DISSERTATION

ENVIRONMENTAL EFFECTS ON CREATIVE THINKING AND THE ROLE OF AFFECT, AROUSAL, AND PERSON-ENVIRONMENT FIT

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY RAYMOND MARC BRODERSEN ENTITLED ENVIRONMENTAL EFFECTS ON CREATIVE THINKING AND THE ROLE OF AFFECT, AROUSAL, AND PERSON-ENVIRONMENT FIT BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

ENVIRONMENTAL EFFECTS ON CREATIVE THINKING AND THE ROLE OF AFFECT, AROUSAL, AND PERSON-ENVIRONMENT FIT

Natural and built physical environments have been shown to differentially affect individuals' emotional states, levels of physiological and cognitive arousal, and performance on a variety of cognitive tasks (Kaplan, 1995; Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998; Ulrich et al., 1991). Previous research has also indicated that creativity may be influenced by positive affect, negative affect, and arousal (James, Brodersen, & Eisenberg, 2004). Additionally, there is evidence suggesting that the degree of fit between the individual and the environment may affect creativity (Kaplan, 1995; Wohlwill, 1974). The present study examined differential responses to built and natural environments on indices of affect, arousal, and two measures of creative thinking (divergent and convergent thinking; Guilford, 1968; James et al., 2004).

It was hypothesized that naturalistic environments would elicit more favorable evaluations and result in decreased negative affect and arousal, and improved positive affect, as compared to exposure to environments containing more built features. These changes in affect and arousal were then expected to impact performance on the creative thinking tasks, such that positive affect would promote creative thinking whereas negative affect and arousal would hinder it. Adding natural elements (e.g., green grass & trees) to a built environment scene was hypothesized to reduce the negative reactions otherwise expected for built environments. A good degree of fit between the individual and the environment, as determined by environmental attitudes and preference ratings, was also hypothesized to result in a positive emotional state and improved performance.

Participants were exposed to one of five 10-minute videotapes showing either an urban traffic scene, an urban park scene, a forested mountain trail with people present, the same natural trail without people, or a control condition of people interacting in the same laboratory room where the study was conducted. Prior to exposure, participants completed a measure assessing environmental attitudes. Additionally, pre- and post-manipulation measures of affect and arousal were taken. After the experimental manipulation, participants completed a landscape assessment scale and the two creative thinking tasks.

As expected, participant responses to the environmental simulations were influenced by the features present in the settings. Landscape assessment and preference ratings were generally more positive as the environments evidenced more natural features and fewer built features. Negative affect was highest for the control and urban conditions while positive affect and arousal did not vary between the experimental conditions. Affective and arousal responses did not influence performance on the creative thinking tasks, nor did exposure to the different environmental scenes. Person-environment fit influenced affect such that participants with a good fit reported more positive affect and less negative affect than those with a poor fit. Again, affective responses failed to influence creative thinking.

The pattern of results suggests that the relationship between affect, arousal, and creativity may be more complicated than was previously believed. Theoretical implications and possible effects of the current operationalizations are discussed.

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Chapter I

INTRODUCTION

Environmental psychologists have long been interested in how different categories of physical environments affect human functioning. One line of inquiry has specifically examined how natural and built environments may differentially influence our emotional states and our ability to process information. A number of theories have been presented to explain these diverse findings. Both Attention Restoration Theory (Kaplan, 1995; Kaplan & Kaplan, 1989) and Ulrich's (1983, 1993; Ulrich et al., 1991) psychoevolutionary theory suggest that exposure to natural environments allows humans to recover from mental fatigue and stress, and thus enhances our emotional and cognitive functions. While numerous studies have provided empirical support for the restorative properties of natural environments, most have used performance on fairly simple cognitive tasks (i.e., proofreading and mathematical tasks) as evidence of the positive effects of nature on our cognitive functioning. Additionally, there appears to be continued debate as to whether these environmental effects should be attributed to influences on our emotional states, our general level of physiological or mental arousal, or as a result of the fit between the person and the environment. The purpose of the present study was to examine these different explanations of environmental effects on more complex cognitive tasks: convergent and divergent thinking, both abilities related to creativity.

Creativity

Creativity has been defined as the bringing together of existing materials and/or ideas into new, novel, and socially useful forms (Averill, 1999; Eysenk, 1995; Feist, 1998; Simon & Ward, 1973). Creative thinking has been described as the association of elements or ideas into new, useful combinations. The more remote the elements are in association, the more creative the resulting solution will be (Eysenk, 1995). Given that when one is attempting to produce new ideas there are no clear guidelines as to how one should go about it, individuals must draw on any number of cognitive resources to find a solution. Two of the most widely used indicators of one's ability to problem solve creatively are divergent and convergent thinking. Divergent thinking is characterized as the ability to generate a wide range of different ideas from a single starting point and to form and reform categories associated with the given problem or idea (Barron, 1963; Guilford, 1968). Convergent thinking is the ability to find associations among ideas that at first seem unconnected (James, Brodersen, & Eisenberg, 2004).

Creative thinking has been shown to be affected both by one's emotional state and one's level of autonomic arousal. For example, Isen (1990; Isen, Johnson, Mertz, & Robinson, 1985) found positive affect to improve both creative problem-solving and ability to make remote associations and diverse conceptual integrations. One explanation for this effect is that positive affect promotes more risk-taking in an individual's problem solving (Schwarz, 1990; Schwarz & Bless, 1991). This may come about as a result of promoting feelings of confidence, especially in situations in which creative performance is relatively unimportant (James et al., 2004). However, evidence has also been provided implicating the beneficial influence of negative affect in some situations (e.g., Kaufmann

& Vosburg, 1997). It has been suggested that negative emotions such as frustration may influence an individual to explore novel ideas and abandon standard thinking patterns (e.g., James, Chen, & Goldberg, 1992; Zhou & George, 2001). Additionally, James, Clark, and Cropanzano (1999) argue that positive and negative affect may differentially influence creativity depending on the goal of that creativity. Specifically, they suggest that negative affect may promote creativity directed toward negative ends (e.g., sabotaging a supervisor), whereas creativity directed toward positive goals may be enhanced by positive affect (e.g., designing a better product).

Arousal has also been implicated in influencing creativity. Martindale's (1993, 1999) neural-network model of creativity suggests that low average arousal throughout the brain can allow low-strength-of-connection neural networks to rise to conscious awareness (i.e., novel ideas and information). Additionally, Martindale's theory suggests that some positive emotions will reduce arousal, therefore improving creative thinking (James et al., 2004). Especially influential on convergent (associational) thinking may be the increased number of low-probability neural connections allowed to rise to conscious attention due to decreased arousal (James et al., 2004). However, creativity may be hindered by conditions of extremely low arousal. The Yerkes-Dodson law predicts that performance is best at intermediate levels of arousal. Extremely high or extremely low levels of arousal are expected to hamper performance on most tasks. For complex tasks, however (e.g., creativity), performance should be best at slightly lower levels of arousal than when performing simple tasks. In fact, in summarizing Martindale's theory, James et al. (2004) state that "the Neural Network model indicates that lower than normal, but not necessarily extremely low, arousal, facilitates access to novel ideas (p. 181)." Therefore, we should expect creativity to be enhanced at moderately low levels of arousal.

Thus far, both affect and arousal have been shown to play a role in influencing creativity. If one's goal is to enhance creativity, it is therefore desirable to identify situations that promote the types of affect and levels of arousal most conducive to creativity. Research in environmental psychology suggests we examine the type of physical environment one is in while trying to think creatively. Below, I summarize the evidence indicating that individuals categorize, prefer, and respond to naturalistic and built environments differentially. I then discuss how characteristics of one's environment should influence creative thinking.

Natural versus Built Environments

Categorization

In examining how people categorize the environments they find themselves in, an intuitive distinction would be between natural and built environments. In fact, a number of studies have shown that people make clear distinctions between these two types of environments (Ulrich, 1983, 1986). Ulrich (1986) has indicated that people tend to categorize and respond to environments as 'natural' if the landscape is perceived as being dominated by vegetation and/or water, and if there is little or no presence of human artifacts such as cars or buildings. As such, it is not just wilderness areas that are responded to as natural; similar reactions have been found in human-made environments such as wheat fields, wooded parks, and golf courses (e.g., Kaplan, Kaplan, & Wendt, 1972; Palmer, 1978). The Biophilia hypothesis (Ulrich, 1993) suggests that we make these distinctions due to an evolutionary affiliation with the natural environment.

Evidence of this affiliation is found in numerous studies showing that humans have a strong preference for natural versus built environments.

Preference

While a number of studies have examined how manipulation of certain contents, such as complexity and coherence of a visual landscape, can affect individuals' aesthetic preference, there is clear evidence that people strongly prefer natural scenes over urban views (Kaplan et al., 1972; Ulrich, 1983, 1986). Ulrich (1983) has noted that this preference is not a result of subjects being exposed to rare or spectacular nature scenes. Aesthetic preference levels have been shown to be higher for unspectacular or subpar nature scenes than for all but a very few urban scenes (e.g., Bernaldez & Parra, 1979; Kaplan et al., 1972; Palmer, 1978; Wohlwill, 1976; Zube, Pitt, & Anderson, 1975). However, preference for urban scenes does tend to rise when natural elements are added (Brush & Palmer, 1979; Thayer & Atwood, 1978). In fact, it has been shown that an urban park and the lowest rated nature scene in Kaplan's (1972) study were equally preferred, that stress recovery was greater in an urban setting with vegetation than without it (Honeyman, 1990), and that participants exposed to a golf course setting evidenced lower arousal and improved performance on a math task than when exposed to a forested scene (Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998). The preference for natural versus urban scenes helps explain why people frequently choose to go to natural environments for vacations and rest (Kaplan, 1995).

Benefits of Natural Environments

Several studies have shown that some of the most important benefits vacationers in natural settings report are aesthetic and emotional experiences, and stress relief

(Driver, 1976; Knopf, 1987; Rossman & Ulehla, 1977, Schroeder, 1989). Empirical investigation has revealed a number of additional benefits of exposure to naturalistic environments. Those exposed to naturalistic environments, as compared to built environments, have evidenced improved performance on concentration tasks, improved emotional state, increased ability to focus attention, decreased arousal, and recovery from stress (Hartig, Boeoek, Garvill, Olsson, & Gaerling, 1996; Hartig, Evans, Jamner, Davis, & Gärling, 2003; Hartig, Mang, & Evans, 1991; Ulrich, 1979, 1981; Ulrich et al., 1991). Another study conducted by Ulrich (1983) found that patients who had recently undergone cholecystectomy and had a view of trees rather than a brick wall from their hospital window spent less time in the hospital, required fewer strong doses of analgesics, and had fewer negative nursing notes written about them. It should also be noted that while most of these studies have compared naturalistic environments with urban scenes containing little or no vegetation, there is empirical evidence showing that the addition of vegetation into built environments is beneficial. Urban scenes with vegetation, golf courses, urban parks, and roadways with more vegetation relative to built structures on the edges have all been shown to aid in stress recovery (Cackowski & Nasar, 2003; Honeyman, 1990; Hull, 1992; Parsons et al., 1998).

Environments and Cognitive Tasks

Empirical support for the differential effects various physical environments have on our cognitive processes have been limited to fairly simple attentional tasks with unambiguous instructions on how the tasks should be completed. Examples of these tasks include proofreading (Hartig et al., 1991; Kaplan, 1995), Paced Auditory Serial-Addition Task (PASAT; Parsons et al., 1998), and speed with which participants could detect validly and invalidly cued visual targets, giving evidence of one's ability to voluntarily shift and focus attention (Laumann, Gärling, & Stormark, 2003). No research to date has examined how exposure to natural and built environments may affect more difficult cognitive tasks with somewhat ambiguous directions as to how the task should be completed--tasks characteristic of many real-life problem-solving situations. Creative thinking is an excellent example of such a task.

Mechanisms of Influence

As Figure 1 indicates, I propose two mechanisms by which one's physical environment is expected to affect creative thinking. The first mechanism is based upon

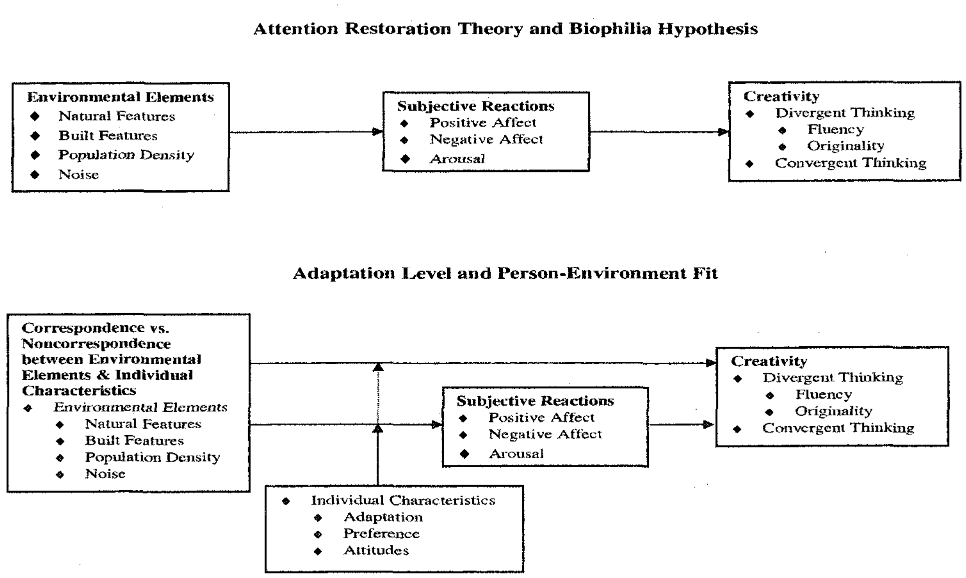

Figure 1. Hypothesized mechanisms of environmental influences on creativity.

empirical evidence suggesting that exposure to naturalistic, as opposed to built, environments serves as a restorative experience and draws upon Ulrich's (1993) Biophilia hypothesis and Kaplan's (1995; Kaplan & Kaplan, 1989) Attention Restoration Theory.

The second mechanism incorporates environmental attitudes and Helson's (1964) Adaptation Level Theory and suggests that creativity will be influenced by the degree of fit between the individual and his or her environment. The various elements of the setting examined in the present study, and detailed later, that might contribute to these environment-creativity effects include natural features, built features, population density, and noise (see Figure 1).

Restoration and Creativity

While exposure to naturalistic environments has been shown to provide a number of benefits, there is still debate as to why and how these benefits occur, and very little attention has been given to the possible interactions these benefits may have. Several theories have been generated in which naturalistic settings are viewed as restorative environments. These environments have the characteristic of allowing one to better recover from the mental fatigue and negative affect associated with stress.

The first theory attempting to explain the restorative nature of naturalistic environments seen in Figure 1 is the Attention Restoration Theory (Kaplan, 1995; Kaplan & Kaplan, 1989). This theory suggests that humans' ability to focus attention is frequently fatigued, and that natural environments promote involuntary attention, allowing our depleted directed attentional capacity to recover. Directed attention has been described as being effortful, under voluntary control, and playing a role in achieving focus and controlling distraction (Kaplan, 1995). As such, it is susceptible to fatigue due to any prolonged mental effort. Natural environments have been shown to replenish fatigued attentional resources and to improve performance requiring directed attention (Hartig et al., 1991). Kaplan (1995) has stated that one function of directed attention is to allow us to step back from a situation and gain a view of the larger picture being presented to us. This ability has readily apparent implications for creative thinking. Additionally, if we view creativity as a problem-solving task requiring one to focus attention, the importance of directed attention becomes clearer. Humans have a limited amount of attentional resources. When trying to focus on a task, directed attention allows one to stay on task and to ignore irrelevant stimuli. Should directed attention become depleted or should one perform tasks in an environment drawing heavily on these resources, performance will deteriorate. In fact, Brown and Poulton (1961) found that participants performing in an environment with a relatively large number of stimuli to attend to performed worse on an attention task than those working in an environment with fewer stimuli. The distracting noise associated with urban environments has also been shown to hamper performance on tasks requiring directed attention (Glass & Singer, 1972).

The second theory related to restorative environments seen in Figure 1 is Ulrich's (1983, 1993; Ulrich et al. 1991) psychoevolutionary theory, also called the Biophilia Hypothesis. This theory does not focus on attentional fatigue, but rather on the positive emotions and recovery from stress or reduced autonomic arousal associated with exposure to naturalistic environments, the cause of which is our unlearned preference to be in these settings. That is, Ulrich proposes an evolutionary affinity for natural environments that predates the emergence of built settings. This biological predisposition to prefer environments similar to those we evolved in is proposed to be the cause of the positive reactions accorded to naturalistic settings.

As Figure 1 illustrates, Kaplan (1995) and Ulrich's (1983) theories are similar in that both view exposure to naturalistic settings as resulting in improved affect and a lowering of arousal, as well as an increased ability to focus attention. Both theories presuppose that one is in some way stressed before exposure, and that natural environments allow us to recover from this stress, whereas built environments hinder this restoration, and in some cases can lead to increased stress.

Affect. Exposure to natural environments can have a number of restorative effects from attentional or 'mental' fatigue. While stress or fatigue on its own is generally viewed as an unpleasant experience, research has shown that such fatigue does not occur as an isolated effect. Rather, mental or attentional fatigue has been shown to be frequently accompanied by negative affect, declines in cognitive performance, and an inability to plan (Hartig et al., 1996; Holding, 1983). It should therefore be no surprise that recovery from such stress, as is frequently seen when one is exposed to natural environments, results in increased positive affect, lower physiological arousal, and improved cognitive performance (Kaplan, 1995; Ulrich, 1979, 1981; Ulrich et al., 1991). Ulrich (1986) has stated that individuals respond to environments in fundamentally different ways, depending on whether those environments are natural or built. One aspect of this response is affective. A large body of evidence has shown that indices of positive affect tend to increase when people are exposed to natural environments, whereas exposure to built or urban environments tends to produce increased negative affect (Cackowski & Nasar, 2003; Hartig et al., 2003; Ulrich, 1979, 1981; Ulrich et al., 1991). An interesting note is that Ulrich et al. (1991) found that post-recovery affective states were more positively toned than those seen at baseline. Additionally, Hartig et al. (2003) found that positive affect increased for participants exposed to natural environments *in the absence* of a previous experimental stressor, suggesting that nature may have instorative as well as restorative effects on our emotional states.

As described above, there is evidence indicating that both positive (Isen, 1990; Isen et al., 1985) and negative affect (Kaufmann & Vosburg, 1997; Zhou & George, 2001) can enhance creative thinking. However, James et al. (2004) suggest that positive affect will improve creativity when performance on the creativity task is relatively unimportant to the individual. This, combined with the pattern of affective reactions accorded to natural and built environments leads to my first hypothesis.

> Hypothesis 1: Creative thinking will be enhanced for those exposed to a more naturalistic, as opposed to built, setting, with affect mediating this effect. Such an effect would be consistent with findings from the restorative environment literature.

Arousal. In addition to having a positive effect on emotions, natural environments have also been shown to beneficially influence our levels of arousal, especially when we are in a state of heightened arousal or stress. Ulrich et al. (1991) have stated that:

> *Arousal* theories (e.g., Berlyne, 1971; Mehrabian & Russell, 1974) imply that recuperation from excessive arousal or stress should occur more rapidly in settings having low levels of arousal increasing properties such as complexity, intensity and movement....Since natural settings may tend to have lower levels of complexity and other arousal properties than urban environments (Wohlwill, 1976), arousal theory implies that nature should have comparatively restorative influences on stress. *Overload* perspectives provide a rather different explanation of why recuperation following a stressor may be more rapid when external stimulation is comparatively low; high complexity and other stimulation place taxing processing demands (Cohen, 1978) that should slow or hamper restoration from stress. (p. 205)

Evidence of nature's effect on arousal has involved cortical activity indicating wakeful relaxation (Ulrich, 1981) and decreased heart rate (Laumann et al., 2003), whereas increased skin conductance and blood pressure have been found with exposure to urban environments (Parsons et al., 1998).

Both Martindale's (1993, 1999) neural-network model and the Yerkes-Dodson law propose a curvilinear relationship between arousal and performance, and suggest that performance on complex tasks is best at moderately low levels of arousal. Given that naturalistic environments have been shown to promote lowered levels of arousal whereas exposure to urban environments tends to increase arousal, I therefore propose the following:

> Hypothesis 2a: Creative thinking will have a curvilinear relationship with arousal.
>
> Hypothesis 2b: Arousal will mediate the effects of the physical environment on creative thinking such that moderately low levels of arousal associated with exposure to a more naturalistic, as opposed to built, setting will enhance creativity. Such an effect would be consistent with findings from the restorative environment literature.

Attitudes, Adaptation, Person-Environment Fit, and Creativity

The potential environmental effects on creative thinking discussed thus far have drawn heavily on the literature looking at the restorative effects of nature. While there is evidence to suggest that factors inherent in naturalistic settings should increase positive affect and/or lower arousal, thereby improving creative thinking, there are other mechanisms through which creative thinking may be affected by the environment. As Figure 1 shows, a second mechanism by which the physical environment may affect creativity is through the interaction between characteristics of the environment and those of the individual. Specifically, the fit between the person and the setting he or she is working in should influence ability to think creatively, independent of any potential restorative effects. Whereas many artists and musicians prefer to create their works in pastoral settings, others thrive among urban settings. This suggests that we examine the interaction between individual preference and his or her experienced environment

Environmental preference, as discussed above, has focused solely on reports of aesthetic preference. Studies examining preference have typically had participants rate visual slides or video presentations of different environments on factors such as pleasantness, scenic beauty, and solitude (Mace, Bell, Loomis, & Haas, 2003; Ulrich, 1983). While use of simulated environments has been shown to work as well as actual environments (Craik, Appleyard, & McKechnie, 1980), when trying to think creatively a preferred environment can involve more than just an assessment of its visual beauty. Our response toward various settings can be influenced by the degree to which we have adapted to those settings (Wohlwill, 1974). Helson's (1964) theory of adaptation level suggests that judgments of any given stimuli are relative to the context of judgment. In relating adaptation level theory to environmental judgments, Wohlwill (1974) suggests that our frames of reference in judging environmental variables are important, indicating we have an optimal level of stimulation. He goes on to state that:

> Their relevance (Optimal levels) resides in the strong possibility that such optimal levels, rather than representing an intrinsically determined characteristic of the effects of stimulus dimensions on the individual, are a function of his history of experience with such dimensions, resulting in the establishment of relatively stable adaptation levels to which expressions of preference or other affective responses become related. (p. 137)

When trying to think creatively, we may prefer certain environments based on the degree to which we have adapted to them, or to which they have previously inspired our creative thinking process. Kaplan (1995) has stated that when acting in an environment, there should be compatibility between that environment and one's purposes and inclinations. As discussed above, one beneficial effect of natural environments is to decrease arousal, especially when one has been previously stressed. However, adaptation level theory states that we must take into account the level of stress and arousal individuals have adapted to. If individuals prefer high levels of arousal, the decrease in arousal associated with exposure to natural environments may actually hinder their ability to think creatively. Van den Berg, Koole, and van der Wulp (2003) have even suggested that environmental psychologists must take care that research participants do not get bored by watching the same environment for too long. This is especially relevant for those who are used to higher levels of arousal. James et al. (2004) have suggested that while lower than normal arousal should enhance creative thinking by facilitating access to novel ideas, extremely low arousal can inhibit this effect. Given that individuals have an optimal level of arousal, they should also have a preference for certain environments based upon their levels of perceived stimulation. Individuals' environmental attitudes give us an indication of their orientation toward the environment, and can serve as an indicator of which environments they prefer, beyond just the visually pleasing aspects of the environment.

Attitudes have typically been defined as consisting of two factors: cognitive and emotional. Attitudes are composed of the cognitive evaluation of an object in a generally positive or negative light (Eagly & Chaiken, 1993). Individuals have as attitude objects people, things, ideas, and even the environment. While it might be difficult to conceive of an individual as having a positive or negative attitude about the environment in general, it might be easier to think about attitudes toward certain aspects of the environment or toward specific environments. When one thinks of a busy metropolis, those with a positive attitude toward such a setting will typically feel positively towards it and think of its positive aspects such as cultural activities, access to a wide range of entertainment, or the high level of stimulation. On the other hand, those with a negative attitude toward urban settings will likely view them in a negative light and conjure up images of traffic jams and heavily overcrowded sidewalks. Similarly, some may desire to hike in a wilderness setting, whereas others may find such a setting threatening or otherwise uninviting. These tendencies might be tapped by the Urban Dweller subscale of The Survey of Environmental Quality Universal Orientations and Individual Attitudes (SEQUOIA) which measures the degree to which individuals prefer urban settings, and the Environmental Concern subscale of the SEQUOIA that measures the degree to which an individual is concerned for and oriented toward the natural environment (Cooney, Bell, & Clarke, 2004). Additionally, attitudes toward various environments can be expected to be influenced by previous experiences. In relation to creativity, one should therefore hold a more favorable attitude toward those environments that have provided inspiration in the past. Therefore:

> Hypothesis 3a: Creative thinking will be best when there is a good person-environment fit, as determined by environmental attitudes and preference. Conversely, creative thinking will be worse when there is a poor person-environment fit.

While individuals may prefer a certain environment based upon the fit of that environment with their optimal level of arousal and prior experience, attitude research suggests that this effect may also be mediated by affective reactions associated with confrontation with an attitudinal object. Given that part of the definition of attitudes is the emotional reaction, we can expect individuals to experience an affective change when exposed to an environment that they evaluate favorably or negatively. Some support for this position comes from the theory of planned behavior (Ajzen, 1991; Kaiser, Wolfing, & Fuhrer, 1999). Put simply, this theory states that some primary determinants of any given behavior are one's attitude and the norms of society. Therefore, when predicting the behavior of individuals while performing a creative thinking task, we can expect that their attitudes activated at the time will have an effect. This effect is independent of an affective change resulting from a restorative experience.

> Hypothesis 3b: Creative thinking will be best when there is a good person-environment fit and worse when there is a poor person-environment fit. This effect will be mediated by positive and negative affect associated with good and poor fit, respectively.

Environmental Elements: Population Density, Noise, and Urban Parks

As discussed above, there is theoretical support to expect natural and built environments to differentially affect creative thinking. However, empirically investigating these theories requires exposure to actual environments. A defining feature of experimental investigation is control, where only those variables of interest are systematically manipulated. However, environmental psychologists are interested in how individuals react to larger environments with multiple stimuli that are difficult to control simultaneously. This bias towards focusing on 'entire' environments maximizes external validity, but sacrifices some internal validity due to the many dimensions by which the environments can vary. Research in environmental psychology must therefore trade some degree of control for environmental realism. What becomes important is to measure reactions to the different environments -- affect and arousal in the present study -- and use these measures to predict some other response, such as creative thinking.

In exposing participants to environments with varying levels of naturalistic and built elements, there is more than just 'nature' that differs between them. Several taxonomies have been developed to categorize various environments. For example, Kaplan (1987, Kaplan & Kaplan, 1989) found that environmental preference is in part determined by the informational content of a scene. This information can be classified along four dimensions: coherence, legibility, complexity, and mystery. Berlyne's (1974) taxonomy focuses upon the dimensions of complexity, novelty, incongruity, and surprisingness. In the present study, it was decided to identify and control for those variables believed to have an influence on affect and arousal. Therefore, environments were selected that varied on such key environmental elements.

As discussed previously, individuals respond to an environment as natural if it is dominated by vegetation or water, and lacks human artifacts (Ulrich, 1986). Natural and built environments have also been shown to differentially influence affect and arousal. Therefore, in selecting relevant environmental variables, one must take into consideration the relative amount of built versus natural features present. There are, however, other environmental factors known to influence affect and arousal. For example, urban environments not only contain built elements that are not present in most natural environments, but also expose people to higher population densities and noise, both of which have known effects on affect and arousal (see Figure 1).

Population density. Research on population density and crowding has shown that the presence of too many people can result in negative affect (Saegert, MacIntosh, & West, 1975) and heightened states of arousal (Baum & Paulus, 1987), two conditions expected to have a negative effect on creativity as discussed above. However, feelings of being crowded and one's tolerable level of population density are subjective and situation specific (Baum & Paulus, 1987). Urban environments are characterized as having high population densities, and can therefore be expected to increase arousal and reports of negative affect from high density alone. While one will typically find fewer people in a natural environment, encountering others while in such a setting may also result in a negative response. The social carrying capacity, or level of social interaction desired, of natural environments tends to be much lower than for urban environments (Manning, Valliere, Wang, & Jacobi, 1999). Given that the tolerable level of population density is situation specific, individuals encountering others in naturalistic environments are more likely to be negatively affected by their presence, even though the absolute number of people in that setting is much lower than in urban environments. Additionally, the amount of people one is used to being around (i.e., adapted to), can be expected to influence one's reaction. However, regardless of one's level of adaptation, a negative reaction will occur in the presence of fewer people while in nature than while in an urban setting. Therefore, comparing the effects of urban versus natural environments requires some degree of control over population density.

Noise. In addition to heightened population density, noise associated with urban environments has also been shown to negatively influence individuals. Glass and Singer (1972) have shown that noise characteristic of urban environments (i.e., loud, random, and uncontrollable) increases stress, hampers performance on tasks involving attention and cognitive processing, and lowers frustration tolerance. While very little research has examined the influence of noise associated with natural environments, the restorative environment literature discussed above would suggest that the stress-inducing aspects of urban noise are absent in natural environments. Therefore, comparing the effects of urban versus natural environments on creative thinking requires some degree of control over noise.

Urban parks. As discussed above, the noise associated with urban environments and the high population densities typically found there are associated with heightened levels of arousal and negative affect, as well as decrements in performance (Baum & Paulus, 1987; Glass & Singer, 1972; Saegert et al., 1975). Additionally, preference studies have consistently found urban environments to receive the lowest ratings (Ulrich, 1986). Given the harsh responses accorded urban environments, Olmstead introduced the idea of urban parks as a means for individuals to experience nature within the city (see Bell, Greene, Fisher, & Baum, 2001). In fact, there is evidence that some of the negative responses associated with urban settings can be alleviated through the introduction of natural elements. Ulrich (1983) has argued that individuals will respond similarly to human-made and natural settings if the human-made settings contain extensive vegetation or water, and if buildings, cars or other built features are not prominent. Empirical evidence has shown that preference ratings and recovery from stress increase when natural elements are added to urban scenes (Honeyman, 1990; Thayer & Atwood, 1978). Parsons et al. (1998) found that stress recovery and cognitive performance were similar for participants exposed to golf course and forest scenes. Given the similar responses attributed to nature scenes and built scenes dominated by vegetation, examination of the responses accorded to different physical environments should take into account the amount of vegetation present in built environments.

Present Study

The present study explored the effects of natural and built environments on creative thinking. Participants were exposed to video and sound recordings of either (1) a natural setting with trees and rock outcroppings with no people present; (2) the same natural setting with periodic hikers coming through and talking; (3) a busy urban intersection with lots of concrete, motorized traffic, noise, and pedestrians; (4) an urban park with expansive green grass and trees, occasional traffic and maintenance noise, and periodic park visitors; or (5) a control condition in which no external environment was presented. Measures were taken of affect, arousal, environmental attitudes and preferences, and divergent and convergent thinking. Table 1 summarizes the hypotheses examined in the present study.

Table 1. Research Hypotheses

Restoration Theory Hypotheses

Hypothesis 1:	Creative thinking will be enhanced for those exposed to a more naturalistic, as opposed to built, setting, with affect mediating this effect. Such an effect would be consistent with findings from the restorative environment literature.
Hypothesis 2a:	Creative thinking will have a curvilinear relationship with arousal.
Hypothesis 2b:	Arousal will mediate the effects of the physical environment on creative thinking such that moderately low levels of arousal associated with exposure to a more naturalistic, as opposed to built, setting will enhance creativity. Such an effect would be consistent with findings from the restorative environment literature.

Adaptation Level and Person-Environment Fit Hypotheses

Hypothesis 3a:	Creative thinking will be best when there is a good person-environment fit, as determined by environmental attitudes and preference. Conversely, creative thinking will be worse when there is a poor person-environment fit.
Hypothesis 3b:	Creative thinking will be best when there is a good person-environment fit and worse when there is a poor person-environment fit. This effect will be mediated by positive and negative affect associated with good and poor fit, respectively.

Chapter II

METHOD

Participants and Design Overview

Participants were 382 undergraduate students enrolled in an introductory psychology class. Participants completed the study as partial fulfillment of course requirements. The ethnic make-up of the sample was predominately Caucasian (90%), with 62% being male. Participants were run in groups of 10 and were randomly assigned to one of the five experimental conditions: Control, Urban, Park, Nature with People (N+P), or Nature without People (N-P). Prior to the experimental manipulation, participants first completed a measure assessing their environmental attitudes. They then completed the pre-manipulation measures of affect and arousal. Following the 10-minute exposure to one of the environmental simulations, participants completed the landscape assessment rating and the post-manipulation affect and arousal measures. Participants were then administered the creative thinking tasks.

Materials

Environments. For the experimental conditions, it was decided to present participants with simulations of the environments of interest rather than transport the participants to the actual environments. This was done so as to control for any extraneous variables and for ease of administration. Efforts were made to make the environmental simulations as ecologically valid as possible. Past research has supported the validity of using simulations in the place of actual environments (Craik et al., 1980; Feimer, 1984). Environmental simulations have been successfully used in studies examining the affective appraisal of and preference for various environments (Kaplan, 1987; Russell & Lanius, 1984). Brown and colleagues (Brown & Daniel, 1989; Hetherington, Daniel, & Brown, 1993) have shown the utility of using video simulations containing sound to represent dynamic environments. Additionally, studies examining the differential effects of natural and urban scenes on stress recovery, arousal, and affect have used video simulations successfully (Parsons et al., 1998; Ulrich et al., 1991; Van den Berg et al., 2003). For the present study, participants were randomly assigned to view video recordings, with sound, of one of four physical environments, or to a control condition. The four experimental video conditions were (1) a natural setting of trees and rock outcroppings with no people present; (2) the same natural setting with periodic hikers coming through and talking; (3) a busy urban intersection with lots of concrete, motorized traffic, noise, and pedestrians; or (4) an urban park with expansive green grass and trees, occasional traffic and maintenance noise, and periodic park visitors. For each of the environments, except the control condition, a 1-hour video recording of the physical environment was made, along with the accompanying sounds. A Sony Digital Handycam with Sony Digital 8 type video cassette was used to record each environment. Each recorded environment was subsequently transferred to a VHS tape. The four videotaped experimental environments were specifically chosen to vary along dimensions believed to influence affect and arousal. These included the degree to which natural elements dominated the scene (i.e., trees and grass) as opposed to urban elements (i.e., buildings and cars), the degree to which people were present in the scene, and the amount of noise naturally occurring in the scene. In all of the environments, the foreground and midground were open so participants would have an unobstructed view of the scene. Detailed descriptions of each of the four experimental scenes, as well as the video used for the control condition, are as follows:

Nature with No People (N-P): In this scene, a section of hiking trail leading up to Horsetooth Rock, a popular hiking area located outside of Fort Collins, CO, was recorded. The recording was made approximately 880 yards (.50m) away from the trail. The scene was dominated by trees and mountain foliage common to the area, and was shot across a small valley. While the hiking trail was visible in this scene, no hikers were present. The only sound present in this condition was that of the occasional bird and wind.

Nature with People (N+P): This scene was identical to the Nature with No People scene. However, in this condition hikers were frequently seen walking on the trail. Additionally, the voices of people in the distance could be heard occasionally.

Park: For this condition, video footage was shot at City Park in Denver, CO. The scene showed a large expanse of manicured lawn. Approximately 300 yards (.17m) away a row of trees partially obscured a busy street and a large building rising above them. Approximately 150 yards (.09m) away a pedestrian path cut across the lawn, upon which individuals could be seen walking periodically. Additionally, an occasional park service vehicle (i.e., tractor or street sweeper) could be viewed using the path. While cars on the street in the distance could not be heard, the talk of pedestrians and the sound of the service vehicles (sometimes loud) were occasionally apparent.

Urban: The urban condition depicted a busy street intersection in the downtown, 16th Street Mall area of Denver, CO. The scene was shot from the second floor of a parking structure approximately 150 yards (.09m) away from the intersection. The parking structure was chosen to reduce the likelihood of pedestrians noticing and reacting to the presence of the video camera. The recorded scene showed vehicles and pedestrians waiting for and crossing a street intersection with a stop light. To the far right of the scene was a modern building. The sound of cars driving by was readily apparent.

Control: As will be described below, when viewing the environmental simulations, participants were instructed to imagine as if they were actually in the projected environment. Pilot data, in which the control condition consisted of nothing being projected during the viewing period, indicated that participants became bored and otherwise reacted negatively to the experimental procedures. Therefore, it was desired to project as neutral an environment as possible so that participants could still be told to imagine themselves in that environment. This gave participants something to focus on during the viewing period and to later rate using the Landscape Assessment Scale (LAS). Given that the manipulation of primary concern in the present study was between natural and built environments, it was decided to project a video of the experimental room itself. Therefore, during the viewing period, participants had something to focus on without having to imagine that they were somewhere else. Because participants were already in the experimental room, projecting that same room should approximate a control condition in which nothing was projected, yet avoid the boredom apparent in the pilot study.

The video was recorded from the back of the room, while students were present and adjourning a meeting. Individuals periodically left and entered the room while others remained in conversation. In contrast to videos of the experimental environments, no sound was projected for the control condition. While the control video was intended to be as neutral a scene as possible, it was of an interior environment with built elements, in which other people were present. Previous restorative environment studies, in which environmental simulations have been used successfully, typically do not utilize a control condition -- they just compare reactions among several different settings. Therefore, results in the present study were assessed both with and without data from the control condition.

Laboratory room and projection material. The laboratory room used for the present study measured 17ft (5.17m) by 23 ft (6.96m) and was equipped with a Panasonic VCR and an Epson PowerLite video projector. The scenes were projected onto a 5.5ft (1.66m) by 7.5ft (2.27m) screen from which participants sat between 9.5ft (2.87m) and 17ft (5.17m).

Dependent Measures

Environmental attitudes. The Survey of Environmental Quality: Universal Orientations and Individual Attitudes (SEQUOIA; Cooney et al., 2004; Appendix A) was administered as a measure of the participants' environmental attitudes. Participants were asked to rate the degree to which they agreed to each of 40 questions. Responses were made on a 1 to 5 scale, ranging from strongly disagree (1) to strongly agree (5). Responses to the SEQUOIA can be scored to generate four factors: Environmental Concern, Modern Sensation Seeker, Independent/Self-Sufficient, and Urban Dweller. The Environmental Concern factor measures the degree to which an individual is concerned about the environment from an environmental awareness perspective. Those scoring high on the Modern Sensation Seeker factor view the physical environment as existing primarily for their use, while low scorers tend to be more ecocentric in their attitudes, viewing the physical environment as existing primarily for its own sake. The Independent/Self-Sufficient factor captures the degree to which individuals prefer settings that require the ability to manipulate the environment for the sake of survival. Finally, the Urban Dweller factor assesses the level of preference an individual has for urban environments.

Subscales of the SEQUOIA have been shown to significantly correlate with other measures of environmental attitudes (Cooney et al., 2004). Additionally, the subscales have been shown to be related to perceptions of environmental loss and likelihood to have engaged in various outdoor activities. Cronbach alpha reliability coefficients for the Environmental Concern, Modern Sensation Seeker, Independent/Self-Sufficient, and Urban Dweller subscales of the PANAS were .893, .646, .875, and .696, respectively.

Landscape assessment scale. Participants completed the Landscape Assessment Scale (Mace et al., 2003; Appendix B) as they viewed the video of the particular environment to which they were randomly assigned. This measure had participants rate the environment on each of the following attributes: scenic beauty, solitude, tranquility, freedom, naturalness, annoyance, and overall preference. Responses were made on a 10-point scale, with the score indicating the degree to which the participant felt the environment possessed the given attribute. These descriptions of the landscape collectively measure one's opinion of the overall scenic beauty of the environment, as well as preference for that landscape. In fact, Mace et al. (1997) found that all six descriptors loaded on a single factor.

For purposes of the present study, specific attention was given to ratings of overall preference for the landscape viewed. Scores on all other Landscape Assessment Scale items were considered in the secondary analyses section.

Situational affect. In order to assess the degree to which participants experienced an affective reaction from exposure to different environments, the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988; Appendix C) was administered immediately prior to and after participants watched one of the videotaped environments. The PANAS is a 20-item scale measuring participants' degree of felt positive and negative affect. Participants rated each of the 20 emotional descriptors on a 5-point Likert-type scale. Responses are then scored so as to generate a positive affect and a negative affect score, with scores on each subscale ranging from 10 to 50. While instructions for the PANAS can be phrased to measure either dispositional or situational affect, instructions for the present study asked participants to indicate to what extent "*you feel this way right now, that is, at the present moment.*" The PANAS has been successfully used in previous environmental studies utilizing a pre- and post-test experimental design (Asmus, & Bell, 1999; Mace et al., 2003). Cronbach alpha reliability coefficients for the pre-manipulation positive and negative affect subscales in the present study were .858 and .744, respectively, while the post-manipulation coefficients were .911 and .760.

Arousal. To measure participants' levels of arousal both before and after the experimental manipulation, Anderson, Deuser, and DeNeve's (1995) Perceived Arousal Scale (PAS) was used (Appendix D). The PAS asks participants to rate 24 adjectives on a 5-point Likert-type scale. Ten of the items correspond to high arousal, whereas the remaining 14 items correspond to low arousal. A total arousal score is determined by reverse scoring the low-arousal adjectives and then summing the resulting scores with those for the high-arousal adjectives. As a result, a higher score represents greater arousal. Scores can range from 24 –120. The PAS has been successfully used in the past in conjunction with physiological measures (Anderson et al., 1995). The internal reliability coefficients for the pre- and post-manipulation measures were .926 and .935, respectively.

Divergent thinking. A one-item version of the Alternative-Uses Test (Christensen, Guilford, Merrifield, & Wilson, 1960; Appendix E) was given to measure participants' divergent thinking abilities. This test can be used to calculate scores of uniqueness (originality) of ideas, as well as for fluency of thought. This test has been used in a number of studies examining individual differences in creative performance (e.g., James & Asmus, 2000; James, Chen & Goldberg, 1992) and has received support regarding its validity (Barron & Harrington, 1981). In the present study, a brick was placed in front of participants and pointed out. The oral and written instructions were as follows:

> The following task measures your ability to generate ideas. You will notice that a brick has been placed in front of you. Please write down as many unusual uses for the brick that you can think of. You have 4 minutes to write down your ideas.

Fluency scores were determined by counting the total number of responses a participant gave. A response was not counted if it was viewed as an unrealistic use for the brick or if it was redundant in relation to another response. Originality scores were calculated using Guilford and Christensen's scoring formula (see Runco, 1991). Briefly, a list of every response across the entire sample was first constructed. The frequency of each response across the entire sample was then calculated. The frequencies associated with each response given by a specific individual were then summed and finally divided by the total number of uses generated by that person (fluency). The resulting score reflects how unique (original) the participant's responses were on average. Due to the nature of the computations, a lower score reflects a higher degree of originality. To determine the reliability of the fluency and originality scores, a random sample of 20 participants' responses were selected and independently scored by two trained raters. Interrater reliability correlations were .96 and .91 for fluency and originality, respectively.

Hocevar and Michael's (1979) percentage scoring formula, using subjective ratings for the originality of each response, was also used to calculate originality scores. However, because results using the two methods of calculating originality were similar, only those using Guilford and Christensen's method are reported.

Convergent thinking. A 10-item version of the Remote Associates Test (RAT; Mednick, 1962; Appendix F) was given to assess participants' convergent thinking abilities. The original RAT is composed of 30 items and was designed to measure the associative aspects of creative thinking. Each item consists of three stimulus words. Participants are instructed to generate a fourth unreported word that is somehow related to each of the stimulus words. For example, "Widow," "Bite," and "Monkey" would be stimulus words to which the correct response would be "Spider." Ten-item versions of the RAT have successfully been used in previous research (Dailey, 1978; McFarlin & Blascovich, 1984). Participants were instructed that they had 10 minutes to complete as many of the 10 items as possible. This gave participants approximately one minute to answer each item. Convergent thinking scores represent the number of items they correctly completed.

Procedure

Upon arriving for the experiment, participants were instructed to sit at one of the tables provided and wait until all 12 people arrived. They were asked to remove all items from the top of the tables except for a pen and pencil, and were then handed an informed consent form to read and sign. Participants were told that they would be taking part in a study examining the effect of different environments on their cognitive abilities and were handed a questionnaire packet. Participants were then instructed to fill out the demographic sheet, the SEQUOIA, the PANAS, the PAS, and then to wait until everyone else had finished. Following completion of the first set of questionnaires, participants were informed that they would be viewing a video simulation of a physical environment for the next 10 minutes. Instructions stated that they should remain at their desk, refrain from talking to those around them, and to try to imagine as if they were truly in that environment. The experimenter then began one of the video simulations described above.

After the 10-minute viewing period was completed, participants were told that the second portion of the study would begin. The video was turned off at this point for the control condition, while for each of the experimental conditions, it continued to play. Participants were instructed to fill out the Landscape Assessment Scale, the PANAS, the PAS, and then to wait until everyone was finished. Once all had completed the questionnaires, they were administered the divergent thinking task. All participants were instructed that they had four minutes to generate as many unusual uses for a brick as possible. Participants were then administered the convergent thinking task. They were told that they had 10 minutes to complete as many items as possible and that if they got stuck on an item, they should go to another and return to it later if they still had time.

Following the convergent thinking task, participants were asked to complete the post-experimental questionnaire. The video was then turned off for those in one of the experimental conditions, participants were thanked for their time, given a debriefing sheet, and dismissed.

Chapter III

RESULTS

Manipulation Check of Environmental Conditions

Landscape assessment scale analyses. Table 2 shows the Landscape Assessment Scale (LAS) means, standard deviations, and univariate *F*s across the five conditions.

Table 2. Means, Standard Deviations, and Univariate *F*s for Landscape Assessment Scale Items Across Conditions

	Control	Urban	Park	N + P	N – P	*F*
Scenic	1.20	3.26	5.07	5.30	5.50	140.348*
Beauty	(0.49)	(1.81)	(1.46)	(1.26)	(1.35)	
Naturalness	2.85	1.95	4.20	6.82	7.31	215.856*
	(2.11)	(1.10)	(1.50)	(1.06)	(0.89)	
Freedom	3.57	3.92	5.03	6.11	6.62	46.231*
	(2.15)	(1.85)	(1.61)	(1.36)	(1.27)	
Annoyance	5.30	4.80	3.49	3.18	2.56	26.281*
	(2.19)	(2.05)	(1.85)	(1.89)	(1.66)	
Solitude	4.01	2.58	4.53	6.08	6.47	69.441*
	(1.86)	(1.79)	(1.76)	(1.48)	(1.39)	
Tranquility	3.09	2.62	4.73	6.10	6.37	85.441*
	(1.88)	(1.71)	(1.69)	(1.26)	(1.42)	
Openness	3.25	2.64	5.23	6.12	6.10	74.562*
	(2.15)	(1.63)	(1.52)	(1.25)	(1.61)	
Preference	2.04	3.99	5.25	5.64	5.47	60.543*
	(1.45)	(2.13)	(1.68)	(1.18)	(1.87)	

Note. $^*p < .001$
Numbers in parentheses represent standard deviations.

To determine how the different environmental simulations were assessed, a MANOVA was conducted examining variation in the overall LAS ratings by Condition. Ratings of the simulated environments were found to vary significantly by Condition, $F(32, 1488) = 22.261$, $p < .001$, $\eta^2 = .324$. Univariate results indicated that each item of the LAS varied significantly across Condition (see Table 2). As expected, responses to every LAS item except Annoyance tended to increase as the environmental simulations evidenced more natural, as opposed to more built, elements. Mean scores for the Annoyance item were highest for those conditions with the most built elements. Examination of the means also suggests that participants tended to rate the Control condition as more favorable than the Urban condition. In fact, post-hoc analyses indicated that the Control condition was rated significantly higher than the Urban condition on Naturalness ($p < .001$), Solitude ($p < .001$), and Openness ($p < .05$), and significantly lower on Scenic Beauty ($p < .001$) and overall Preference ($p < .001$). The Control and Urban conditions did not differ significantly on Freedom, Annoyance, and Tranquillity.

While the Urban condition received the lowest mean scores on many of the LAS items, post-hoc analyses suggested that participants responded differently to built environments when natural elements were incorporated into the scene. In fact, comparison of the Urban and Park conditions indicated that participants rated the two environments significantly different ($p < .001$) on each item of the LAS. Comparisons between the Park and Nature with and without People conditions showed that while ratings of Scenic Beauty and overall Preference were similar, the two Nature conditions were rated more favorably on all other LAS items than was the Park condition ($p < .001$). Finally, post-hoc comparisons between the N + P and N – P conditions indicated that the only effect the presence of people in naturalistic environments had was to significantly reduce ratings on the Naturalness item ($p < .001$).

Pre- to post-manipulation changes in affect and arousal. To determine if affect and arousal changed as a result of having viewed the environmental simulations, and if these changes varied in nature between experimental conditions, a mixed between-within-subjects MANOVA was conducted. Because of findings described in a later section of the results, involving the affect and arousal measures when the Control condition was included, the Control condition was excluded from the following analyses. The combined affect and arousal measures were found to vary significantly between pre- and post-manipulation assessment, $F(3, 296) = 94.309$, $p < .001$, $\eta^2 = .489$. Condition did not interact to affect the pre- to post-manipulation changes in affect and arousal, $F(9, 894) = 1.308$, $p > .05$. Univariate analyses showed scores on PA, NA and arousal significantly decreased from pre- to post-manipulation ($p < .001$; see Table 3). Post-hoc analyses showed that the affect and arousal measures did not vary between conditions prior to the environmental manipulation. Environmental effects on post-manipulation scores will be described below.

Table 3. Pre- and Post-Manipulation Means for PA, NA, and Arousal

	Pre	Post	*F*
PA	26.28	20.63	206.251*
NA	13.98	12.92	25.745*
Arousal	75.02	71.32	22.661*

Note. *$p < .001$

Tests of Restorative Environment Effects on Creative Thinking

Mediating role of positive and negative affect. Hypothesis 1 states that creative thinking will be enhanced when performed in more naturalistic settings due to the improved affect associated with restorative environments (see Table1). This suggests that positive and negative affect will mediate any influence the physical environment has on creative thinking. To determine mediation, Baron and Kenny (1986) state that three criteria must be met. First, the predictor (physical environment; Condition) must be related to the outcome variable (Creativity). However, even when there is no significant effect of the predictor, there can be theoretical reasons to continue estimating the mediated effect. In the present study, it was possible that the physical environment affected creative thinking only through its influence on affect. The second criterion is to show a relationship between the predictor (Condition) and the mediators (Affect). Third, the mediators (Affect) must be shown to affect the outcome variables (Creativity). To test the first criterion, a multivariate analysis of variance (MANOVA) was conducted in which the control and four experimental conditions were used to predict Fluency, Originality, and Convergent Thinking. Table 4 shows the means and standard deviations for the three creativity scores across the five conditions and for the overall sample, as well as the univariate F statistics. Using Pillai's criterion, condition did not significantly affect the combined creativity scores $F(12, 1131) = 0.827$, $p > .05$. Condition also failed to have univariate effects on the three creativity scores (see Table 4). A second MANOVA in which data from the Control condition were omitted also failed to show a multivariate effect $F(9, 897) = 0.902$, $p > .05$.

Table 4. Creativity Score Means, Standard Deviations, and Univariate *F* Statistics Across Environmental Conditions.

	Control	Urban	Park	N + P	N –P	Overall	*F*
Fluency	10.19	10.00	9.01	9.79	10.06	9.82	0.214
	(2.97)	(3.49)	(3.48)	(3.71)	(3.32)	(3.38)	
Originality	66.98	68.73	70.99	66.74	66.63	68.05	0.757
	(21.35)	(21.62)	(25.31)	(23.25)	(26.22)	(23.46)	
Convergent	4.48	4.28	4.48	4.82	4.73	4.55	0.549
Thinking	(2.13)	(2.38)	(2.17)	(2.06)	(2.09)	(2.17)	

Note. Numbers in parentheses represent standard deviations.
N+P = nature with people, N-P = nature without people.
Degrees of freedom for univariate *F*s are (4, 377).

To test Barron and Kenny's (1986) second criterion of mediation, a MANOVA was run in which condition predicted post-manipulation Positive Affect (PA), Negative affect (NA), and Arousal. Results involving arousal scores will be discussed in a later section pertaining to Hypotheses 2a and 2b. Table 5 shows the means, standard deviations, and univariate *F*s for the post-manipulation PA, NA, and arousal scores across the five conditions.

Table 5. Means, Standard Deviations, and Univariate *F* Statistics for the Affect and Arousal Measures Across Environmental Condition.

	Control	Urban	Park	N + P	N – P	Overall	*F*
PA	16.38	20.48	20.63	20.93	20.51	19.75	6.036**
	(6.46)	(7.31)	(6.12)	(7.40)	(6.99)	(7.06)	
NA	14.35	14.29	12.45	12.37	12.37	13.22	6.060**
	(4.20)	(4.26)	(3.05)	(3.60)	(3.49)	(3.87)	
Arousal	63.46	72.45	70.55	70.99	71.13	69.67	3.777*
	(15.90)	(16.56)	(16.08)	(17.22)	(15.95)	(16.60)	

Note. $*p < .01$, $**p < .001$
Numbers in parentheses represent standard deviations.
N+P = nature with people, N-P = nature without people.
Degress of freedom for univariate *F*s are (4, 376).

Using Pillai's criterion, Condition had a significant effect on the combined dependent variables $F(12, 1128) = 4.302$, $p < .001$. Condition also significantly influenced PA, NA, and Arousal at the univariate level (see Table 5). However, post-hoc analyses and the pattern of means suggested that the effect on PA and Arousal was primarily due to the Control condition. Therefore, a second MANOVA was run in which the Control condition was omitted. Results indicated that the four experimental conditions significantly influenced the combined DVs, $F(9, 894) = 2.284$, $p < .05$. At the univariate level, only NA was significantly affected by Condition $F(3, 298) = 5.413$, $p = .001$. Post-hoc comparisons showed that participants in the Urban condition reported significantly more negative affect than all other experimental conditions (see Figure 2).

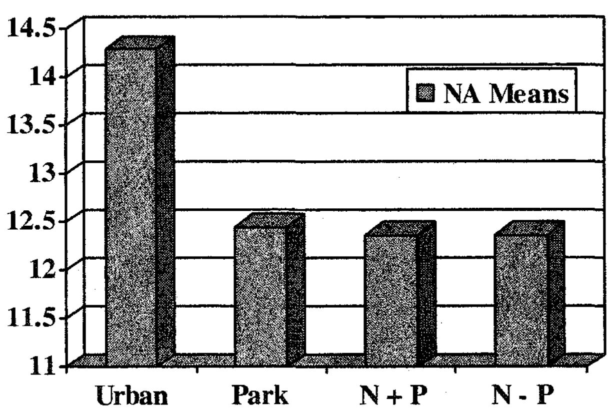

Figure 2: Negative affect across experimental condition

No other comparisons were significant. Surprisingly, the bivariate correlations between PA, NA, and Arousal indicated that Arousal had a strong, positive relationship with PA and a much smaller, though significant, negative relationship with NA (see Table 6). This pattern of relationships is opposite of what was expected based upon the restorative environment literature.

Finally, to assess the third criterion of mediation, the relationships between the creativity and affect measures were assessed. Because of the pattern of results on the affect measures described above, the Control condition was excluded from the following analyses. As Table 6 shows, across experimental conditions, the correlations between PA and NA and the three measures of creativity were insignificant.

Table 6. Correlations among the Creativity, Affect, Arousal, Environmental Attitudes, and Preference Measures Across Experimental Conditions

	FL	OR	CT	PA	NA	AR	EC	MSS	I/SS	UD	PR
FL	-	-.356**	.095	-.017	.059	.006	.045	.098	.227**	-.004	-.014
OR	-	-	.008	.033	.001	-.010	-.009	.004	-.180**	.041	.045
CT	-	-	-	.012	-.075	.066	-.155*	-.015	-.029	.064	.059
PA	-	-	-	-	.006	.617**	.090	.100	.161*	.081	.320**
NA	-	-	-	-	-	-.185**	-.008	-.015	-.029	.012	-.280**
AR	-	-	-	-	-	-	.062	.008	.121*	-.034	.172**
EC	-	-	-	-	-	-	-	-.201**	.064	-.009	-.007
MSS	-	-	-	-	-	-	-	-	.320**	.216**	.096
I/SS	-	-	-	-	-	-	-	-	-	-.224**	.054
UD	-	-	-	-	-	-	-	-	-	-	.162**
PR	-	-	-	-	-	-	-	-	-	-	-

Note. $*p < .05$, $**p < .01$
FL = Fluency, OR = Originality, CT = Convergent Thinking, PA = Positive Affect, NA = Negative Affect, AR = Arousal, EC = Environmental Concern, MSS = Modern Sensation Seeker, I/SS = Independent/Self-Sufficient, UD = Urban Dweller, PR = Preference.
Control condition was not included.

To determine if PA and NA together aided in the prediction of creativity, each creativity score was regressed onto PA and NA. With PA and NA entered into the regression model at the same time, the two affect measures failed to significantly predict Fluency, $F(2, 378) = 0.576, p > .05$, Originality, $F(2, 378) = 0.158, p > .05$, and Convergent Thinking, $F(2, 378) = 0.858, p > .05$.

Overall, results indicated that while affect was significantly influenced by environmental condition, neither condition nor affect had an effect on the measures of creative thinking. Therefore, results do not support Hypothesis 1, that affect would mediate the influence of the physical environment on creativity. Data failed to support Barron and Kenney's (1986) first and third criteria for mediation.

Curvilinearity and the mediating role of arousal. To test Hypothesis 2a, that there would be a curvilinear relationship between arousal and creative thinking, a series of regressions were performed. To assess curvilinearity, participants' arousal scores were squared. Each creative thinking measure was then regressed upon both the Arousal and $Arousal^2$ scores. Because of the pattern of results involving the arousal measure discussed above, the control condition was omitted from the following analyses. Table 7 shows results for each of the three regressions. Results indicated that the $Arousal^2$ term failed to significantly predict any of the creative thinking measures. Therefore, the data did not support the hypothesis of creativity having a curvilinear relationship with arousal.

Table 7. Tests of Arousal's Curvilinear Relationship to Creative Thinking

Variable	β	*t*	R^2	F_{model}
Fluency			.003	0.505
Arousal	-.411	-0.977		
$Arousal^2$	.421	1.000		
Originality				
Arousal	.383	0.909	.004	0.461
$Arousal^2$	-.397	-0.943		
Convergent Thinking			.004	1.618
Arousal	-.511	-1.220		
$Arousal^2$	.582	1.390		

Note. Arousal and $Arousal^2$ were entered into the regression equations simultaneously.

Hypothesis 2b proposed that arousal would mediate the effects of the physical environment on creative thinking (see Table 1). Therefore, analyses were performed to determine if Barron and Kenney's (1986) three criteria for mediation were met. Because there did not appear to be a curvilinear relationship between arousal and creativity, analyses assuming linear relationships were deemed to be appropriate. The MANOVA results discussed above and univariate tests shown in Table 4 failed to meet the first criterion of mediation, that Condition would be significantly related to creative thinking. While Condition did have a multivariate effect on affect and arousal (see above), univariate results indicated that arousal was only significantly affected by Condition when the Control condition was included (see Table 5). When the Control condition was excluded from the analysis, the four experimental conditions failed to differentially influence arousal, thus failing to meet the second criterion of mediation. Finally, bivariate correlations between Arousal and the three creative thinking measures failed to show a significant relationship between the mediating variable (Arousal) and the outcome variables (Creativity; see Table 6). Therefore, there was no evidence indicating a mediating role for arousal, thus failing to support Hypothesis 2b.

Supplemental moderation analyses. Above, it was shown that environmental condition, affect, and arousal failed to have either direct or mediating effects on creative thinking. Therefore, supplemental analyses were performed to see if affect and arousal interacted to affect creative thinking. Additionally, interactions between environmental condition and the affect and arousal measures were examined.

To examine whether PA, NA, and Arousal interacted to influence creative thinking, a series of hierarchical regressions were performed. Cross-product terms were first calculated between the affect and arousal measures. These terms were entered into the regression equations after the main effects of PA, NA, and Arousal were controlled for. Results indicated that PA, NA, and arousal failed to have either main or interaction effects on the measures of creative thinking (see Table 8).

Table 8. Tests of PA, NA, and Arousal Interactions of Creative Thinking

Variable	R^2	R^2_{change}	F_{change}
Fluency			
Step 1	.004	.004	0.567
Step 2	.017	.013	1.326
Originality			
Step 1	.001	.001	0.015
Step 2	.005	.004	0.416
Convergent Thinking			
Step 1	.006	.006	0.858
Step 2	.012	.006	0.623

Note. PA, NA, and arousal were entered into Step 1 simultaneously.
The three cross-product interaction terms were entered into Step 2 simultaneously.

To determine whether affect and arousal interacted with environmental condition, a second series of hierarchical regressions were performed. Because the comparison of primary concern was between built and natural environments, the Control condition was not included in the moderation analyses. Additionally, since the Urban condition was thought to possess most of the environmental elements believed to influence affect and arousal (see Figure 1), Condition was effect-coded such that the urban condition was assigned –1's in each of the three effect-coded variables, whereas the other environmental conditions were assigned a 1 for the effect-coded variable representing that specific condition and 0's for all other effect-coded variables (Pedhazur, 1982).

Because the three creativity measures were previously shown not to vary between the experimental conditions, the primary consideration in the following analyses was the effect of the interaction terms in the regression equations. To assess moderation effects, cross-product terms were calculated separately between the three effect-coded condition variables and PA, NA, and arousal. Regressions were then run on Fluency, Originality, and Convergent Thinking scores, individually examining the interaction effects of condition with the affect and arousal measures, after the main effects had been controlled for. Examination of the change in R^2, after the interaction terms have been added to the regression equation, gives an indication of whether the regression lines of the creativity measures on the affect and arousal measures are parallel for each environmental condition (Pedhazur, 1982). Stated differently, a test of the interaction shows whether the relationship between creativity and affect and arousal is significantly different across the experimental conditions.

As Tables 9-11 show, Step 1 in each of the regression analyses was insignificant, indicating that Condition, PA, NA, and arousal failed to have a main effect on any of the creative thinking measures. These regression results confirmed the univariate results reported from the MANOVA above (see Tables 4 & 6). Examination of the significance of R^2_{change} in Step 2 of the regression analyses showed that experimental condition only interacted significantly with NA in predicting Fluency.

Bivariate correlations between Fluency and NA, for each of the four experimental conditions, are shown in Table 12. To test for differences among the correlations, a series

Table 9. Tests of Environmental Condition and Positive Affect Interaction on Creative Thinking

Variable	R^2	R^2_{change}	F_{change}
Fluency			
Step 1	.014	.014	1.073
Step 2	.018	.004	0.403
Originality			
Step 1	.007	.007	0.508
Step 2	.013	.006	0.618
Convergent Thinking			
Step 1	.011	.011	0.857
Step 2	.019	.008	0.767

Note. The 3 effect-coded condition variables and PA were entered into Step 1 simultaneously. The three cross-product interaction terms were entered into Step 2 simultaneously.

Table 10. Tests of Environmental Condition and Negative Affect Interaction on Creative Thinking

Variable	R^2	R^2_{change}	F_{change}
Fluency			
Step 1	.017	.017	1.252
Step 2	.058	.041	4.275*
Originality			
Step 1	.006	.006	0.427
Step 2	.014	.009	0.851
Convergent Thinking			
Step 1	.014	.014	1.080
Step 2	.018	.003	0.337

Note. $*p < .01$

The 3 effect-coded condition variables and NA were entered into Step 1 simultaneously. The three cross-product interaction terms were entered into Step 2 simultaneously.

Table 11. Tests of Environmental Condition and Arousal Interaction on Creative Thinking

Variable	R^2	R^2_{change}	F_{change}
Fluency			
Step 1	.014	.014	1.089
Step 2	.016	.002	0.183
Originality			
Step 1	.005	.005	0.408
Step 2	.011	.006	0.587
Convergent Thinking			
Step 1	.014	.014	1.090
Step 2	.025	.010	1.038

Note. The 3 effect-coded condition variables and arousal were entered into Step 1 simultaneously. The three cross-product interaction terms were entered into Step 2 simultaneously.

Table 12. Bivariate Correlations Between Fluency and Negative Affect Across Experimental Conditions

Urban	-.144
Park	-.118
N + P	.318*
N - P	.187

Note. $*p < .01$

of z-tests were conducted (see Chen & Papovich, 2002, p. 21). Results indicated that the correlations between NA and Fluency were significantly different between the Urban condition ($r = -.144$) and both the Nature with People ($r = .318$; $z = 2.915$, $p < .01$) and Nature without People conditions ($r = .187$; $z = 2.027$, $p < .05$).

Tests of Person-Environment Fit Effects on Creative Thinking

As Figure 1 shows, person-environment fit is characterized as correspondence or lack thereof between one's individual characteristics/preferences and elements of the environment one is in. As such, it takes into account an individual's adaptation level, preferences, and environmental attitudes. A good fit is one in which the environment is preferred, evaluated favorably (attitude), and matches the individual's level of desired stimulation (adaptation). While adaptation level was not measured in the present study, it was believed to be at least partially captured by environmental preference and attitude. Individually, preference and attitude only represent a portion of the person-environment fit. It is possible to hold a favorable attitude toward one's environment, yet not prefer it at that time. Therefore, to gain a stronger determination of person-environment fit, Fit was operationalized as a cross between preference for the simulated environment and one's environmental attitudes.

In the present study, Fit was calculated by first determining which SEQUOIA subscale had the strongest relationship with the overall Preference score from the Landscape Assessment Scale (LAS), for each experimental condition (see Table 13).

Table 13. Bivariate Correlations Between Environmental Attitudes and Preference Across Experimental Conditions

Preference Condition	ECC	MSS	I/SS	UD
Control	.041	-.031	.193	-.096
Urban	-.354**	.251*	-.123	.564**
Park	-.129	.242*	-.090	.325**
N + P	.287**	-.123	.401**	-.202
N – P	.446**	-.215	.286*	-.307**

Note. *$p < .05$, **$p < .01$
ECC = Environmental Concern, MSS = Modern Sensation Seeker, I/SS = Independent/Self-Sufficient, UD = Urban Dweller.

Preference was most correlated with UD in both the Urban ($r = .564$) and Park conditions ($r = .325$), with I/SS in the Nature with People condition ($r = .401$), and with EC in the Nature without People condition ($r = .446$). Because no external environment was presented in the Control condition and preference for the Control condition did not show a significant correlation with any of the environmental attitudes, it was excluded from the person-environment fit analyses.

Within each condition, median splits were made for Preference and the attitude it was most related to. Participants were classified as high fit if they scored above the median for both Preference and the relevant environmental attitude. Participants were classified as low fit if they scored below the median split on both measures. All other participants were excluded from further analyses. Sample sizes of high and low fit participants within each condition are shown in Table 14. Figure 3 shows the scatterplots of Preference and attitude for each condition.

Table 14. Sample Sizes for High and Low Fit Participants Within Each Environmental Condition

	Urban	Park	N + P	N – P
High Fit	27	23	27	28
Low Fit	28	21	24	17

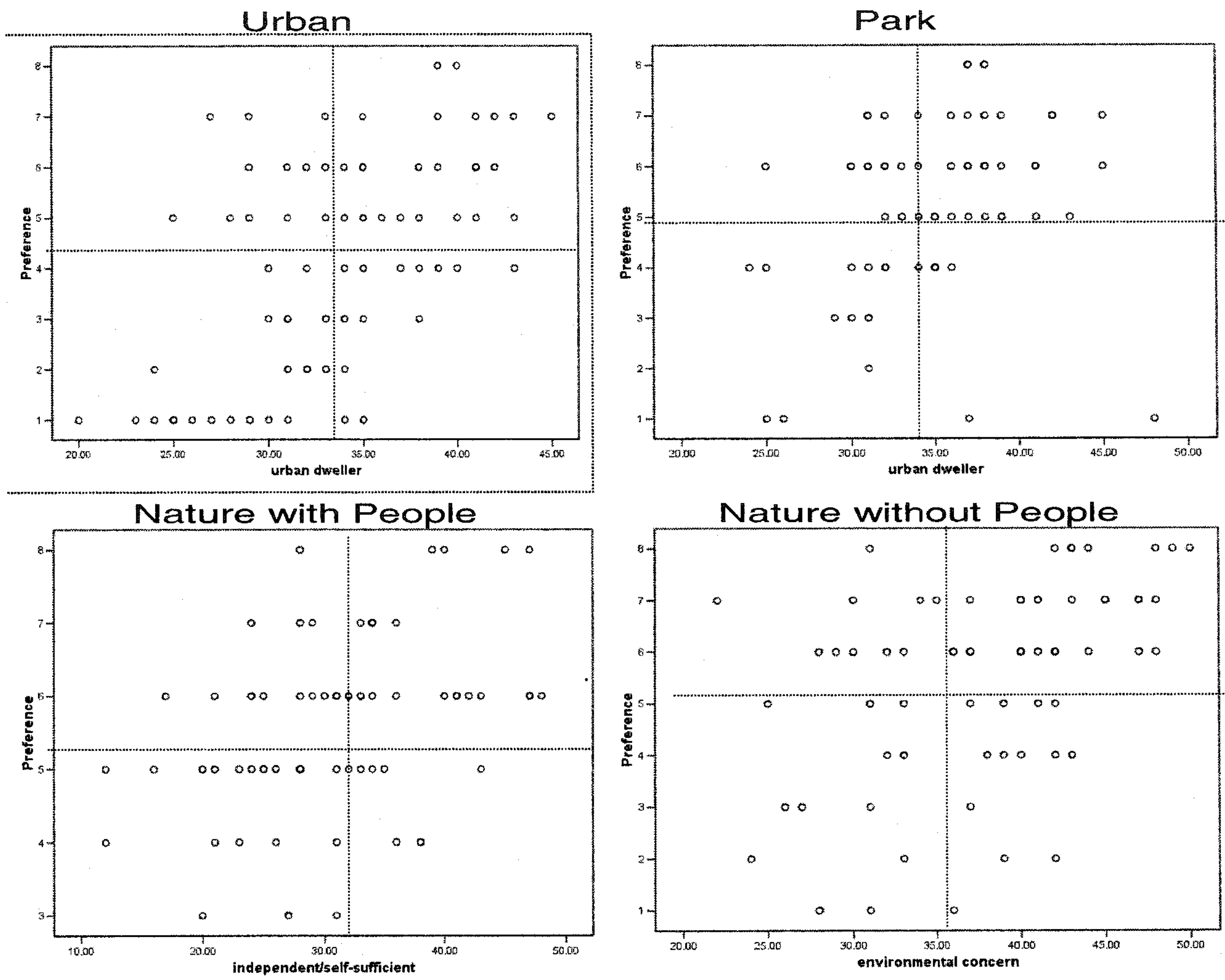

Figure 3. Scatterplots of preference and environmental attitudes by condition

To test Hypothesis 3a, that person-environment fit would have a significant effect on creative thinking (see Table 1), a MANOVA was run on the three creative thinking measures, with low versus high fit as the independnet variable. Multivariate results indicate that fit failed to have a significant effect on the combined creativity measures, $F(3, 199) = 0.540$, $p > .05$, thus failing to support Hypothesis 3a.

Hypothesis 3b stated that affect would mediate the influence of person-environment fit on creative thinking. The data were examined to see if they met Baron and Kenny's (1986) three criteria for mediation. Because Fit failed to influence the combined creative thinking measures (see above), the first criterion of mediation was not met. To assess the second criterion of mediation, a MANOVA was run in which Fit was used to predict PA and NA. Because person-environment fit was theorized to take into account individuals' levels of adaptation, Arousal was not included. The combined affective measures were significantly affected by Fit, $F(2, 200) = 21.721$, $p < .001$, $\eta^2 = .178$. Univariate results indicated that Fit had a significant influence on both positive [$F(1, 201) = 32.38$, $p < .001$] and negative affect [$F(1, 201) = 7.618$, $p < .01$]. Across experimental conditions, PA was higher for high fit participants ($M = 23.12$) than low fit participants ($M = 17.67$), while NA was lower for high fit participants ($M = 12.21$) than low fit participants ($M = 13.59$).

Previous analyses showed that creative thinking was unaffected by positive and negative affect (see Table 6), thereby failing to meet the third criterion of mediation. While Fit did have an influence on affect, creative thinking was not affected by either Fit or affect, thus failing to support Hypothesis 3b.

Supplemental moderation analyses. While Fit failed to have an effect on creative thinking, either directly or through its effect on affect, further analyses were conducted to determine whether Fit, PA, and NA interacted to affect creative thinking. To determine moderation, cross-product terms were first calculated between the three independent variables. These terms were then entered into the regression equations after the main effects were controlled for. Examination of Table 15 shows that the addition of the interaction terms failed to significantly aid in the prediction of the creative thinking measures.

Table 15. Tests of Interactions Between Fit, Positive Affect, and Negative Affect

Variable	R^2	R^2_{change}	F_{change}
Fluency			
Step 1	.005	.005	0.359
Step 2	.039	.034	2.291
Originality			
Step 1	.010	.010	0.651
Step 2	.017	.008	0.512
Convergent Thinking			
Step 1	.022	.022	1.477
Step 2	.050	.028	1.955

Note. Fit, PA, and NA were entered into Step 1 simultaneously.
The three cross-product interaction terms were entered into Step 2 simultaneously.

A second moderation analysis was conducted to see if Fit interacted with environmental condition. A MANOVA was performed in which Fit and Condition were used to predict Fluency, Originality, and Convergent Thinking. Multivariate results indicated that the interaction between Fit and Condition was not significant, $F(9, 585) = .870, p > .05$.

Supplemental mixed sample analyses. Because sample sizes for the Condition x Fit cells were fairly small (see Table 14), additional analyses examining Hypotheses 3a and 3b were conducted in which the Nature with People and Nature without People samples from the present study were combined. Previous analyses indicated that scores on the creative thinking, affect, and arousal measures did not vary between these two conditions. Additionally, responses to the Landscape Assessment Scale (LAS) items were nearly identical (see secondary analyses below). To increase the sample size in the Urban condition, pilot study participants were added to those from the present study. The Urban environmental simulation and experimental procedures between the two studies were identical. To ensure the equivalency of the two Urban samples, a series of MANOVAS were performed examining differences among the combined LAS, affect, and creativity measures. Results indicated that the combined LAS items did not vary significantly between the two samples, $F(4, 117) = 1.766, p > .05$. Additionally, the two samples did not vary on the affect measures, $F(2, 118) = 2.066, p > .05$, nor on the creative thinking measures, $F(3, 118) = 1.463, p > .05$.

Participants were classified as high or low fit according to the methodology described above. Table 16 shows the bivariate correlations between Preference and the SEQUOIA subscales for the combined Urban and Nature conditions.

Table 16. Bivariate Correlations Between Preference and the SEQUOIA Subscales for the Urban and Nature Combined Samples.

Preference Condition	EC	MSS	I/SS	UD
Urban	-.408**	.310**	-.084	.604**
Nature	.372**	-.174*	.326**	-.253**

Note. *$p < .05$, **$p < .01$
ECC = Environmental Concern, MSS = Modern Sensation Seeker, I/SS = Independent/Self-Sufficient, UD = Urban Dweller

Preference had the highest correlation with UD in the Urban condition ($r = .604$, $p < .001$), while EC had the highest correlation with Preference in the Nature condition ($r = .372$, $p < .001$). After Fit was determined for the two conditions, samples sizes in the Urban condition were 41 for high fit and 49 for low fit. Samples sizes in the Nature condition were 51 and 39 for high and low fit respectively.

To test Hypothesis 3a, that Fit would have a significant influence on creative thinking, a MANOVA was performed on the three creative thinking measures. Results indicated that Fit failed to have a significant effect on creative thinking, $F(3, 176) = .316$, $p > .05$. To examine whether fit indirectly influenced creative thinking through its effect on affect, a second MANOVA was first performed examining the effect of Fit on affect. Fit had a significant effect on the combined affect measures, $F(2, 177) = 15.626$, $p < .001$, with both PA and NA varying significantly at the univariate level, $F(1, 178) = 17.423$, $p < .001$ and $F(1, 178) = 9.518$, $p < .01$, respectively. High fit participants reported more PA ($M = 23.09$) and less NA ($M = 12.65$) than low fit participants ($M_{PA} = 18.66$, $M_{NA} = 14.74$). A series of regressions were then run in which PA and NA were used to predict each of the creative thinking measures. Results showed that affect failed to have an effect on Fluency, $F(2, 177) = 2.915$, $p > .05$, Originality, $F(2, 177) = 1.574$, $p > .05$, and Convergent Thinking, $F(2, 177) = 1.211$, $p > .05$. Hence, there was no support for Hypothesis 3b.

Chapter IV

DISCUSSION

The environments depicted in this study had substantial differential impact on preference. Moreover, positive affect was higher and negative affect lower for participants whose attitudes fit with the depicted setting. Nevertheless, neither the affect nor arousal measures, nor the creative thinking measures, differed as expected across the four experimental settings. It may be that the hypothesized relationships are simply not present in the real world or the laboratory, or it may be that something specific to the current operationalization yielded the current results. These possibilities are elaborated upon below.

Influences on Creativity

Restorative environment effects. In the present study, two mechanisms were proposed by which the physical environment was expected to influence creative thinking (see Figure 1). The first was based upon Attention Restoration Theory (Kaplan, 1995) and Ulrich's (1983) Biophilia Hypothesis. Previous research has shown that exposure to settings dominated by vegetation and generally lacking human artifacts results in an increase in positive affect and a decrease in negative affect and arousal (Hartig et al., 2003; Kaplan, 1995; Ulrich, 1979, 1981). Additionally, creativity has been shown to be affected by affect and arousal (Isen, 1990; Martindale, 1993; Zhou & George, 2001). It was therefore hypothesized that exposure to various physical environments would affect performance on two creative thinking tasks through their differential effects on affect and arousal (see Table 1).

Consistent with previous research, participants in the present study evaluated and responded to the environmental conditions differentially based upon features present in the environmental simulations, such that evaluations were generally more favorable for the more naturalistic settings. Affective and arousal responses were such that, regardless of condition, scores decreased from pre- to post-manipulation assessment. As expected, comparison of post-manipulation affect and arousal showed that they were significantly influenced by environmental condition. This effect was primarily attributable to the higher negative affect reported by participants in the Urban condition. However, environmental condition, positive affect, negative affect, and arousal all failed to significantly influence the fluency and originality measures of divergent thinking, and convergent thinking. Therefore, there was no evidence of affect and arousal mediating the effect of the physical environment on creativity (Hypotheses 1 & 2b). Additionally, creative thinking was not shown to have a curvilinear relationship with arousal (Hypothesis 2a).

One explanation for the failure of the environmental conditions to influence creativity revolves around the lack of congruence between the affective and arousal responses from the present study and previous research. The restorative environment literature consistently shows urban and natural environments to have opposite effects on positive affect, negative affect, and arousal (Hartig et al., 1996; Hartig et al., 2003; Hartig et al., 1991; Ulrich, 1979, 1981; Ulrich et al., 1991). It was this difference that was expected to affect creativity. While negative affect was higher in the Urban condition than all other conditions, affect and arousal decreased for all participants after they had viewed the environmental simulations. Negative affect simply decreased less for those in the urban condition. The direction of the affect and arousal responses was essentially identical between the conditions.

It could be argued that the lack of influence on creativity was the result of the failure of the environmental manipulations to differentially influence affect and arousal. This is particularly relevant given the expectation that an increase in positive affect associated with exposure to more naturalistic environments would drive the improvements in creativity. It was expected that performance on the creative thinking tasks would be of little personal importance to the participants. Under such circumstances, positive affect is expected to have more of an influence on creativity than negative affect (James et al., 2004). As discussed above, post-manipulation positive affect did not vary between conditions. However, even when examining individual differences in affect and arousal regardless of environmental condition, neither factor predicted creativity (Table 6). Such an outcome at least raises the question of whether affect and arousal associated with an environment have any influence on creativity. Rather, it may be that affect and arousal associated with personal or interpersonal experience, short-term or long-term needs, or inspirational factors are better predictors of creative outcomes.

Interaction effects. While affect and arousal did not have significant main effects on creativity, supplemental analyses indicated that negative affect interacted with condition to differentially affect fluency. Specifically, negative affect was shown to be negatively correlated with fluency in the Urban condition and positively correlated with fluency in the Nature with People and Nature without People conditions. The fact that fluency scores increased as participants felt more negative affect in the two nature conditions is contrary to expectations based upon restoration theory. It is possible that that those who responded negatively to the nature scenes chose to ignore the projected stimuli and focus their attention on the divergent thinking task. Additionally, negative emotions have been shown to improve creative thinking in some situations by potentially motivating individuals to adopt alternative thinking patterns (James et al., 1992; Kaufmann & Vosburg, 1997; Zhou & George, 2001).

Person-environment fit. The second mechanism by which the physical environment was proposed to influence creative thinking involved the degree of fit between characteristics of the individual and elements of the environment he or she was in (see Figure 1). Wohlwill (1974) suggested that the manner in which we respond to our environment is partially determined by the degree to which we have adapted to elements found in that environment. In the present study, preference for one's environment and environmental attitudes were used to determine person-environment fit, and therefore take into account participants' adaptation levels. For example, when exposed to an urban environment, an individual holding a favorable attitude toward such environments and reporting preference for that specific environment can be expected to respond favorably, even though that environment may contain features previously shown to negatively influence affect and arousal. Such an individual has adapted to the amount of arousal-causing stimulation found in that environment, and would be expected to have a positive emotional reaction when confronted with a preferred environment and a positively evaluated attitude object. When exposed to an environment that is not preferred and to which one has a negative attitude, a negative emotional reaction is expected. Person-environment fit is also expected to influence performance. By taking into account one's level of adaptation, a good person-environment fit indicates an environment that matches an individual's optimal level of stimulation.

As such, person-environment fit was hypothesized to directly influence creative thinking. Additionally, positive and negative affect were hypothesized to mediate this relationship (see Table 1). Results indicated that person-environment fit had a significant effect on both positive and negative affect. Positive affect was higher and negative affect was lower for participants evidencing a good person-environment fit, as opposed to those with a poor fit. However, person-environment fit failed to have an effect on creative thinking. Participants performed just as well when they were acting in a low fit environment as when they were in a high fit environment. As discussed above, creativity was also unaffected by affect. There was therefore no evidence of either a direct or mediated effect of person-environment fit on creative thinking (Hypotheses 3a & 3b).

As described above, exposure to the environmental simulations resulted in a decrease in arousal, as compared to pre-manipulation levels, while arousal did not vary between conditions post-manipulation. This finding may partially explain why person-environment fit had no influence on creativity. Fit was operationalized so as to take into account participants' levels of adaptation to features of the environments to which they were exposed. The fact that arousal did not vary between conditions suggests that the environmental elements incorporated into the simulations were not those to which participants may or may not have adapted. Essentially, adaptation level was irrelevant in the present study. While previous studies have successfully used environmental simulations as the primary manipulation, their focus has typically been on the aesthetic evaluation and affective reaction to said simulations (Craik et al., 1980; Feimer, 1984; Kaplan, 1987; Russell & Lanius, 1984). Additionally, those studies that did assess performance effects utilized participants who had been negatively aroused prior to exposure to the simulations (Hartig et al., 1996; Kaplan, 1995; Parsons et al., 1998; Ulrich et al., 1991). Differences in performance were then attributed to differential rates of recovery from that negative arousal.

Results from the present study showed that affect did vary as a function of fit, though these differences did not translate into performance effects on the creativity measures. Although creativity has been shown to be influenced by both positive and negative affect (Isen, 1990; Isen et al., 1985; Kaufmann & Vosburg, 1997), it appears that differences in fit did not result in the degree of affective polarization necessary to influence creative thinking. Again, both positive and negative affect decreased from pre- to post-manipulation assessment. It is possible that in order for the physical environmental to have an effect on creative thinking, individuals must react strongly when exposed to an environment, either as a result of features present in the environment or as a result of fit. This reaction must be such that affect, either positive or negative, increases from baseline levels. Under these conditions, affect, and therefore the physical environment, may influence cognitive functions. In the present study, participants did not react to the simulations with more affect or arousal so much as they became sedated by them.

An alternative explanation is that as with the previous discussion on affect and arousal as primary mediators of environment-creativity effects, it may be that affect and arousal associated with attitude-environment fit are not reliable predictors of creativity.

Rahter, the fit between personal or interpersonal experience, needs, or inspirational forces and the environment—types of fit not measured in this study—may be more reliable predictors of creativity.

Non-Creativity Environmental Responses

Analyses examining participants' assessments of their environment, their emotional states, and their general level of arousal suggest that the features present in one's environment have a substantial impact. As Figure 1 illustrates, the environmental simulations used in the present study varied in the degree of natural and built features, population density, and noise present. In general, as the environments evidenced more natural and fewer built features, there was also a decrease in population density and noise. As expected, participants rated the more natural environments as being higher on attributes such as naturalness, solitude, and tranquility. While this was expected given the inherent qualities present in the simulations, participants' ratings also differed in relation to amount of annoyance felt and overall preference. It was found that among the experimental conditions the highest levels of annoyance and lowest levels of preference were attributed to the Urban conditions. Preference ratings did not differ between the Park and nature scenes. These findings support Ulrich's (1983, 1986) assertion that individuals' responses to their environment is in large part determined by the degree to which vegetation dominates the scenes. Additionally, past research has consistently shown preference to be higher for naturalistic settings (Kaplan et al., 1972; Ulrich, 1986; Van den Berg et al., 2003). While the Park scene was obviously human-made, it was still dominated by greenery.

In addition to assessing the simulated environments differently, affective reactions also varied across conditions, although not entirely as expected. Comparison of pre- to post-manipulation positive affect, negative affect, and arousal scores showed each to have decreased after viewing the environmental simulations, with pre-manipulation scores not varying between conditions. Analyses examining environmental effects on post-manipulation positive affect and arousal indicated that the Control condition elicited the lowest arousal and lowest positive affect. Surprisingly, arousal and positive affect did not vary across the four experimental conditions. While participants in the present study were not in a state of heightened stress or arousal prior to the experimental manipulation, research examining the restorative effects of natural environments suggests that positive affect would increase while both negative affect and arousal would decrease as the environments evidenced more naturalistic elements (Hartig et al., 1996); only the negative affect results were consistent with this expectation. Negative affect was lowest for those participants viewing environments dominated by greenery (Park, Nature with People, Nature without People). In the Control and Urban conditions, in which there was very little or no greenery, negative affect was highest.

While positive affect and arousal did not vary by condition, it is interesting to note that the two were positively correlated ($r = .617$) while negative affect and arousal were negatively correlated ($r = -.185$; see Table 4). Based upon the restorative environment literature, the opposite relationships were expected. Exposure to naturalistic settings has typically resulted in a decrease in arousal and an increase in positive affect, suggesting a negative correlation (Kaplan, 1995; Ulrich, 1979, 1981), while exposure to urban settings is usually accompanied by increases in both negative affect and arousal, suggesting a positive correlation (Laumann et al., 2003; Parsons et al., 1998).

Condition comparisons. Past studies have suggested that by adding natural elements to built environments, some of the negative reactions accorded them may be alleviated (Brush & Palmer, 1979; Honeyman, 1990). In comparing reactions between the Urban and Park conditions from the present study, it was found that participants responded much more favorably to the Park condition. While the Park condition was dominated by greenery, its obvious artificial nature was evident in the manicured lawns and the orderly rows of trees. Additionally, the presence of people, maintenance equipment, and noises associated with urban environments (e.g., roadway noise) was obvious. However, participants were less annoyed, had less of a negative affective reaction to, and in general preferred the Park scene over the Urban scene.

Comparisons between the Park condition and the two nature conditions showed the Park condition to be scored lower on most of the Landscape Assessment Scale items. However, rated preference, positive affect, negative affect, and arousal did not vary. Given that the Park scene was dominated by vegetation and that the built elements, while present, were not prominent, it appears that participants responded to the Park scene in the same manner that they respond to nature scenes (Ulrich, 1983). These findings replicate those of Parsons et al. (1998) who found responses to be similar between a drive through a forest and through a golf course. Surprisingly, arousal did not vary between the Urban and Park scenes. Arousal was expected to be higher in the urban condition due to the high levels of unpredictable stimuli (Glass & Singer, 1972) and increased population density (Baum & Paulus, 1987). However, after failing to elicit increased arousal in response to urban stimuli, Ulrich et al. (1991) suggested that differences in affective reactions and recovery rates are best attributed to content differences between natural and urban environments rather than to variations in stimulation levels. The present findings suggest that some of the negative reactions typically found in response to urban environments can be alleviated through the introduction of natural elements.

The presence of people in a naturalistic environment was expected to decrease some of the benefits associated with nature. Specifically, the decreased social carrying capacity of natural environments (Manning et al., 1999) led me to hypothesize that the nature scene with people would be rated less favorably and that participants' emotional reactions would be more negatively toned than when there were no people present. It was found that landscape assessment ratings of the two scenes varied only on the dimension of naturalness. The two scenes did not differ in terms of overall preference or annoyance. Additionally, ratings of solitude and tranquility did not vary based upon the presence of others. While it was expected that arousal and negative affect would be higher when others were present in a naturalistic environment, ratings on these and the measure of positive affect did not differ between the two conditions.

Environmental attitudes and fit. In the present study, person-environment fit was operationalized by crossing preference ratings with the environmental attitude most related to preference, within each condition. It is interesting to note that for both the Urban and Park conditions, the Urban Dweller subscale of the SEQUOIA had the strongest correlation. While this was expected for the Urban condition, the relationship between Urban Dweller and preference of the Park condition support the notion that participants were responding to the vegetation in a manicured environment. As expected, Environmental Concern had the strongest correlation with preference for those in the Nature without People condition. It was expected that this same relationship would hold in the Nature with People condition. However, Independent/Self-Sufficient (I/SS) was more related to preference in the Nature with People condition. I/SS is an attitude that captures the degree to which individuals prefer settings in which they can manipulate the environment (Cooney et al., 2004). Given that in the Nature with People condition individuals were seen hiking on a mountain trail, participants fitting well with and preferring this environment may have judged it from the perspective of their personal use.

Conclusions and Implications

While the hypotheses predicting the influence of natural versus built environments and person-environment fit on creative thinking were largely unsupported, there was an instance in which creativity was affected. Assessment ratings and negative affect all varied across environmental condition, suggesting that participants responded to their environments, at least in part, as a reaction to the elements present in the environment. Unfortunately, this response did not translate into performance effects. The fact that Negative Affect positively influenced Fluency for those participants in the two Nature conditions, as compared to those in the Urban condition, is contrary to the restorative environment literature and suggests that the relationship between individuals' cognitive abilities, emotional states, and their environment may be more complicated than was previously thought. It appears that the pattern of affect and cognitive relations expected from restoration theory is not uniform across differing cognitive tasks and physical environments. Further examination of the influence of specific physical and social elements present in one's environment on creative thinking and other cognitive functions is warranted. While previous research has shown the effect of the environment on affect and arousal (Kaplan, 1995; Ulrich, 1979, Ulrich et al., 1991), and the influence of affect and arousal on creative thinking (James et al., 2004), the link between the environment and creative thinking, at least as operationalized herein, appears tenuous. Future research might also explore whether affect and arousal generated by other factors independent of the environment (e.g., personal or interpersonal experience) might be better predictors of creativity than environment-associated affect and arousal.

While no causal link was established between the physical environment and creative thinking, either directly or mediated by affect and arousal, the pattern of findings in the present study suggest some alternative explanations to be explored in future research. Specifically, the fact that positive affect and arousal were positively correlated and that fluency improved as participants reported more negative affect in the two nature conditions while fluency and negative affect were negatively related in the Urban condition, suggests that the relationship may be more complicated than was originally thought. It may be necessary to distinguish between positively and negatively toned arousal. Previous research has typically characterized the arousal associated with urban environments as a negative phenomenon, correlated with negative affect (Ulrich et al., 1991). In the present study, while negative affect was highest for those in the Urban condition, arousal did not vary, and across conditions was positively correlated with positive affect. Additionally, negative affect may not always be associated with poor performance, as suggested by James et al. (2004).

Previous environmental research has typically measured affect and arousal as separate constructs. However, Russell's (1980) circumplex model of affect characterizes affective reactions as falling upon two bipolar dimensions: pleasure-displeasure, and arousal-sleepiness. This model, in which positive and negative affect are theoretically linked with arousal, has been successfully used in research examining how adaptation level influences the affective appraisal of environments (Russell & Lanius, 1984) and in examinations of the affective quality attributed to environments (Russell et al., 1981). Given the contradictory findings between the present study and previous research, future studies examining the performance effects of exposure to different environments should consider utilizing Russell's model of affect.

In addition to the uncertain theoretical links between affect, arousal, and creativity, there are several methodological issues that may have influenced the results. A good portion of the literature examining restorative environments' effects on various cognitive abilities has utilized participants who were attentionally fatigued or otherwise negatively aroused (Hartig et al., 1996; Kaplan, 1995; Parsons et al., 1998; Ulrich et al., 1991). Performance differences between conditions were attributed to differential rates of recovery from stress. In the present study, participants were not stressed nor negatively aroused prior to the experimental manipulation. Additionally, when the sample was restricted to only those participants scoring above the mean on the pre-manipulation arousal and negative affect measures, condition failed to have a significant multivariate effect on creative thinking, $F(12,165) = .556$, $p > .05$. These findings suggest that one's cognitive functions are less likely to be influenced by the physical environment when one is in a relatively neutral affective state than when in a state of heightened arousal.

Another factor that may have influenced the results is the length of time in which participants were instructed to attend to the environmental simulation. Studies examining the effects of the environment on affect and arousal have typically presented the simulations for relatively brief periods of time (7-15min.; Hartig et al., 1996; Parsons et. al., 1998; Ulrich et al., 1991; Van den Berg et al., 2003). However, Hartig et al. (1996) reported that performance effects have not consistently appeared after 15-20 minute viewing periods, whereas they have appeared after longer periods. While no direct measure of attention was utilized in the present study, these findings are especially relevant for tests of the restorative environment hypotheses. Though uncertain, it is possible that exposure to the environmental simulations may have been to brief and/or artificial to induce differential attentional restoration. Therefore, future research looking into the effects of the environment on cognitive abilities might incorporate longer viewing periods.

While increasing the length of time in which participants view the environmental simulations may increase the likelihood of producing performance effects, one must take care that participants do not get bored (Van den Berg et al., 2003). In the present study, the fact that, across conditions, positive affect, negative affect, and arousal all decreased after participants had viewed the simulations suggests that this may have occurred. Extremely low levels of arousal have been shown to hinder performance on many cognitive tasks. In the present study the environmental simulations contained dynamic elements, such as movement and noise, which have been shown to increase the ecological validity of such simulations (Hetherington et al., 1993). However, the simulations were also static in that the videos did not change angles or locations. A single scene was framed and did not change, though there was movement within the static scene. Given the concerns about boredom and the apparent longer viewing times needed to elicit performance effects, it is suggested that future research utilize simulations in which the frame of reference (video camera) moves throughout the environment, such as when one takes a walk on a forest trail or through an urban shopping plaza.

A link between affect, arousal, and creativity has been observed in previous research. Similarly, differences in environmental preference and fit have been found to vary reliably with factors such as urban versus natural elements. Although there are good theoretical grounds to expect an environment-creativity linkage between these sets of literatures—with affect and arousal as mediators—the present research suggests that demonstrating such linkage is going to require alternative methods and conceptualizations.

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Appendix A

Survey of Environmental Quality: Universal Orientations and Individual Attitudes

Environmental Attitudes

Please rate the degree to which you agree or disagree with each of the following statements. Using the scoring numbers below, place the appropriate number in the space provided to the left of the statement.

5 = strongly agree / 4 = agree / 3 = neutral / 2 = disagree / 1 = strongly disagree

____1. One of the most important reasons to conserve is to preserve wild areas.
____2. I like social gatherings where I can enjoy myself without worrying about other people.
____3. The idea of walking into the forest and "living off the land" for a week appeals to me.
____4. I like the variety of stimulation one finds in the city.
____5. I would support the protection of an endangered bird species, even if I were never able to see one in the wild.
____6. Jet air travel is one of the great advances of our society.
____7. Everyone should have the opportunity to live in a great city.
____8. Wild plants and animals have a right to live unmolested by humans.
____9. I would like to live in a modern, planned community.
____10. In this country, land pollution is a very serious environmental problem
____11. I can repair just about anything around the house.
____12. I would enjoy riding a motorcycle.
____13. We must prevent any type of animal from becoming extinct, even if it means sacrificing some things for ourselves.
____14. As a child, I often watched when someone repaired things around the house.
____15. I would like to build a cabin in the woods.
____16. The cultural life of a big city is very important to me.
____17. If I had the money, I would enjoy owning an expensive stereo set.
____18. I'd be willing to make personal sacrifices for the sake of slowing down pollution even though the immediate results may not seem significant.
____19. Endangered wildlife species should be protected at any cost.
____20. I am afraid of driving in the city.
____21. I would like to take flying lessons.
____22. I would enjoy living the rest of my life in a large city.
____23. I would enjoy going to the opera.
____24. Old buildings are usually depressing.
____25. I am quite skillful with my hands.
____26. It makes me sad to see natural environments destroyed.
____27. Cities are too noisy and crowded for me.
____28. I usually save spare nuts and bolts.
____29. I would enjoy working with precision power tools.
____30. Unique environments should be protected at all costs.
____31. I like places that have the feeling of being old.
____32. It is fun to make scale models of things.

___33. I like amusement parks.
___34. It is exciting to go shopping in a large city.
___35. I would enjoy building a radio.
___36. Natural ecosystems have a right to exist for their own sake, regardless of human concerns and uses.
___37. I enjoy browsing in antique shops.
___38. I would enjoy driving a racing car.
___39. I enjoy tinkering with mechanical things.
___40. I like to ride on roller coasters.

Appendix B

Landscape Assessment Scale

Landscape Assessment Scale

Please rate the degree to which the video you have been watching possesses each of the characteristics below. Place a check mark, indicating whether the video possessed much or little of each attribute. The more you feel the scene did or did not possess the attribute, place the check mark closer to the end of the scale. If you feel the scene was neutral in regard to the attribute, place your check mark near the center of the scale

Scenic Beauty

___ ___ ___ ___ ___ ___ ___ ___
very low — very high

Naturalness

___ ___ ___ ___ ___ ___ ___ ___
unnatural — very natural

Freedom

___ ___ ___ ___ ___ ___ ___ ___
very low — very high

Annoyance

___ ___ ___ ___ ___ ___ ___ ___
very low — very high

Solitude

___ ___ ___ ___ ___ ___ ___ ___
very low — very high

Tranquility

___ ___ ___ ___ ___ ___ ___ ___
very low — very high

Openness

___ ___ ___ ___ ___ ___ ___ ___
very low — very high

Preference
(overall, how much do you prefer this type of environment?)

___ ___ ___ ___ ___ ___ ___ ___
very little — a great deal

Appendix C

Positive and Negative Affect Schedule

Positive and Negative Affect Schedule

This scale consists of a number of words that describe different feelings and emotions. Read each item, and then mark the appropriate answer in the space next to that word. Indicate to what extent *you feel this way right now, that is, at the present moment*. Use the following scale to record your answers. **Please do not look at your responses from the previous questionnaire.** Thank you.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

interested	___	irritable	___
distressed	___	alert	___
excited	___	ashamed	___
upset	___	inspired	___
strong	___	nervous	___
guilty	___	determined	___
scared	___	attentive	___
hostile	___	jittery	___
enthusiastic	___	active	___
proud	___	afraid	___

Appendix D

Perceived Arousal Scale

The Perceived Arousal Scale

Different people react very differently to the same situations. Indicate to what extent you feel this way right now, that is, at the present moment. Use the following 5-point rating scale. Write the number corresponding to your rating on the blank line next to each word.

Very Slightly or Not at All	*A Little*	*Moderately*	*Quite a Bit*	*Extremely*
1	*2*	*3*	*4*	*5*

Active	____	Drowsy	____
Energetic	____	Exhausted	____
Lively	____	Sluggish	____
Vigorous	____	Alert	____
Depressed	____	Weary	____
Excited	____	Dull	____
Weak	____	Forceful	____
Sharp	____	Tired	____
Worn-Out	____	Sleepy	____
Alert	____	Aroused	____
Quiet	____	Inactive	____
Fatigued	____	Slow	____

Appendix E

Divergent Thinking

Divergent Thinking Task

The following task measures your ability to generate ideas. You will notice that a brick has been placed in front of you. Please write down as many unusual uses for the brick that you can think of. You have the following 4 minutes to write down your ideas in the space provided below.

Appendix F

Convergent Thinking

Convergent Thinking Task

The following measures your reasoning ability. You will see 10 sets of three words. Your job is to figure out what the fourth word in the set should be. For example, given the set: *Athletes-Web-Rabbit*, the fourth word would be *Foot*. Another example is: *Chocolate-Fortune-Tin,* the fourth word would be *Cookie*. You will have 10 minutes to complete the 10 sets of words. Try to complete as many of the sets as possible. If you get stuck on a set, go to another one and come back to it later if you still have time.

1. Hot – Butterflies - Pump: ______________
2. Head – Street – Dark: ______________
3. Stalk – Trainer – King: ______________
4. Bald – Screech – Emblem: ______________
5. Room – Saturday – Salts: ______________
6. Car – Swimming – Cue: ______________
7. Widow – Bite – Monkey: ______________
8. Red – Go – Car: ______________
9. Mouse – Sharp – Blue: ______________
10. Cherry – Time – Smell: ______________