were repeated using between-subjects ANCOVAs with RSA

Table 9. *Descriptive Statistics for Negative Affect Analyses*

	Recovery Group			
	Nature *M (SD)*	Pleasant *M (SD)*	Neutral *M (SD)*	Control *M (SD)*
STAXI Scores During Anger Recall	25.47 (7.77)	23.13 (5.65)	25.63 (6.94)	24.65 (8.37)
STAXI Scores After Recovery	17.18 (3.38)	16.49 (2.80)	18.67 (7.84)	17.62 (6.49)
Change in STAXI Scores from Anger-to-Post Recovery	-8.93 (7.13)	-6.89 (4.48)	-7.17 (8.02)	-7.24 (5.79)
Negative Affect During Anger Recall	17.96 (5.34)	18.09 (5.15)	18.84 (5.33)	17.38(6.26)
Negative Affect After Recovery	12.98 (3.66)	13.10 (4.08)	13.98 (4.94)	13.45 (4.11)
Change in Negative Affect from Anger-to-Post Recovery	-4.96 (4.08)	-5.02 (3.77)	-5.00 (5.21)	-4.40 (4.72)

reactivity as a covariate. These analyses did not change the results. Therefore, the values reported are for the one way ANOVAs. Table 10 provides a summary of the sympathetically-mediated physiological recovery analyses. A series of between-subjects ANCOVAs with RSA reactivity as a covariate was used for the RSA analyses. Contrary to hypothesis 4, there were no significant differences among the groups on RSA recovery time or RSA levels across the recovery period (all *ps* > .05). Table 11 provides a summary of the RSA recovery analyses.

Follow-up and Exploratory Analyses

Planned comparisons. Given the conservative approach to analysis using one way ANOVA with post-hoc Bonferroni adjustments and the a priori hypotheses, a series of planned comparisons was conducted to examine differences in physiological recovery

Table 10. *Recovery Time in Minutes for Sympathetically-Mediated Variables*

	Recovery Group			
	Nature *M (SD)*	Pleasant *M (SD)*	Neutral *M (SD)*	Control *M (SD)*
SBP ($F(3, 181) = .78$, $p > .05$)	5.62 (3.22)	6.48 (3.38)	5.57 (3.29)	6.17 (3.51)
DBP ($F(3, 181) = .71$, $p > .05$)	6.77 (3.22)	6.52 (3.22)	5.81 (3.21)	6.17 (3.53)
HR ($F(3, 183) = 1.55$, $p > .05$)	3.22 (2.64)	2.89 (2.02)	3.24 (2.65)	3.98 (2.70)
CO ($F(3, 181) = 2.30$, $p > .05$)	4.31 (3.17)	3.39 (2.70)	4.75 (3.39)	4.94 (3.05)
SV ($F(3, 181) = .24$, $p > .05$)	4.42 (3.10)	4.13 (3.19)	4.59 (2.90)	4.60 (3.00)
PEP ($F(3, 181) = .15$, $p > .05$)	4.78 (3.10)	4.52 (2.97)	4.73 (3.14)	4.94 (2.92)
TPR ($F(3, 178) = 3.54$, $p < .05$)	6.49 (3.70)	7.65 (3.35)	5.41 (3.56)†	5.66 (3.74)†

† = significantly differs from pleasant condition

Table 11. *Recovery Analyses for RSA*

	Recovery Group			
	Nature *M (SE)*	Pleasant *M (SE)*	Neutral *M (SE)*	Control *M (SE)*
RSA Recovery Time ($F(3, 183) = .52$, $p > .05$)	3.00 (.31)	3.53 (.32)	3.14 (.32)	3.13 (.31)
Average RSA Level During Recovery ($F(3, 184) = 1.03$, $p > .05$)	6.73 (.13)	6.46 (.13)	6.48 (.13)	6.45 (.13)

NOTE: Estimated Marginal Means and Standard Errors are reported and include RSA reactivity as a covariate.

time among various group combinations in an effort to reduce the likelihood of a Type II error. Three separate orthogonal planned comparisons were conducted for each of the physiological measures: 1) the control condition was compared to the neutral, pleasant, and nature conditions, 2) the control and neutral conditions were compared as a set to the pleasant and nature conditions as a set, and 3) the nature condition was compared to the control, neutral, and pleasant conditions as a set. Consistent with previous research, the planned contrasts revealed that those in the control condition had longer HR recovery times than those in the image viewing conditions ($t(180) = -2.02$, $p < .05$), and those in the control and neutral conditions had longer CO recovery times than those in the pleasant and nature conditions ($t(178) = -2.17$, $p < .05$). Contrary to previous research, the planned contrasts revealed that those in the control and neutral conditions had shorter TPR recovery times than those in the pleasant and nature conditions ($t(175) = 2.85$, $p < .01$).

Arousal predisposition as a moderator. A series of factorial analyses of covariance (ANCOVA) was conducted to examine the potential moderating effect of APS scores on condition and recovery time. Recovery condition and APS scores were entered as main effects. The interaction between recovery condition and APS scores was also entered. For RSA analyses, RSA reactivity was entered as a covariate, recovery condition and APS scores were entered into the model as main effects, and the interaction between recovery condition and APS scores was entered into the model as well. The analyses revealed a significant main effect of recovery condition on TPR recovery time ($F(3, 174) = 3.49$, $p < .05$). Consistent with the aforementioned analyses, those in the pleasant condition took longest to recover, followed by those in the nature condition, followed by those in the control condition, and finally those in the neutral condition. Additionally, there was a marginally significant main effect of arousal predisposition such that higher APS scores were associated with shorter recovery time ($F(1, 174) = 3.61$, $p = .059$). Finally, there was a marginally significant condition by APS score interaction on TPR recovery time ($F(3, 174) = 2.64$, $p = .051$). The pattern of the interaction was such that in the image viewing conditions, increasing arousal predisposition was associated with faster recovery, whereas in the control condition, higher arousal predisposition was associated with slower recovery. Figure 10 provides a graphical depiction of the interaction. There were no other significant main effects or interactions (all *p*s > .05).

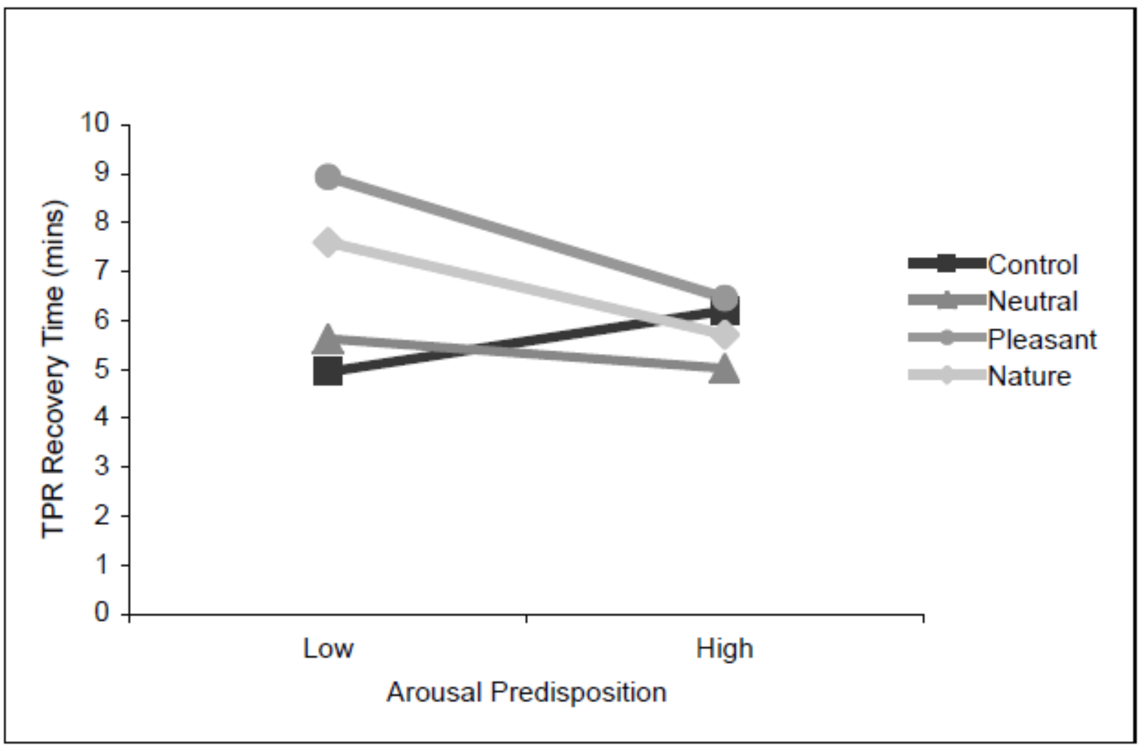

Figure 10. Interaction between condition and arousal predisposition on TPR recovery time.

Discussion

Overall, the results of this study were unexpected and inconsistent with Restorative Environments Theory (RET). Although participants in the nature condition had the highest image ratings on the Restoration Scale, there was no effect of condition on distraction, negative affect, or physiological recovery for most of the physiological variables. Unexpectedly, those in the control condition actually exhibited higher positive affect after recovery than those in the image-viewing conditions. These results warrant further discussion.

No Effect of Distraction

First, it is curious that the distraction manipulation did not produce the same effects seen in other studies with similar protocols. For example, Neumann et al. (2004) and Gerin et al. (2006) conducted very similar studies to the current study in which participants engaged in an anger recall task and were randomly assigned to a distraction versus no distraction recovery period. Additionally, Glynn et al. (2002) conducted a study in which participants were randomly assigned to distraction or no distraction recovery periods after completing a mental arithmetic laboratory stressor task. In each of these three studies, the authors found that distraction predicted more rapid and complete physiological recovery than no distraction. Therefore, it was expected that the present study would replicate the effect of distraction on physiological recovery (i.e., those who viewed slideshows would recover more quickly and completely than those in the control condition). While one of the planned comparisons suggested that the effect of distraction was replicated for HR recovery, this was the only analysis that was significant. Therefore, this single finding does not support the conclusion that the present study replicated the effect of distraction on physiological recovery that has been found in previous studies. However, in each of the aforementioned studies, the distraction manipulation was somewhat different from the distraction manipulation in the present study. For example, participants in the study by Neumann et al. (2004) were required to read a neutral article about outer space in the distraction recovery condition. In the study by Glynn et al. (2002), participants who were randomly assigned to the distraction recovery condition completed a lengthy questionnaire about moral dilemmas, which was designed to be engaging, but not physiologically arousing. Finally, in the study by Gerin et al. (2006), participants in the distraction recovery condition were shown colorful cards and posters on a very large screen (1.5m x 2m) and were allowed to read magazines or play with small toys. Therefore, in the studies by Neumann et al. (2004) and Glynn et al. (2002), the distraction condition required active participation and engagement on behalf of the participants. In the Gerin et al. (2006) study, participants viewed a screen that was much larger than the current study and were given the option of engaging in reading or playing with small toy puzzles. Additionally, all participants in the Neumann et al. (2006) study were seated in a sound-attenuated room and those in the Gerin et al. (2006) study were in a room that was devoid of “incidental distractions” (p. 67).

Overall, the two main differences between the present study and previous, similar studies are the degree of engagement achieved by the distraction manipulation and the possibility of “accidental” distraction in the control condition. The distraction manipulation in the present study may have been too uninteresting to elicit the same effect on physiological recovery that has been seen in other studies. Sitting quietly and passively watching a slideshow arguably does not achieve the same degree of engagement as reading, answering questions, or playing with puzzle toys. Additionally, in 2 of the aforementioned studies, participants in the no distraction recovery conditions (analogous to the control condition in the present study) were presumably protected from the possibility of distraction by hearing external noises (Neumann et al, 2004) and other visually interesting elements of the room (Gerin et al., 2006). By contrast, the present study took place in a room that consisted of computer and media equipment, shelves with study supplies, and periodic interference of hallway noise. Although a white noise machine was used in an attempt to eliminate hallway noise, it was still audible at times. Therefore, it is possible that the control condition in the present study included “accidental” distraction.

Finally, it is possible that other, similar studies that included a distraction manipulation may have induced a process other than distraction. For example, each of these studies included an activity that was engaging and required active participation on behalf of the participant. The researchers assumed these activities were simply distracting, but it is possible that these activities altered mood states or facilitated recovery through some other process. Further, none of these studies measured distraction directly. In the present study, there was no relationship between self-reported distraction and recovery time. Therefore, other studies that found an effect of distraction on physiological recovery may not have actually been measuring distraction.

Positive Affect

Second, the present study did not replicate previous studies that demonstrated an effect of positive affect on physiological recovery from stress with the exception of CO recovery time. Those in the positively-valenced image viewing conditions exhibited shorter recovery time for CO than those in the neutral and control conditions. Additionally, another planned comparison revealed the opposite effect for TPR recovery time in that those in the neutral and control conditions exhibited shorter recovery times for TPR than those in the positively-valenced image viewing conditions. Therefore, the findings from the present study do not warrant the conclusion that the effect of positive affect was replicated. Again, however, there are some protocol differences between the present study and other studies that have found an effect of positive affect on physiological recovery. For example, Friedricksen and her colleagues (1998; 2000) demonstrated that positive affect-inducing films promoted faster recovery than neutral affect-inducing and sadness-inducing films. The present study did not include a direct mood induction manipulation. While the images in the slideshow viewing conditions were normed on arousal and valence, viewing images that are more positively valenced is arguably a distinct construct from positive mood induction. That is, simply viewing a collection of images that are rated as pleasant may not necessarily induce positive affect. Other studies that have found a relationship between positive affect on health and lower cardiovascular levels have demonstrated the effect through trait-like positive affect versus state-like positive affect (e.g., Steptoe et al., 2005; Pressman & Cohen, 2005). The present study did not measure trait positive affect, and therefore, this explanation remains speculative.

Sample Characteristics and Expectations

Third, it is possible that the slideshow viewing conditions had an incidental and opposite effect of what was intended. For example, participants may have thought that they would be tested on the images they were viewing or that the images were a part of the laboratory stress. Anecdotally, some participants reported expecting to be startled during the slideshow and thus, found it difficult to relax due to anticipatory anxiety. Consistent with this theory, the sample consisted of mostly upperclassmen, which may have influenced the degree of suspicion they had about the experimental protocol. Those who have taken more psychology courses are arguably more educated about the possibility of deception in experimental studies. Thus, it is possible that participants did not take the experimental protocol at face-value and were not recovering "naturally" while viewing the slideshows. This may help to explain the unexpected finding that participants in the control condition exhibited more positive affect after recovery than those in the slideshow conditions. If participants were suspicious about the intention behind viewing the slideshows, it is possible that the control condition was actually a better representation of "natural" recovery. As such, they exhibited more positive affect than the slideshow viewing conditions.

Restorative Environments Theory

Finally, the present study did not replicate previous studies that have demonstrated physiological arousal reduction from exposure to pleasant natural stimuli. This finding is peculiar given that other studies have found reduced physiological arousal using media presentation of pleasant natural stimuli (e.g., Ulrich et al., 2003; Ulrich et al., 1991; Parsons et al., 1998; Pretty et al., 2005). However, these studies differed from the present study in their presentation of pleasant natural stimuli either in content, screen size, or immersion. Therefore, another explanation for the lack of significant findings in the present study is that the presentation of the environmental stimuli was too far removed from the environment it was intended to depict. This explanation is discussed in greater detail below.

Screen size. In their study, de Kort et al. (2006) found that adjusting field of view on the same size screen had a significant effect on the degree to which participants exhibited physiological recovery. Those who viewed nature imagery with a larger field of view (110 x 145cm) exhibited greater physiological recovery from the stress task than those who viewed imagery with a smaller field of view (47 x 60cm). Likewise, Pretty et al. (2005) used a stimulus presentation that was very similar to the present study, but with a large projection screen. Participants were randomly assigned to view a pleasant, nature slideshow, an unpleasant, nature slideshow, a pleasant urban slideshow, an unpleasant urban slideshow, or a white screen while exercising on a treadmill. Only participants in the pleasant nature slideshow condition exhibited decreases in blood pressure while viewing the slideshow. In addition to viewing the slideshow on a large screen, participants were asked to absorb as much information about the images as they could. In the present study, participants viewed a slideshow on a medium-sized computer screen (31.70cm x 52.07cm) that was placed approximately 1.5m away and were given no instructions about the images other than to direct their attention toward the screen.

Content. Other studies that have used media presentation of natural environments (e.g., Ulrich et al., 2003; Ulrich et al., 1991; Parsons et al., 1998) have done so using videos that depict natural environments. Arguably, this mode of presenting pleasant natural stimuli is more engaging or interesting due to its increased complexity over viewing a slideshow of photographs on a medium-sized computer screen. These videos contained auditory stimuli in addition to dynamic movement, both of which are more realistic depictions of the environment of interest. As such, videos of natural environments may be a better proxy for the actual environment compared to slideshows.

Immersion. Multiple studies have demonstrated that the degree of immersion in the environment plays a large role in the recovery of participants (e.g., de Kort & IJsselsteijn, 2006; Valtchanov, Barton, & Ellard, 2010; de Kort, Meijnders, Sponselee, & IJsselsteijn, 2006). In another study, Valtchanov, et al. (2010) used virtual reality to explore the degree to which "surrogate nature" can produce the restorative effects seen in the RET literature. Those in the control condition viewed a slideshow with virtual reality and those in the experimental condition were able to actively explore a virtual forest. Those in the active exploration condition exhibited an increase in positive affect and greater physiological recovery than those who viewed the slideshow. Overall, researchers in the area of RET have argued that experiential realism (i.e., a sense of "being there" or "being away") is essential to produce the restorative effects found in pleasant natural environments (e.g., deKort et al., 2006; de Kort & IJsselsteijn, 2006). Some early studies in this area of research found the effects of pleasant natural environments on physiological recovery in real-life settings such as going on a nature walk (Hartig et al., 1991; Hartig et al., 2003). In the present study, it is likely that the quality of the images presented as well as the proximity of the screen to participants were insufficient to produce a degree of immersion and experiential realism required to show the effects demonstrated in the literature. Consistent with this explanation, Kahn et al. (2008)

examined whether a “plasma” window (i.e., an HDTV with a video camera view of nature) would produce the same effects as a real window with the same view of nature and whether these two presentations would differ from a blank wall. The authors found that only the real window view produced reductions in heart rate. Those in the “plasma window” condition did not differ from those in the blank wall condition. Again, these findings suggest that the degree of realism or immersion is important when examining the effects of pleasant natural environments on physiological arousal reduction.

Strengths, Limitations, and Implications

The primary strength of the present study is the enhanced experimental control achieved by the between-subjects experimental design. The enhanced experimental control allowed for a more rigorous test of RET than has been possible from existing research and allowed for causal inference. Also, the present study examined the role of PNS activity as a factor in the relationship between restorative environments and stress recovery. Despite its benefits, the enhanced internal validity afforded by this study likely came at the expense of external validity. Arguably, the laboratory paradigm was not an accurate reflection of experience in a non-virtual natural environment. What this study does demonstrate is that virtual nature and virtual distraction interventions have limited utility. The findings of the current study suggest that for a recovery intervention to be effective, it needs to be sufficiently distracting and provide a somewhat realistic and immersive experience. Simply viewing a slide show of nature, pleasant,, or neutral images appears to be no more effective at promoting recovery than sitting quietly in a room full of potential distractors. Paradoxically, however, if the currently proposed components of RET are to be thoroughly explored, a less ecologically valid design may be more appropriate to allow for better experimental control. Future studies should focus on elucidating the necessary and sufficient components of RET so that the method of stimulus presentation can be effectively implemented into treatment-oriented environments (i.e., presenting patients with images of pleasant nature images that are adequately immersive should be incorporated into clinical settings where patients must recover after undergoing stressful procedures). Or, further yet, the intervention should include “real” nature that is accessible through a window view or by visiting a healing garden. Finally, it is the author’s intention to conduct future investigations in this area using more immersive environmental manipulations. Combining experimental research on RET with research that is more ecologically valid has the potential to inform current practice that uses nature-based interventions to enhance patient well-being.

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Appendices

Appendix A: Pre-Screening Questionnaire

1) Are you fluent in English?

   a. No
   b. Yes

2) Has a medical professional ever diagnosed you with cardiovascular problems or cardiovascular disease (e.g. arrhythmia, congenital heart defect, blocked arteries, heart attack)?

   a. No
   b. Yes

3) Has a medical professional ever diagnosed you with high blood pressure (i.e. hypertension)?

   a. No
   b. Yes

4) Are you currently taking prescription medication that you know to have an effect on your cardiovascular system (such as raising/lowering your blood pressure or heart rate)?

   a. No
   b. Yes

Appendix B: Demographic Questionnaire

1) What is your age? _______

2) What is your gender?

a. Female
b. Male

3) How would you describe your race or ethnicity?

a. American Indian or Alaska Native
b. Arab or Middle Eastern
c. Asian or Asian-American
d. Black or African American
e. Hispanic or Latino
f. Other/Not listed
g. White or Caucasian

4) Are you a U.S. citizen?

a. No
b. Yes

5) Were you born in the United States?

a. No
b. Yes

6) Did you receive your education, K-12, in the United States?

a. No
b. Yes

7) What is your current student class?

a. Freshman
b. Sophomore
c. Junior
d. Senior
e. Post-Bachelor's

8) Please indicate which of the following categories best describes the highest level of education that you have attained.

a. High school graduate (including GED)
b. Part college
c. Associate's or technical degree
d. Four-year college graduate
e. Part graduate school
f. Master's degree
g. Other graduate degree

9) What was your approximate annual income last year? Include all sources of income (i.e., wages of everyone contributing to your home, any alimony, child support, welfare, food stamps, or any other source of income).

a. 0$ - $4,999
b. $5,000 - $9,999
c. $10,000 - $14,999
d. $15,000 - $19,999
e. $20,000 - $24,999
f. $25,000 - $34,999
g. $35,000 - $44,999
h. $45,000 - $54,999
i. $55,000 - $64,999
j. $65,000 - $74,999
k. $75,000 and over

Appendix C: Health Status Questionnaire

Eating, drinking caffeine, smoking and taking certain medications can affect the cardiovascular system. Some medications are taken for the specific purpose of affecting the cardiovascular system, such as medication to lower blood pressure. However, some medications are taken for other reasons, but also happen to affect the cardiovascular system. Therefore, we need to know all medications that you take as well as when you last ate, drank caffeine, and smoked nicotine.

1. Please list all prescription and non-prescription medications that you are currently taking. Be sure to include any medications you have taken in the last 48 hours, even if it is something you do not regularly take (cold medicine, for example).

____

____

____

2. When did you last eat? _______________ am/pm (circle one)

3. Do you drink caffeine? Yes No (circle one)

   If yes, when did you last drink caffeine? Time: _______________ am/pm (circle one)

4. Do you smoke nicotine cigarettes? Yes No (circle one)

   If yes, when did you last smoke? Time: _______________ am/pm (circle one)

Appendix D: Self-Reported Distraction

No-image control Condition:

1) While you were sitting quietly, how much (in percentage of time) did you think about the situation that made you angry?

   ________% of the time

2) While I was sitting quietly, I was thinking about the situation that made me angry.

not at all true	somewhat true	mostly true	completely true
0	1	2	3

3) While I was sitting quietly, I felt distracted from thinking about the situation that made me angry.

not at all true	somewhat true	mostly true	completely true
0	1	2	3

Picture Viewing Conditions:

1) While you were viewing the pictures, how much (in percentage of time) did you think about the situation that made you angry?

   ________% of the time

2) While I was viewing the pictures, I was thinking about the situation that made me angry.

not at all true	somewhat true	mostly true	completely true
0	1	2	3

3) While I was viewing the pictures, I felt distracted from thinking about the situation that made me angry.

not at all true	somewhat true	mostly true	completely true
0	1	2	3

Appendix E: Script of Instructions

Instructions Presented Prior to the Anger Recall Task

In a moment, you will be asked to recall and discuss a situation in which you became very angry or frustrated. Please select an incident you experienced within the last 6 months. You will be asked to discuss this situation for 3 minutes. First, you will be asked to fill out some questionnaires. Then, a research assistant will enter the room and will ask you to begin discussing your situation. If you stop discussing the situation before the 3 minutes is over, the research assistant will ask you to elaborate and continue discussing the situation. It is important that you discuss the situation for the full 3 minutes.

Instructions Presented During the Anger Recall Task

Please tell me the situation you would like to discuss. [The research assistant awaits a description from the participant.] *When I say "begin," please describe this situation in great detail. Try to recreate the situation as best you can, by describing what happened, what you did, how you responded, how others in the situation responded, and how you felt during the situation. Ready? Begin.* [If the participant stops describing the situation before 3 minutes have elapsed, probe him/her to elaborate by saying any of the following]: *Tell me more about that. Please continue. Then what happened?*

Instructions Presented After the Anger Recall Task

[Alarm sounds] *Thank you. You may stop describing the situation now. Please direct your attention to the computer monitor, sit quietly, and await further instruction.*

Appendix F: USF IRB Approval Letter

USF
UNIVERSITY OF SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd.. MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

January 5, 2011

Kristi White
Psychology
Department of Psychology, University of South Florida
4202 E. Fowler Ave. PCD 4118G

RE: **Expedited Approval** for Initial Review
IRB#: Pro00001392
Title: The Role of Nature in Physiological Recovery from Stress: A Critical Examination of Restorative Environments Theory

Dear Kristi White:

On 1/5/2011 the Institutional Review Board (IRB) reviewed and **APPROVED** the above referenced protocol**.** Please note that your approval for this study will expire on 1-5-12.

Approved Items:
Protocol Document(s):

KWhiteDissProp_FINAL_Rev.pdf	7/19/2010 1:22 PM	0.04

Consent/Assent Documents:

Name	Modified	Version
Kristi White Dissertation Informed Consent.pdf	1/5/2011 8:41 AM	0.01

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

((4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving xrays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note, the informed consent/assent documents are valid during the period indicated by the official, IRB-Approval stamp located on the form. Valid consent must be documented on a copy of the most recently IRB-approved consent form.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-9343.

Sincerely,

John Schinka, PhD, Chairperson
USF Institutional Review Board

Cc: Various Menzel, CCRP
USF IRB Professional Staff