

# The influence of a natural environment on cognitive abilities and emotion

by Dianyì Jiang (2018)

## *Abstract*

There are increasing number of literatures demonstrating substantial benefits for cognitive abilities when contacting with natural environments. According to the Attention Restoration Theory and Stress Reduction Theory, natural environments have restorative influences on cognitive abilities and emotional state. Therefore, based on these two theories, the aim of this study was to investigate how natural and urban settings can affect postgraduate students' cognitive functioning as well as emotional state, and whether there are differences between influences of natural and urban environments. To do this, a within-subject pre-test post-test design was employed to compare the restorative influences of natural pictures and downtown pictures on three measures. Digit Span Backwards Task was used to assess directed attention and Guilford's Alternate Uses Task was applied to examine participants' divergent thinking; positive and negative emotion were measured through PANAS in this study. Repeated measures analysis of variance (ANOVA) was conducted to analyse data, with two within-subject factors: picture types (nature vs. downtown) and time of test (before picture viewing vs. after picture viewing) for three measures. Results showed that participants have significant improvement on directed attention, divergent thinking as well as positive emotion, and significant decrease was found in negative emotion after viewing pictures depicted natural environments. However, no significant differences were found after viewing downtown pictures. Therefore, this study provides students with guidance on where to refresh themselves after school and begin to study in a better psychological state. Implications for practice and future research are also discussed.

*Key words:* natural environment, restoration, attention, divergent thinking, emotion

ID NUMBER: 2294362

SUPERVISOR: Dr Steve Draper

MSc Psychological Studies Dissertation 2017-18

Delivered jointly: Education (EDUC5839) and Psychology (PSYCH5040)

University of Glasgow

Permission has been granted to distribute this to others.

## Contents

ABSTRACT.....	1
1. INTRODUCTION .....	2
1.1. RESEARCH CONTEXT AND THEORY .....	3
1.1.1. ENVIRONMENTAL RESTRICTIVENESS AND ATTENTION RESTORATION THEORY .....	3
1.1.2. STRESS REDUCTION THEORY .....	6
1.2. EVIDENCE FOR ATTENTION RESTORATION THEORY AND STRESS REDUCTION THEORY .....	6
1.3. THE PRESENT STUDY .....	10
2. METHODS .....	10
2.1. DESIGN.....	11
2.2. PARTICIPANTS .....	11
2.3. MATERIALS .....	11
2.4. MEASURES .....	11
2.5. PROCEDURE.....	12
3. RESULTS .....	13
3.1. ATTENTION.....	13
3.2. CREATIVE THINKING .....	14
3.3. MOOD .....	16
4. DISCUSSION .....	18
4.1. OVERVIEW OF RESULTS AND RELATION TO PREVIOUS THEORY AND RESEARCH .....	18
4.2. STRENGTHS AND LIMITATIONS OF THE PRESENT RESEARCH AND FUTURE RESEARCH SUGGESTION .....	21
4.3. IMPLICATIONS FOR PRACTICE .....	24
5. CONCLUSION .....	24
6. REFERENCES.....	27
7. APPENDIX .....	26

## Acknowledgements

I would like to express my thanks to my supervisor, Dr Steve Draper for his continuous guidance and encouragement, for his great patience and willingness to help throughout this research.

I would also like to express my thanks to my fellow Master students and friends, for their supports and times listening to me and help me during the difficult course of the dissertation.

I would like to especially appreciate thirty-two postgraduate students in the University of Glasgow who helped me with my research, for their enthusiastic participate.

## 1. Introduction

### 1.1. Research Context and Theory

Although it seems like common knowledge that natural environment can benefit many aspects of people's daily life, it is only in recent decades that scientific and verifiable research can be provided to confirm the positive impact of nature environment. Researchers found contact with nature may have both psychological and physiological benefits for people (Bowler, Buyung-Ali, Knight & Pullin, 2010; Brymer, Cuddihy & Sharma-Brymer, 2010; Reese & Myers, 2012). Exposure to natural environment can also reduce blood pressure and activate parasympathetic nervous system (Park, Tsunetsugu, Kasetani, Kagawa & Miyazaki, 2010; Gladwell et al., 2012), which enable people to release their pressure (Lottrup, Grahn & Stigsdotter, 2013) and anxiety (Mackay, Neill, 2010) from busy life; thus, interacting with natural views can serve as a therapeutic for diseases and increase patients' vitality (Ryan et al., 2010). Nature also play a crucial role in the prevention of obesity and myopia in children (Rose et al., 2007; Lachowycz & Jones, 2011).

Researches also indicated nature also has a beneficial influence in educational and social areas. For example, classrooms with nature views can improve students' academic performance and tend to have more positive evaluation toward curriculum (Benfield, Rainbolt, Bell & Donovan, 2015). Korpela (2001) suggested contact with nature helps individual reflect on their life issue as well as improve subjective well-being. Moreover, immersion in nature make people become more caring because it promotes individual's prosocial and other-focused value orientations (Weinstein et al., 2009). Study of Wakefield et al., (2007) showed that people lived in community with garden perceived increased mental and physical health, which has a positive influence in social health and community cohesion. In addition, through testing effects of viewing videos of natural and built places, results (Zelenski, Dopko & Capaldi, 2005) suggested that natural videos are more likely to produce cooperative and sustainable behaviours.

#### 1.1.1. Environmental Restrictiveness and Attention Restoration Theory

Restorative influence of natural setting is another prevalent research topic currently. The term of "restorative environment" has been proposed firstly by Kaplan and Talbot (1983), which refers to natural or other environments that can help recovery from mental fatigue and anxiety. Recently, a growing body of research has investigated which kinds of environments belong to restorative environment. Results suggested that natural environment has a restorative influence for the majority of people; museums are restorative environment for frequent visitors (Kaplan, Brdwell & Sakter, 1993). For most pilgrims and college students, monastery can be viewed as restorative environment as well (Ouellette, Kaplan & Kaplan, 2005). Furthermore, places being liked by individual are also have a restorative influence for them (Korpela, Hartig, Kaiser & Fuhrer, 2001).

There are many factors have been discovered in previous researches that can influence environments' restoration. The researchers' conclusions were inconsistent regarding different stages of lifespan may affect the preference for restorative environment. In the study of Scopelliti and Giuliani (2004), they recruited 67 Italians as participants, and found that young people mentioned the frequency of they have restorative in outdoor and natural environments was higher than at home; adult have a higher frequency of restorative experience in natural environment than expected, whereas for the elderly, they tend to have more restorative experience at home than outdoor or natural environment. However, in order to examine whether natural environment is more restorative than built environment, Berto (2007) combined the results of three studies and found that three groups participants in different stages of lifespan (adolescents, adults and the elderly) showed similar trend in the scores of assessing five types of environments (housing, industrial zone, city streets, hills and lakes). The results suggested natural environments were more restorative than built environments for participants, no matter what age group they belong to. The differences between the results of these two studies may be attributed to the fact that Scopelliti and Giuliani used the frequency of subjects mentioned restorative experience as a criterion for environments' restorative evaluation, whereas Berto applied PRS scale to assess restorative experience.

Many literatures also emphasized the importance of social interaction for restorative experience, which is regarded as the fundamental aspect of restoration. Scopelliti and Giuliani (2004) indicated that restorative experiences characterized in terms of social interactions are particularly important for adults and elderly; adults value relationship with families and partner more than young people; friends are mainly important for young people. In addition, Korpela, Ylen, Tyrvaïnen and Silvennoinen (2008) found that the recovery experience of a person being alone and a person being in company are different. Staats and Hartig (2004) further demonstrated that companion can increase people's preference for the urban environment but does not increase the preference for the natural environment, which may be attributed to the fact that the companion can ensure sense of security, and thus improve recovery. Furthermore, the time spent in the environment and the frequency of contacting with environment may also have influence on restorative experience. Study suggested that longer time spent in the environment and higher frequency of contacting with environment will increase individual's restorative experience in that environment.

However, how to explain restorative function of environments? According to Attention Restoration Theory (ART; Kaplan, 1989,1995), interaction with nature can lead to improvements in cognitive abilities that mainly depend on directed attention. ART is mainly proposed based on James' s (1892) theory about two types of attention: directed or voluntary and involuntary attention, which distinguished from each other in terms of how much efforts involved in the attention. Involuntary attention refers to passive attention without requiring much effort. Stimuli such as fascinating and interesting things can arouse involuntary attention. For instance, people are naturally attracted by beautiful views like sunsets and sunrises, flowing river and blue ocean.

In comparison, directed attention is directed by personal awareness and thoughts. It requires more cognitive efforts because all potential distraction should be ignored and excluded in order to continuously focus on tasks at hand. Activities depend on continuous attention, such as taking exams, writing reports and discussing with group members generally involve directed attention, which help people maintain their current work. Compared with involuntary attention, directed attention is not triggered by outside stimuli but inner thoughts and control. Moreover, the physiological basis of these two attentional systems also show some differences. Directed attention primarily associated with frontal lobe and parietal lobe in human brain, whereas involuntary attention depends less on these brain regions (Fan, McCandliss, Fossella, Flombaum & Posner, 2005).

ART argues that interacting with nature allows individual to restore directed attention, especially when people suffering from mental fatigue. Kaplan (1995) suggested restorative environments (natural views) provide people with more intrinsically fascinating stimulus, resulting in involuntary attention. Because of fulling use of involuntary attention, directed attention get the chance to replenish and restore from tiredness. Therefore, after exposure to natural setting, directed attention can be promoted and restore. Additionally, other cognitive abilities depend on directed attention can be accordingly improved, such as emotional functioning and short-term memory (Jonides et al., 2008). The theory is consistent with our daily experience. For instance, after walking in a green park, people can always become more energetic and manage work with higher efficiency. However, unlike natural settings, urban settings involve more external stimulation and require directed attention to cope with them. For example, when you are walking, you need to pay attention to the car horns in streets; in order to arrive at the destination on time, you need to avoiding traffic if you are driving. This means urban environments generally require people to focus on certain target with awareness for being safe or achieving their goals, and thus involving more directed attention. Consequently, contrasted with natural environments, urban environments may be less restorative.

Additionally, Kaplan (1989) concluded four characteristics commonly belong to restorative environments: being away, fascination, extent and compatibility. Firstly, people will have a sense of psychologically or physical distance from different routines or places. For example, people emerge themselves in a completely unfamiliar park or engage in activities they have never participated, which allow directed attention to rest. Secondly, people's attention will focus on fascinating stimulus effortlessly in the environment. Moreover, extent refers to the notion that sufficient contents and structure of environment will provide people with opportunities to continuously explore, allowing a sense of coherence. Compatibility refers to the idea that people's demands and needs will make a well match with activities supported by the environment. If someone's favourite activity is swimming, then running in the environment may not have desired restorative effects. Essentially, these four factors hold in restorative environment allow directed attention to recover from mental fatigue for a long period.

### *1.1.1. Stress Reduction Theory*

Beside restoration of directed attention when exposure to natural environment, Stress Reduction Theory (SRT) provides an explanation for the relationship between nature experience and emotion. Ulrich (1991) proposes that natural environment have beneficial effects on emotional functioning psychologically and physiologically. To be more specific, contact with natural setting results in adjust of neurophysiological activation due to the innate association with nature, and thus experience particular physical changes such as decrease of blood pressure, muscle tension and heart rate (Ulrich et al., 1991), which generally involve in declining level of mental stress. Particular natural views such as forests, lake and sea give people opportunities to survive and a sense of intimacy due to the innate connection to natural world. Because of the inborn preference for nature environment, exposure to these types of landscapes activates physiological changes in affectively beneficial ways (Ulrich et al., 1991). Therefore, natural views tend to have a restorative advantage over built environments and interacting with natural landscape can naturally generate positive emotional changes and help stress recovery. SRT provides a series of testable assumption concerning the impact of natural environment on people's autonomic nervous system, and thus the later researches applied physiological measurements of individuals to explore the restorative influence of nature.

### *1.2. Evidence for Attention Restoration Theory and Stress Reduction Theory*

Based on ART and SRT, there is growing body of evidence supported these two theories and prove the restorative effects of natural environment compared with urban environments. By comparing the differences between group of patients with tree-view in room and patients only with wall-view, Ulrich (1984) firstly investigated therapeutic influence of viewing window and found patients had access to natural scenes tend to have shorter hospital stays and evaluated more negatively to nurses. In school, Tennessen and Cimprich (1995) indicated that students had accommodation with more natural scenes from windows performed better on directed attention tests.

An early research (Hartig, Mang & Evans, 1991) investigated restorative effects of natural environment by randomly assigned participants from college to complete one of the tasks of walking in a natural environment, walking in an urban environment, or staying in a relaxation state. Through assessments of emotional state by self-report and cognitive performance, result suggested restorative influences only taking place from participants who walked in nature. Although the majority of researches concerning benefits of nature focus on adults or students instead of children, Maller's study (2009) applied qualitative method to explore the perceived benefits of children after school activities involving in interacting with natural environments. Through face-to-face interviews, researchers concluded that contacting with nature is significant for children's development of emotional, mental and social health. However, Maller noted that these benefits are based on researcher's perception and may be translated in an exaggerated way. Thus, more empirical experiments and data should be collected in future researches.

Brenman (2008) compared restorative functioning of both natural and urban environments, requiring participants to walk in two kinds of environments or view the pictures of natural environment. After comparing per-test and post-test data, study showed that participants performed better in backwards digit-span, which means recovery of directed attention. Additionally, the results of PANAS indicated that participants viewing pictures of natural areas showed more significantly improved positive feelings such as refreshing and enjoyable, but no emotional changes have been found in participants viewing pictures of urban environments. Berto's study (2005) used restorative and nonrestorative pictures to compare the different levels of recovery in attentional capacity using SART. The different performance of SART in pre-test and post-test supported the hypothesis that natural views have restorative effects and help promote attentional abilities.

In addition to directed attention, many recent studies also found natural views' influence on emotional functioning and physiological state. Through a repeated design measure of physical changes and emotion in sitting or walking in natural and urban settings (Hartig, Evans, Jamner, Davis & Gärling, 2003), Hartig suggested that natural walking promoted changes of blood pressure and reduced anxiety. According to the study of Bratman (2015), after 50-minute walk in natural environments or urban environments, participants walked in nature tend to decrease in anxiety and negative emotion. However, this between-subject design may produce unreliable results due to individual variability such as different levels of emotional self-regulation and strategies (Gross, John, 2003). Therefore, in order to minimize individual differences, Gidlow (2016) used a cross-over within-subject design. In his study, every participant walked in three different settings for about 30 minutes, that is, urban environment, green environment and blue environment with canal, and walked in different environment at the same time on three days. The results showed that natural environments have positive effects on restorative experience and cognitive functioning such as working memory. Additionally, a recent research (Martyn & Brymer, 2014) used both quantitative and qualitative methods to investigate the relationship between feeling stressed and being exposure to natural scenes and results indicated that contacting with nature is significantly associated with lower level of cognitive anxiety. Another study carried out by Laumann (2003) compared the restorative influences of natural and urban stimulus by viewing video depicting both kinds of environments. By analysing the performance on attention-orienting task and cardiac inter-beat interval to assess attentional ability and heart rate respectively, the study indicated that subjects who watched natural video had longer inter-beat interval, that is lower heart rate, which is consistent with the theory of stress reduction. Likewise, in order to investigate the influences of natural environments on changes in cardiovascular autonomic control, Gladwell (2012) measured heart rate variability (HRV) and blood pressure (BP). The results showed that HRV and BP increased significantly when participants watching natural slides contrasted with viewing slides of built environment, which indicated that natural environments may cause alterations in autonomic control and increasing of vagal activity in particular. However, the majority of researches used limited natural or urban fields and

pictures to explore the effects. These results may lack representativeness and generalization because different natural environments involved different scenes. It is difficult to identify whether other natural environments have similar influence with the tested environments. Thus, an extensive research carried out by Park (2010) conducted experiments in 24 forests cross Japan from 2005 to 2006. Researchers measured seven physiological parameters such as salivary cortisol, pulse rate and diastolic blood pressure, and the profile of mood states (POMS) was used to measure psychological states such as anxiety, depression, anger, fatigue and vigour. The results showed that participants who assigned to view forest landscape tend to have lower level of salivary cortisol, diastolic blood pressure and pulse rate, whereas reflect greater parasympathetic activity.

Furthermore, Ulrich (1993) also associated people's biological affinity for nature with creative thinking or performance. As mentioned earlier, ART suggested that restorative environment like natural environment involves fascinating stimulus that can replenish cognitive capacity. Barron (1969) and MacKinnon (1962) suggested individual high in creativity tend to be sensitive to sensuous experiences, thus allowing natural environment with multiple stimulus to have beneficial effects on creative thinking (Ackerman, 1991). McCoy (2002) investigated the problem of what kinds of physical environments can be conducive to creativity by comparing participants' creative performance in setting high in creativity potential with low in creativity potential. This study suggested that contacting with natural setting or natural materials help to facilitate creative potential, contrasted with settings with manufactured materials. In addition, natural environment can also serve as a suitable place for students to explore and challenge new things in school, which give them an opportunity to foster creativity. Another study carried by Pribadi (2018) successfully improve students' science learning achievement and creativity through surrounding natural environment approach. Students' creativity improved in terms of ability to learn science contents by measuring the average scores of creativity test. It is possibly because through directly learning in natural environment, individual's mind is open to of thinking, thus supporting student to produce novel ideas.

The majority of researches demonstrated that there is significant correlation between natural environments and cognitive abilities or emotion, but most of them focus on studying healthy individual's improvement on cognition and emotional state instead of people with cognitive impairment or other deficits. It is unclear whether ART and SRT can also generalize to individuals with mental disorder, which is also a field worth exploring. Taylor (2009) recruited twenty-five children from age 7 to 12 and professionally diagnosed with ADHD to enter the program of natural environments. All participants were required to walk a route in three different environments (park, downtown and neighborhood) in turn. Before and after exposure to three settings, participants completed a series of tasks including Digit Span Backwards (DSB), Stroop Color-Word Test (Dordrill, 1978), Symbol Digit Modalities (SDM; Smith, 1968) and Vigilance Task of the

Gordon Diagnostic System Model 111-R (VT; Gordon, McClure, & Aylward, 1996). Analysis of DSB scores indicated that participants performed significantly better in DSB after walking in the park than in neighborhood and downtown. The results are consistent with the theory of attention restoration and extent previous research into people with ADHD. Likewise, Berman (2012) explored whether walking in natural environment can improve cognitive ability and affective functioning for individual diagnosed with major depressive disorder (MDD). In this study, 20 participants with MDD were recruited in this research. Backward digit-span task and PANAS were used to measure short term memory and emotion, respectively. Data analysis indicated that interacting with nature facilitated the performance of short-term memory and positive emotion.

Additionally, another aspect of restorative effects worth exploring is long lasting effects and duration. According to the study of Gidlow (2016), participants' emotion, cognitive function and physiological responses were repeatedly assessed before walking, after walking immediately, and 30 min after leaving environment respectively.

And data analysis suggested restorative influence of walking in natural environment on cognitive function can persist for at least 30 min after walking. From the long-lasting effects of natural environment, it appears that nature is of particular significant to people than we expected, and people should be encouraged to spend more time in natural environment.

However, the results of researches concerning attention restorative theory and stress recovery theory are inconsistent. For example, although Gidlow (2016) found positive influence of natural environment on cognitive function when contrasted with urban environment, no significant differences were observed between walking in natural condition and urban condition. Additionally, in the study of Laumann (2003), participants who watched natural videos did not show significant improvement on voluntary attention and they made lower attentional shifts than group of watching urban video. One potential reason is that contacting with natural scenes may decrease automatic arousal. This can result in less spatially selective attention (Easterbrook, 1959). In terms of the relationship between natural environment and creative thinking, Kerr (2017) applied an innovative research method called comprehensive literature review to explore this topic. The results suggested that most interviewees did not agree the idea about natural environment can be regarded as an inspiration for creative thinking. Furthermore, some participants indicated that built environments with multiple stimulus can encourage individual to produce more new ideas. For example, museums, libraries and music venues usually located in urban areas, which provide citizens with places to seek inspiration and exchange their ideas with other people.

### 1.3. *The Present Study*

Nowadays, college students encounter intense competition in both school and society and many of them feel stressed and mentally fatigued. It is necessary to provide them with effective ways to restore their cognitive functioning and emotion. Green space has been generally accepted as a place for people to have a break and replenish themselves. According to attention restoration theory (ART; Kaplan, 1995, 2001), after interacting with environments with inherently fascinating stimuli (e.g., sunset, trees), people's directed-attention mechanism may replenish. This means that people who contact with nature environment may have better performance on the tasks that depend on directed-attention abilities. Previous studies also demonstrate the restorative effect of natural connection on the mental well-being. Martyn and Brymer (2014) argued that experience of being connected to nature may reduce unhelpful anxiety. Moreover, outdoor stimulation can have a positive effect on creative thinking. The research of Oppezzo and Schwartz (2014) suggested walking outside can be a strategy to increase appropriate novel idea generation. However, studies carried out by Berman (2008) indicate that not all kinds of outdoor conditions can have cognitive benefits, experiment showed that participants walked downtown did not improve their performance in directed-attention measurement. Thus, this theory needs more deep researches due to inconsistent results. Furthermore, there is limited research explore the restorative effects of natural environment on student population. In addition, how natural settings can affect creative thinking do not appear as strongly evaluated in previous literatures.

Taken that into account, this study aims to investigate how natural and urban settings can affect postgraduate students' cognitive functioning as well as emotional state, and whether there are differences between influences of natural and urban environments. To address this goal, we employed measures of attention (backward digit-span; Wechsler, 1955), creative thinking (Guilford's alternative use test; Guilford, 1967) and affect (PANAS; Watson, Clark, & Tellegen, 1988). Two group were developed to aid in the study of these aims. Through a pre-test and post-test design, attention, creative thinking and emotion test were compared across two different conditions. In the first condition, participants were required to view pictures depicted natural scenes for about 10 minutes. In the second condition, participants were required to view pictures depicted urban environments for about 10 minutes. The hypotheses of the study were based on attention restoration theory and stress reduction theory. The results of studies evaluated scores of pre-test and post-test of natural and urban settings. I tested three main hypotheses. First, I hypothesized that viewing natural pictures will increase participants' positive emotion and reduce their negative emotion, when compared to urban pictures. Second, after viewing natural pictures, participants will perform better in the test of attention than before, whereas viewing urban pictures will have no significant influence on attention. Third, viewing natural pictures will help develop participants creative thinking, with more novel ideas in alternative use test.

## 2. *Methods*

### 2.1. *Design*

Using a pre-test post-test design, all participants experienced two sessions of viewing pictures, but they were randomly assigned to one of two groups of viewing picture in reverse order, with one group viewed natural pictures firstly and another viewed urban pictures firstly. Each session of viewing picture involved in a pre-test and a post-test of three different measures (emotion, attention and creative thinking), and the post-test of viewing first session of pictures will be regarded as the pre-test of the second session of viewing picture. In this study, participants' performance in attention, creative thinking and emotion tasks were dependent variables and viewing images of nature or downtown were independent variables. This within-subject design was investigated whether participants' scores on three different measures differed between viewing different pictures and whether there were significant differences between pre-test and post-test of three measures.

### 2.2. *Participants*

The participants that took part in this study consisted of 32 postgraduate Psychology students from the University of Glasgow. Students were invited to participate in the study through online social network advertisements and personal communication. Students included 19 women and 13 men (mean age = 22.2 years, SD = 3.3 years). No exclusion criteria were employed and participation in this study was entirely voluntary without any reward.

### 2.3. *Materials*

Both two types of pictures contained 10 images depicted different environmental categories of scenes. For natural environments, pictures mainly depicted grassland, lakes, hills, beaches, forests and blue sky. Downtown pictures primarily depicted views of city streets, housing, industrial zone and skyscrapers.

### 2.4. *Measures*

Digit Span Backwards Task (DSB) was firstly proposed and described by Wechsler (1955) and is widely used as a standardized measure of concentration (Tennessen & Cimprich, 1995) by assessing working memory's number storage capacity. It is useful in detecting impaired attention and has been recommended to apply in diagnosing of Attention Deficit Hyperactivity Disorder (ADHD) (Hale, Hoepfner, & Fiorello, 2002). When exploring the restoration effects of different environments on cognitive abilities, DSB has also been proven as an effective measure of attention. Digit-span task can be commonly used primarily because participants' performance in the test generally would not be influenced by other factors such as semantics and complexity. Thus, DSB was used in this experiment to assess participants' directed attention ability that mainly depends on attentional focus and personal efforts. In the test, participants heard a sequence of number and were required to recall the sequence correctly in reverse order. Sequences were three to nine digits in length, with increasingly longer length being presented in each trial. The final score of this test is

the number of digits in the longest sequences that participants can successfully recall in two consecutive trials (Wechsler, 1955).

Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) was used to assess participants' emotion. PANAS is a self-report questionnaire that yields separate score for positive and negative affect and consists of two 10-item scales to measure both affects. Mood-related adjectives items (e.g., "enthusiastic", "nervous") were rated on a 5-point scale of one ("very slightly or not at all") to five ("extremely") for how well each item describes participants' current experiencing of feelings or emotions. PANAS has been commonly used as measure of mood in group studies as well as clinical work with individual. Moreover, PANAS also has the potential to assess mental illness. For instance, a study carried by Dyck (1992) has proved its effectiveness and reliability in distinguishing between depression and anxiety in clinical samples. In this study, PANAS was used in both pre-test and post-test to investigate changes in participants' positive and negative affect when contacting with pictures of different environments. The final score is mean of scores, and higher average score indicate higher positive and negative affect respectively.

Although it is difficult to specifically define creativity, one of the key components of creative thinking is the generation of novel idea. Thus, I adapted an operational definition of creative as the production of appropriate novelty. This study employed Guilford's Alternate Uses Task (Guilford, 1967) to measure creative thinking. Each item in Alternate Uses Task presented the name of common house hold object, such as a brick, a newspaper. Participants were required to list as many uses as possible for each item within a limited time. It has been widely used as an effective way for measuring divergent creative thinking and help participant to generate novel ideas. In this study, the final results of Alternate Uses Task based on the criteria of fluency, that is, the number of appropriate novel alternate uses on the test.

## 2.5. Procedure

Participants were invited to meet in the waiting room at the psychology department and then were taken to an experiment room without any distractions. In the experiment room, researcher provided participants with information sheets and asked them to sign the consent form before taking part in the experiment.

Participants were seated in front of computer screen and then completed a series of tests presented in this order: GAU tasks, Digit Span Backwards (DSB) and PANAS. After all the pre-test tasks, participants were randomly assigned to view either pictures of natural or urban which were presented randomly on table and participants had only to look freely at the pictures. Picture viewing last about 10 minutes. After viewing all the pictures, participants completed all tasks the second time followed by another session of viewing complementary pictures. Next, they completed all tasks the third time. A debriefing sheet is handed out once they completed the final stage and participants were given the opportunity to ask any question.

The whole experiment took 1 hour and 30 minutes and participants were tested individually. Ethical approval was obtained from the School of Psychology Ethics Committee at the University of Glasgow.

### 3. Results

It has been hypothesized that students' directed attention abilities measured by Digit Span Backwards test would vary significantly depending on which pictures they viewed during intervention session. Specifically, it was predicted that participants' DSB scores would be higher after viewing pictures depicted natural views than after exposure to pictures depicted city environment. Additionally, it was also hypothesized that test scores in Alternate Uses Task show a greater difference in which type of pictures they viewed and participants who viewed pictures of nature were expected to performed better in the test of Guilford's Alternate Uses. Finally, it was hypothesized that participants' affect would also show significant differences after viewing natural pictures.

I conducted repeated measures analysis of variance (ANOVA), with two within-subject factors: picture types (nature vs. downtown) and time of test (before picture viewing vs. after picture viewing) for three measures: attention, creative thinking and affect. Scores of three tests were dependent variable and different conditions of viewing pictures were independent variable, at both pre-test and post-test. The aim was to test whether there were significant differences between viewing natural and urban pictures concerning cognitive functioning and emotion. Data analysis suggested that there are significant interactions between time and pictures on the performance of Digit Span Backwards test and PANAS. However, no significant time-by-picture interaction was found in Alternate Uses Task. Additionally, from the follow-up *t* test, significant improvement was found only in viewing pictures of natural environment in measures of attention, divergent thinking and positive emotion, while significant decrease was found in negative emotion. However, no significant difference was found after viewing downtown pictures. Specific results of each measure are presented below separately.

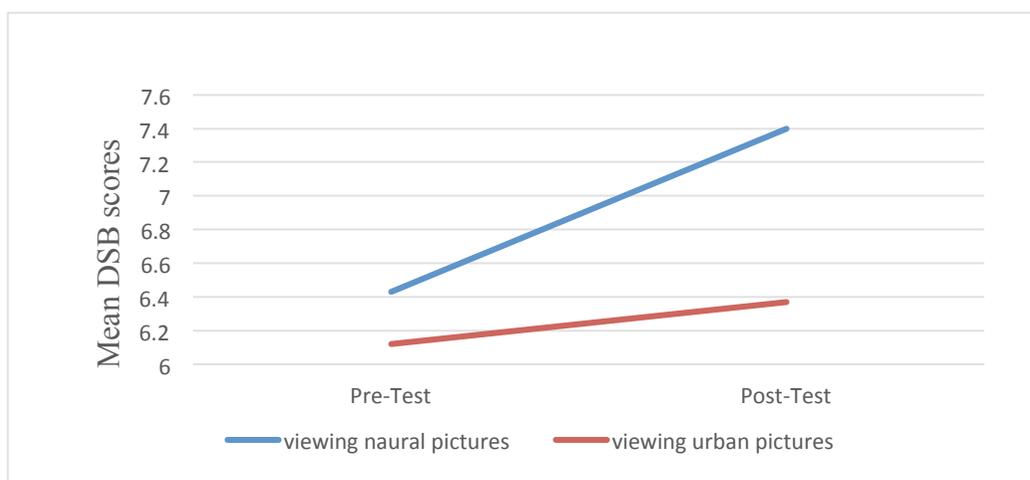
#### 3.1. Attention

From 32 participants' data, mean and standard deviation were calculated for the Digit Span Backwards test scores. As shown below in Table 1. The mean scores suggest that participants performed better in post-test regardless of which type of pictures they viewed before. A repeated measure (within-subject) analysis of variance (ANOVA) was conducted in order to assess the impact on students' scores on Digit Span Backwards test across two time period (pre-test vs. post-test) after viewing pictures of either nature or urban setting. The picture-by-time interaction was of most interest and was found reliable,  $F(1, 62) = 6.836$ ,  $p = 0.011$ ,  $\eta^2 = 0.099$ , showing that the improvement in Digit Span Backwards test performance was greater after viewing natural pictures than viewing urban pictures (see Graph 1). In the follow-up analysis, I explored the effects with paired *t* test and found that the improvement after viewing natural pictures was

highly reliable,  $t(31) = -5.669$ ,  $p < 0.0005$ ,  $d = 0.77$ ; but it was not when viewing urban pictures,  $t(31) = -1.161$ ,  $p = 0.255$ ,  $d = 0.19$ . Additionally, in all analyses, there were no main effects or interactions associated with viewing order (i.e., view natural pictures first or second), which means the improvement of performance in Digit Span Backwards test was not simply practice effect.

Table 1: mean and standard deviation for Digit Span Backwards scores

	Pre-test		Post-test		
	M	SD	M	SD	d
Viewing Natural Pictures	6.43	1.13	7.40	1.36	0.77
Viewing Urban Pictures	6.12	1.38	6.37	1.15	0.19



Graph 1: effect of viewing natural pictures on attention

### 3.2. Creative thinking

As shown below in Table 2, mean and standard deviation were calculated for Guilford's Alternate Uses Task. The mean GAU scores at pre-test before viewing pictures of nature was 6.37 with a standard deviation of 1.40, whilst viewing pictures of downtown was 5.93 with a standard deviation of 1.31. At post-test, scores of participants who viewed pictures of nature increased to 7.08 with a standard deviation of 1.20, and participants who viewed pictures depicted downtown scenes slightly increased to 6.12 with a standard deviation of 1.84. A further repeated measure (within-subject) analysis of variance (ANOVA) was

conducted in order to assess the impact on students' scores on Guilford's Alternate Uses Task after viewing pictures of either nature or urban setting. The picture-by-time interaction was not reliable,  $F(1, 62) = 3.716$ ,  $p = 0.058$ ,  $\eta^2 = 0.057$ . However, the follow-up  $t$  tests found that performance on Guilford's Alternate Uses Task only improved reliably when viewing pictures of nature,  $t(31) = -3.321$ ,  $p = 0.002$ ,  $d = 0.54$ ; but not when viewing pictures of urban scenes,  $t(31) = -1.099$ ,  $p = 0.280$ ,  $d = 0.11$ . The results revealed that participants' divergent thinking improved significantly after viewing pictures of nature.

Table 2: mean and standard deviation for Guilford's Alternate Uses Task

	Pre-test		Post-test		d
	M	SD	M	SD	
Viewing Natural Pictures	6.37	1.40	7.08	1.20	0.54
Viewing Urban Pictures	5.93	1.31	6.12	1.84	0.11



Graph 2: effect of viewing natural pictures on Guilford's Alternate Uses Task

### 3.3. Mood

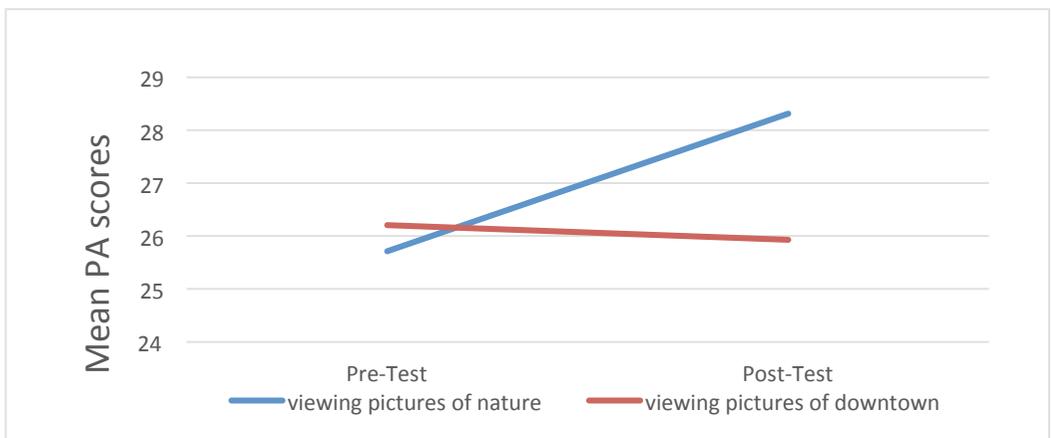
Participants' mood was assessed by Positive and Negative Affect Schedule (PANAS), and positive affect (PA) and negative affect (NA) were analysed and reported separately below.

#### Positive affect

The mean scores of PANAS in positive affect were presented below in Table 3. From the mean scores and standard deviation, it appears that positive affect both increased after viewing intervention but viewing pictures of nature tend to improve to a greater extent. A follow-up repeated measure analysis of variance (ANOVA) was conducted to assess the influence on students' positive affect scores on PANAS after viewing pictures of either nature or urban setting. Result of ANOVA yield a significant interaction between time and type of pictures,  $F(1, 62) = 13.616, p = 0.000, \eta^2 = 0.180$  (see Graph 2). The follow-up  $t$  tests found that the improvement of positive affect after viewing natural pictures was highly reliable,  $t(31) = -4.555, p = 0.000, d = 0.70$ ; but it was not when viewing urban pictures,  $t(31) = 0.529, p = 0.601, d = 0.10$ , showing that viewing pictures of natural area can significantly improve individual's positive affect.

Table 3: mean and standard deviation for Positive Affect in PANAS

	Pre-test		Post-test		
	M	SD	M	SD	d
Viewing Natural Pictures	25.71	3.73	28.31	3.64	0.70
Viewing Urban Pictures	26.21	2.56	25.93	2.68	0.10



Graph 2: effect of viewing natural pictures on Positive Affect

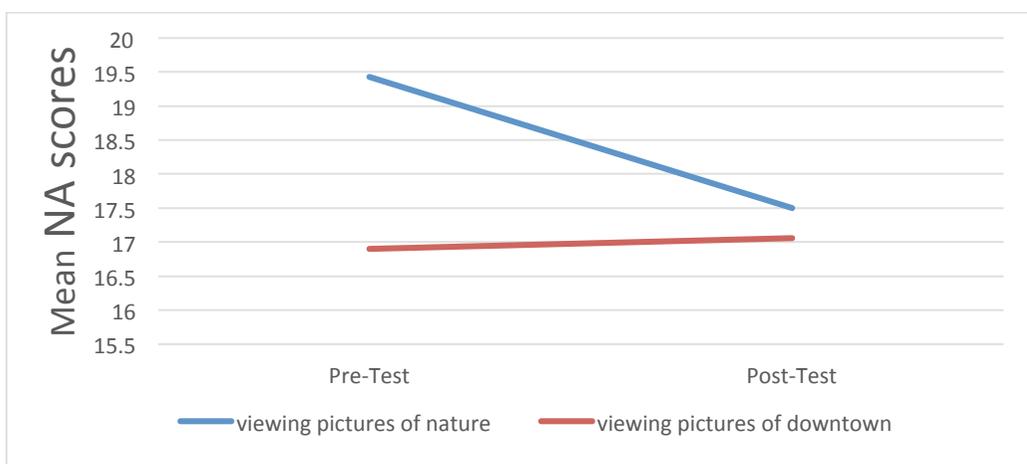
### Negative affect

The mean scores of PANAS in negative affect were also calculated and presented below in Table 4. Mean scores of negative emotions show a greater decrease after viewing natural images, whereas when viewing images of downtown, mean scores slightly increased. A further repeated measure (within-subject) analysis of variance (ANOVA) was used to explore the influence on students' scores of negative emotions on PANAS after viewing pictures of either nature or urban setting. Results of analysis indicated a significant interaction between time and pictures,  $F(1, 62) = 6.924, p = 0.011, \eta^2 = 0.100$ , showing that the negative affect decreased to a greater extent after viewing natural pictures than viewing urban pictures (see Graph3). furthermore, A follow-up paired  $t$  test was conducted to assess the main effects and found that negative affect was significantly decreased after viewing natural pictures,  $t(31) = 3.674, p = 0.001, d = 0.61$ ; but it was not when viewing urban pictures,  $t(31) = -0.262, p = 0.795, d = 0.05$ . The results revealed that viewing natural images can effectively decrease negative emotion compared with downtown images. However, viewing downtown images may not have significant effect on negative mood.

Table 4: mean and standard deviation for Negative Affect in PANAS

	Pre-test		Post-test		d
	M	SD	M	SD	
Viewing Natural Pictures	19.43	3.32	17.50	2.90	0.61
Viewing Urban Pictures	16.90	2.70	17.06	3.16	0.05

Graph 3: effect of viewing natural pictures on Negative Affect



## 4. Discussion

### 4.1. Overview of Results and Relation to Previous Theory and Research

This study aimed to investigate the impact of viewing pictures depicted natural views or downtown views on cognitive functioning and emotional state. It was hypothesized that participants' performance in attention and creative thinking tasks would be better after viewing pictures depicted natural views than after exposure to pictures depicted city environment. Additionally, it was predicted that participants' affect would also show significant differences after viewing natural pictures than downtown pictures. Results indicated that pictures depicted natural environments tend to have higher restorative value than pictures depicted downtown views, which strongly supported this study's hypothesis. Specifically, significant and reliable interaction between time (pre-test and post-test) and type of pictures (nature and downtown) in the scores of attention, positive affect and negative affect were found in results; but it was not found in the performance of creative thinking. Moreover, measures of attention ability, creative thinking, positive affect and negative affect showed significant differences after viewing natural pictures but was not significantly different after viewing pictures depicted downtown environment.

#### Attention

As predicted, when participants that were required to view pictures depicted natural environment, they demonstrated a significantly greater overall accuracy in Digit Span Backwards task after viewing pictures. In addition, the reliable time-by-picture interaction revealed that natural pictures have significantly better restorative impact on directed attention than pictures of downtown environments. In this study, Digit Span Backwards task allowed participants to move items in and out of attentional focus (Cowan, 2001). Thus, the whole processing in the tasks depends heavily on directed attention mechanisms. This finding is consistent with Attention Restoration Theory proposed by Kaplan (1989), which assumes that interacting with nature allows individual to restore directed attention abilities, especially when people suffer from mental fatigue. Additionally, other cognitive abilities depend on directed attention can be accordingly improved, such as emotional functioning and short-term memory (Jonides et al., 2008). Therefore, the results of present paper contribute to the existing knowledge and give some evidence to the Attention Restoration Theory. Additionally, these findings are also in line with previous study carried out by Berman (2008), which required participants to walk in two kinds of environments or view the pictures of natural environment and the results showed that participants performed better in backwards digit-span, which means the recovery of directed-attention.

Natural pictures may provide participants with a sense of peace, although they are not engaged in real natural environments in person. Findings in this study suggest that media such as natural pictures also have restorative value and improve participants' attention directed by personal awareness and thoughts.

Significant improvement in Digit Span Backwards task means that people tend to be more concentrated and

focused on tasks after spending some time viewing pictures depicted natural environments. One of the potential reasons may be the innate intimacy with natural objects and scenes, which enable people to be more peaceful and relaxed than before. The inner peace helps individual to excluded potential distraction and become more focused on task in hand. However, in contrasted with nature images, pictures depicted downtown images may not have the similar restorative influence on individual. It is may due to the fact that the majority of downtown pictures depicted artificial environments such as busy streets and heavy traffic. These senses involved in many distractions and stimulus that requiring people to focus attention on them in order to be safe or achieve goals. Therefore, in built environment, people tend to be more difficult to concentrate on targets than in nature environments. Consequently, contacting with pictures depicted nature settings are more likely to facilitate directed attention than downtown pictures.

### Creative thinking

Creative thinking has been widely considered as the key competencies nowadays and appropriately use it allows us to explore the world. Generally, creativity is defined as successfully production of works that are novel or innovation in public sense (Sternberg and Lubart 1999). Additionally, cognitive process is the basis of creative thinking since creative activities requires the interaction between convergent thinking and divergent thinking(creative). According to Kaplan' s Theory of Attention Restoration, exposure to nature environment can benefit cognitive abilities such as attention, thus it can be assumed that other abilities such as creative thinking that relies on cognitive processing may also improve accordingly. In this study, the results suggested that scores of Alternate Uses Task increased significantly after viewing pictures of nature environments, but it was not found in downtown pictures. This finding is also in line with the Theory of Attention Restoration, that is, natural materials have restorative influence on cognitive abilities. Thus, divergent thinking may also improve. Additionally, this finding supports the trend reported in a study of (Oppezzo and Schwartz, 2014), which explored the influence of walking on a treadmill or outside on participants' divergent thinking and convergent thinking. Their results suggested that walking outside lead to improved creative performance on Guilford's Alternate Uses Task.

Improving creative thinking appears to be a complex procedure and involve a series of training due to the fact that creativity contains different abilities such as convergent thinking, divergent thinking and problem solving. Although in this study, only divergent thinking was measured by Alternate Uses Task, it still provides an easier method to develop creative thinking. Findings in this study indicate that natural setting have the potential to facilitate creativity, which can be served as the fundamental environment of creative ideation.

### Positive and negative affect

In support of our hypothesis, compared to view downtown pictures, viewing pictures depicted natural environments improved positive affect and decreased negative affect. These findings build upon previous studies that were motivated by the Theory of Stress Reduction, which argued that interacting with natural landscape can naturally generate positive emotional changes and help stress recovery. Findings in this study extend previous work by comparing the different influence between using natural pictures and downtown pictures. Results suggested that relative to viewing downtown pictures, images depicted natural environment have positive impact on emotional state. These findings also in line with previous study of Bratman (2015), data analysis in their study demonstrated that nature experience is more likely to decrease negative affect and increase positive affect compared with urban experience.

People tend to keep in a relatively healthy psychological and physiological state when exposure to nature environment may be due to the innate intimacy with nature. According to the perspective of physiological anthropology, human beings have existed in natural environment for almost 5 million years. Thus, it can be predicted that people's physiological functions are more adapted to natural environment. As a result, exposure to natural environment can promote relaxation and replenish emotional energy, which is reflected in the improvement of positive affect and decreasing of negative affect, as shown in findings of this study.

Furthermore, there are many arguments concerning the relationship of emotional state and cognitive abilities. For example, some theories suggested that improvement of positive affect can result in increases in working memory capacity through improving levels of dopamine (Ashby, 1999) and broadening behavioral repertoire (Fredrickson, 2001). Whereas some other researchers indicated that positive emotional state may lead to poorer performance in cognitive-control ability (Oaksford et al., 1996). In addition, there are still some other studies demonstrated the selective effects relies on task requirement and stimulation (Phillips et al., 2002). For instance, the improvement of positive affect has negative impact on performance on tasks highly depends on focused attention, while it can facilitate performance on tasks depends on creative activity (Phillips et al., 2002). If participants carried out a test involved in creativity, it is possible that emotional state would be found to be associated with performance on this test. However, findings in this study appear to consistent with theories of Ashby and Fredrickson. Although this study does not directly analyze the correlation and attribution of attention, creative thinking and emotion, participants' performance on attention, creativity and positive affect improved after viewing nature images. It is possible to assume that positive emotion may have benefit on cognitive processing such as focused attention and creativity. This idea worth researching in future studies.

#### 4.2. *Strengths and Limitations of the present research and future research suggestion*

This study provide evidence for the restorative influences of natural environment by making comparison with urban environment. Significant differences of performance on attention, divergent thinking and emotion were found after viewing natural pictures. In this study, it is noteworthy that pictures were presented to participants in a different way from previous studies (Berman, 2008). Pictures were randomly presented in the table and participants were required to view these pictures freely instead of viewing pictures in a sequence within a limited time. This means that participants can decide which pictures they want to focus on with relaxation. Presenting pictures in this way allowed participants to feel more relaxed and freer when taking part in this experiment, which create an atmosphere that are similar to real experience when contacting with natural environment or viewing pictures in daily life. This innovative way of presenting pictures may shed light on a new perspective for study design.

This study is based on Attention Restoration Theory and Stress Recovery Theory. They provide some explanations to the mechanisms behind the beneficial influence of natural experiences from different perspectives. Specifically, ART tends to explain the impact of natural experiences on cognitive abilities, whereas SRT focused more on the influence on mental health. However, both of them put forward their theory on the basis of evolutionary theory. They suggested that the intimacy to nature is due to the fact that human being have been lived in nature environment for a long time and thus it can benefit human being in terms of physiology and psychology. This is the common premise of them, however, it is difficult to empirically identify whether the positive impact of natural experiences results from innate intimacy with nature. Future researches can examine the benefit of nature environment based on other psychological theories. For example, the Place Attachment Theory, which draws on Bowlby's attachment theory, mainly focused on the emotional bond between person and place, as well as the influence of this connections on individual (Hernández, Hidalgo, & Ruiz, 2013).

There are also several limitations concerned methodology. First of all, it is noteworthy that a limitation of this study is the relatively small sample size (32 participants). However, the size effects analyzed in this study were larger and a within-subject design were used in this study, which can help to mitigate concerns about sample size. Another limitation regarding sample is the age of participants is young and they are all students. Due to a recent study demonstrated that elderly participants tend to have larger effect sizes of positive influence on natural experience than young people (McMahan & Estes, 2015). It is possible to separate different ages of participants and explore the distinctive influence among them. Another factor should be taken into consideration is individual differences. Although this study used within-subjects design, some other individual diversities such as personality traits can still affect study results. It is also significant to examine whether individual factors can mediate and regulate the restorative impact of nature. Therefore, it is necessary for future study to investigate the role of age and individual differences.

Additionally, the subjects of exploring restorative experience mainly limited to adults as well as college students. However, limited research paid attention to preschool children and adolescents who have heavy work of study, who are also under pressure from work and family. Thus, it is also significant to investigate whether restorative experience of nature can make some difference on mental and physiological state of children and adolescents.

Furthermore, this study mainly compared the influence of pictures depicted nature and downtown environment and it was hypothesized that the impact of nature environment is positive, whereas downtown environment is negative. However, no control group was designed, so it can only indicate that natural pictures have more beneficial influence on cognition and emotion compared with downtown pictures while it is difficult to deduce the restorative influence of natural environment. In this case, it is important for future study to set a control group in which participants will not receive any manipulation, and thus, a more scientific study design can be provided to explore the restorative influence of natural environment.

Additionally, according to the Attention Restoration Theory, the premise of restorative influence of natural environment is mental and physical fatigue. In this study, all participants are postgraduate students and they participated this study during the period of preparing their dissertation. Additionally, testing took place in the late afternoon and participants generally spent a tired day. Thus, it can be assumed that participants in this study were in high levels of anxiety, stress and fatigue. However, in some prior studies, researches induced participants' mental fatigue through extra tests like long-time difficult mathematical tests or asking them to imagine themselves as attentionally fatigue. While in this study, it is hard to say that all participants have same levels of mental fatigue. Therefore, restorative influence of natural environment may not be fully reflected, because it is possible that the recovery tends to be more obvious if people feel stressed and tired to a certain extent. Further study can focus on the problem of how to induce participants' mental fatigue to the same levels.

Moreover, is it necessary to improve the standard of choosing environmental images and the way of presenting these images. In this research, there is no uniform criteria for the selection of stimulating materials such as images and videos. Specifically, whether images contain factors such as characters and landmark building. Due to the fact that some pictures contain many complicated information. Therefore, it is difficult to determine which factor in the picture play a restorative function and which factor play a role in impeding recovering. The non-standardized pictures are not conducive to researcher's comparison of different studies' s results. Therefore, future studies can try to explore the key factors that have effective restorative influence and make a uniform criteria of picture selection.

Another limitation is that this study applied pre-test and post-test design to examine the impact of interacting with nature environment, however, it ignored the facts that some beneficial influence of environment may

disappear after the interaction. For instance, a study carried out by Bowler et al. (2010) conducted a meta-analysis of 25 studies concerning nature environment. The results suggested that there is significant positive influence on participants' emotional state and focused attention after contacting with natural environment. However, there is no significant changes in physiological parameters such as blood pressure and cortisol. Therefore, it is possible to predict that natural impacts on physiological may continue during the experiment, however, physiological parameters will return to their original levels once the stimulus disappear. Some studies using natural pictures and videos as stimulus support Bowler's prediction. They continuously measured participants' physiological indicators during the course of experiments and found that these indicators were significantly influenced by stimulus during the experiment. Consequently, based on previous researches and measurement of physical parameters, further studies can explore the changes of brain activity as well as cognitive processing when exposure to nature environment through neuroimaging and eye movement techniques. This can help us deeply investigate how the positive influence of natural environment produced and changed.

Although theories concerning the beneficial influence of nature environment is on the basis of theory of human evolution and intimacy with nature, there is no research has investigated the influence of long-term exposure to nature environment on person's psychological and physiological state. It is also significant to explore the long-lasting influence of natural environment. In this study, participants were required to contact with natural pictures within a limited time, however, problems such as whether the positive influence can last for a long time or there will be different influence still remain to be solved. Thus, in addition to measure the immediate influence of natural environment, future studies can also focus more attention on the long-term effects of interacting with natural environment using longitudinal study (Bowler et al. 2010).

In addition, this study manipulates the effects of nature and downtown environments through requiring participants to view images depicted nature and downtown scenes. Compared with some field experiments that directly expose participants to nature or downtown settings, this study design can effectively control other confounding variables. For example, uncontrollable factors such as the duration of exposure to environments, the weather at the time and some unrelated physical activities (walking) appeared in the experiments can influence the results if organizing participating to directly contact with environment. However, there are differences between interacting with natural pictures and being in a real natural environment, especially the lack of olfactory stimuli, which may influence participants' physiological changes during the study. Therefore, it is for future study to investigate the differences of natural impact under the condition of realistic nature setting and manipulated virtual nature setting. Specifically, from the perspective of physiology, it is worth researching how the neural activities change differently under these two conditions using neuroimaging techniques.

Nowadays, the majority of empirical research tend to focus on restorative influence of natural environment on attention and emotion, whereas limited research tried to investigate other factors that may be also influenced by natural environment. In the study of Weinstein et al. (2009), they used 4 experiments to compare the influence of exposure natural pictures, real plants and built environment on motivation (internal and external motivation) and prosocial behaviors. Results suggested that interacting with natural environment can improve participants' internal motivation and prosocial behaviors, whereas external motivation decreased after exposure to natural environment. However, built environment tend to produce adverse influence. Additionally, another study (Mayer et al, 2009) suggested that contacting with natural environment or viewing natural films can improve participants' reflective ability in life issues. A study carried out by Zelenski et al. (2015) found that watching films about natural environment can also promote participants' cooperative behavior. Therefore, it can be predicted that contacting with natural environment can have many other positive influences on psychological function. Future study can pay attention on whether contacting with nature can influence participants' other characteristics such as gratitude, forgiveness, responsiveness, creativity and self-control.

#### *4.3. Implications for Practice*

This study provides empirical evidence for the restorative benefits of viewing pictures depicted natural environment. Students' attention, divergent thinking as well as emotion can benefits from freely viewing natural pictures, which will have significant implications for our daily life.

Students nowadays, especially for college students, always spent long time studying in school or library. After studying for a long time, the majority of them tend to have a rest through electronic devices such as computers and mobile phones. However, this study suggested that viewing natural pictures can serve as an effective way for them to recovery from mental fatigue. Therefore, students can fully make use of natural pictures in their rooms. For example, they can hang natural pictures on the wall in their bedrooms and set as images of desktop in computer or mobile phone. Additionally, according to the ART, it is also beneficial for students to spend more time contacting with natural environment. For instance, they can choose to walk in a park after school in order to replenish their attention. Natural environment can also be considered as a place to regulate and change their emotion when they feel anxiety or depressed.

These findings are also important for universities. It encourages them to create restorative environment for students. In university campus, there could be more natural landscapes such as grasslands and trees. Providing students and university staff with natural environment can refresh their mood and begin to work or study with a better psychological and physiological condition. Additionally, schools can encourage students to contact with natural environment in spare time in order to take a break.

## 5. *Conclusion*

In conclusion and in support of Attention Restoration Theory (ART) as well as Stress Reduction Theory (SRT), the present study indicated that viewing natural pictures can significantly improve performance on the test of focused attention, divergent thinking and positive emotion, as well as significant decrease scores of negative emotions. However, no significant differences were found after viewing pictures depicted downtown environment in performances of all measures. In addition to demonstrate the existence of effects from nature experience and provide strong evidences for the restorative experience occurred from interacting with natural experience. This study used an innovative way to contact with pictures, that is, allowing participants to watch pictures freely instead of watching them in a restricted way. This created a relatively more relaxed atmosphere for participants to feel more similar to contacting with natural environment in their real life. This study is of significant for both students and universities and seeks to provide guidance into the ways of replenishing their cognitive abilities including focused attention and creative thinking. Moreover, natural environments can be proved to be an important part in universities' campus to provide students with a restorative environment to study with a more refreshing emotional state, in order to maximize their academic performance.

Moving forward, it is necessary for future studies to focus on investigating the long-term restorative benefits of natural environment in terms of cognitive abilities and emotional state. In addition, as for the experiment design concerning restorative influence, future study can try to design it in a stricter way such setting a control group, inducing participants' mental fatigue to the same levels and making a uniform criteria of picture selection. Furthermore, individual diversities such as personality traits are likely to affect study results. It is also significant to examine whether individual factors can mediate and regulate the restorative influence of natural environment. Another important aspect need to be further investigated is whether contacting with nature can influence participants' other characteristics such as gratitude, forgiveness, responsiveness, creativity and self-control, which can help to extend the beneficial impacts of natural environments.

## 6. Appendices

### Appendix A

#### **The digit-span backward task instructions**

In this task, you will hear a sequence of digits. The start and the end of the digit sequence are announced by a red circle that appears in the center of the screen. Immediately after the second red circle disappears, a response console is provided.

Enter the digits in the reversed order.

Example: if the sequence '7 4 5 1' was presented, enter '1 5 4 7'.

### Appendix B

#### **An example of alternative use task**

Alternative Uses Task (J.P. Guilford, 1967) version A

You can see a common house hold item below, please think of as many possible uses for the item.

Example: name all the uses for a **brick**:

1. A paperweight
2. A doorstep
3. A mock coffin at a Barbie funeral
4. To throw through a window
5. To use as a weapon
6. To hit my sister on the head with

name all the uses for a **paperclip**:

## Appendix C

**PANAS Questionnaire**

The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. **Indicate to what extent you feel this way right now, that is, at the present moment *OR* indicate the extent you have felt this way over the past week.**

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

1. Interested		11. Irritable	
2. Distressed		12. Alert	
3. Excited		13. Ashamed	
4. Upset		14. Inspired	
5. Strong		15. Nervous	
6. Guilty		16. Determine	
7. Scared		17. Attentive	
8. Hostile		18. Jittery	
9. Enthusiastic		19. Active	
10. Proud		20. Afraid	

## 7. References

- Ackerman, D. (1991). *A natural history of the senses*. New York: Vintage.
- Ashby, F.G., Isen, A.M., Turken, U., (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review* 106 (3), 529.
- Barbara A. Kerr, Maxwell Birdnow, Jenelle Hallaert, Keely Alexander, Robyn Malmsten, Olivia Stull, J. D. Wright, Brittany Lucas, Rachel Swanson & Grace J. Claiborn (2017). Creativity and innovation in Iceland: Individual, environmental, and cultural variables, *Gifted and Talented International*, 32:1, 27-43, DOI: 10.1080/15332276.2017.1397903
- Barron, F. (1969). *Creative person and creative process*. New York: Holt, Rinehart & Winston.
- Benfield, J. A., Rainbolt, G. N., Bell, P. A., & Donovan, G. H. (2015). Classrooms with nature views: Evidence of differing student perceptions and behaviors. *Environment and Behavior*, 47(2), 140–157.
- Berman, M., Jonides, J., & Kaplan, S. (2008). The Cognitive Benefits of Interacting With Nature. *Psychological Science*, 19(12), 1207-1212. doi:10.1111/j.1467 9280.2008.02225.x
- Berman, M., Kross, E., Krpan, K., Askren, M., Burson, A., & Deldin, P. et al. (2012). Interacting with nature improves cognition and affect for individuals with depression. *Journal Of Affective Disorders*, 140(3), 300-305. doi: 10.1016/j.jad.2012.03.012
- Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal Of Environmental Psychology*, 25(3), 249-259. doi: 10.1016/j.jenvp.2005.07.001
- Berto, R. (2007). Assessing the restorative value of the environment: A study on the elderly in comparison with young adults and adolescents. *International Journal of Psychology*, 42(5), 331–341.
- Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, 10(1), 456.
- Bratman, G., Daily, G., Levy, B., & Gross, J. (2015). The benefits of nature experience: Improved affect and cognition. *Landscape And Urban Planning*, 138, 41-50. doi: 10.1016/j.landurbplan.2015.02.005
- Brymer, E., Cuddihy, T. F., & Sharma-Brymer, V. (2010). The role of nature-based experiences in the development and maintenance of wellness. *Asia-Pacific Journal of Health, Sport and Physical Education*, 1(2), 21–27.
- Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences*, 24, 87–114.
- Crawford, John R.; Henry, Julie D. "The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample". *British Journal of Clinical Psychology*. 43(3): 245–265. doi:10.1348/0144665031752934.
- Dodrill, C. B. (1978). A neuropsychological battery for epilepsy. *Epilepsia*, 19, 611-623.
- Faber Taylor, A., & Kuo, F. (2009). Children With Attention Deficits Concentrate Better After Walk in the Park. *Journal Of Attention Disorders*, 12(5), 402-409. doi: 10.1177/1087054708323000
- Fan, J., McCandliss, B.D., Fossella, J., Flombaum, J.I., & Posner, M.I. (2005). *The activation of attentional networks*. *NeuroImage*, 26, 471–479.

- Fredrickson, B.L., (2001). The role of positive emotions in positive psychology — the broaden-and-build theory of positive emotions. *American Psychologist* 56 (3), 218.
- Gidlow, C., Jones, M., Hurst, G., Masterson, D., Clark-Carter, D., & Tarvainen, M. et al. (2016). Where to put your best foot forward: Psycho-physiological responses to walking in natural and urban environments. *Journal Of Environmental Psychology*, 45, 22-29. doi: 10.1016/j.jenvp.2015.11.003
- Gladwell, V., Brown, D., Barton, J., Tarvainen, M., Kuoppa, P., & Pretty, J. et al. (2012). The effects of views of nature on autonomic control. *European Journal Of Applied Physiology*, 112(9), 3379-3386. doi: 10.1007/s00421-012-2318-8
- Gordon, M., McClure, D. F., & Aylward, G. P. (1996). *The Gordon Diagnostic System: Interpretive guide*. DeWitt, NY: GSI Publications.
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, 85(2), 348–362.
- Guilford, J. P. (1967). Creativity: Yesterday, today, and tomorrow. *Journal of Creative Behavior*, 1, 3–14. doi:10.1002/j.2162-6057.1967.tb00002.x
- Hartig, T., Evans, G., Jamner, L., Davis, D., & Gärling, T. (2003). Tracking restoration in natural and urban field settings. *Journal Of Environmental Psychology*, 23(2), 109-123. doi: 10.1016/s0272-4944(02)00109-3
- Hartig, T., Mang, M., & Evans, G. (1991). Restorative Effects of Natural Environment Experiences. *Environment And Behavior*, 23(1), 3-26. doi: 10.1177/0013916591231001
- Hernández, B., Hidalgo, M. C., & Ruiz, C. (2013). Theoretical and methodological aspects of research on place attachment. In L.C. Manzo & P. Devine-Wright (Eds.), *Place attachment: Advances in theory, methods and applications* (pp. 125–137). New York, NY, USA: Routledge.
- James, W. (1892). *Psychology: The briefer course*. New York: Holt.
- Jonides, J., Lewis, R.L., Nee, D.E., Lustig, C.A., Berman, M.G., & Moore, K.S. (2008). The mind and brain of short-term memory. *Annual Review of Psychology*, 59, 193–224.
- Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge: Cambridge University Press.
- Kaplan, S. & Talbot, J. F. (1983). Psychological benefits of a wilderness experience. In I. Altman & J. F. Wohlwill (Eds), *Human behavior and environment: Advances in theory and research: Vol. 6: Behavior and the natural environment* (pp. 163–203). New York: Plenum Press.
- Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, 15 (3), pp. 169–182.
- Kaplan, S. Brdwell, L. V. & Sakter, D. B. (1993). The museum as a restorative environment. *Environment and Behavior*, 26(6), 725–742.
- Korpela, K. M., Hartig, T., Kaiser, F. G., & Fuhrer, U. (2001). Restorative experience and self-regulation in favorite places. *Environment and Behavior*, 33(4), 572–589.
- Korpela, K. M., Yle n, M., Tyrväinen, L., & Silvennoinen, H. (2008). Determinants of restorative experiences in everyday favorite places. *Health & Place*, 14(4), 636–652.

- Lachowycz, K., & Jones, A. P. (2011). Greenspace and obesity: A systematic review of the evidence. *Obesity Reviews*, *12*(5), e183–e189.
- Laumann, K., Gärling, T., & Stormark, K. (2003). Selective attention and heart rate responses to natural and urban environments. *Journal Of Environmental Psychology*, *23*(2), 125-134. doi: 10.1016/s0272-4944(02)00110-x
- Lottrup, L., Grahn, P., & Stigsdotter, U. K. (2013). Workplace greenery and perceived level of stress: Benefits of access to a green outdoor environment at the workplace. *Landscape and Urban Planning*, *110*, 5–11.
- Mackay, G. J., & Neill, J. T. (2010). The effect of “green exercise” on state anxiety and the role of exercise duration, intensity, and greenness: A quasi-experimental study. *Psychology of Sport and Exercise*, *11*(3), 238–245.
- MacKinnon, D. (1962). The nature and nurture of creative talent. *American Psychologist*, *17*, 484–495.
- Maller, C. (2009). Promoting children's mental, emotional and social health through contact with nature: a model. *Health Education*, *109*(6), 522-543. doi: 10.1108/09654280911001185
- Martyn, P., & Brymer, E. (2014). The relationship between nature relatedness and anxiety. *Journal Of Health Psychology*, *21*(7), 1436-1445. doi: 10.1177/1359105314555169
- Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why is nature beneficial? The role of connectedness to nature. *Environment and Behavior*, *41*(5), 607–643.
- McCoy, J., & Evans, G. (2002). The Potential Role of the Physical Environment in Fostering Creativity. *Creativity Research Journal*, *14*(3-4), 409-426. doi: 10.1207/s15326934crj1434\_11
- McMahan, E. A., & Estes, D. (2015). The effect of contact with natural environments on positive and negative affect: A meta-analysis. *The Journal of Positive Psychology*, 1–13 (Epub ahead-of-print)
- Oaksford, M., Morris, F., Grainger, B., Williams, J.M.G., (1996). Mood, reasoning, and central executive processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition* *22* (2), 476.
- Oppezzo, M., & Schwartz, D. (2014). Give your ideas some legs: The positive effect of walking on creative thinking. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *40*(4), 1142-1152. <http://dx.doi.org/10.1037/a0036577>
- Ouellette, P., Kaplan, R. & Kaplan, S. (2005). The monastery as a restorative environment. *Journal of Environmental Psychology*, *25*(2), 175–188.
- Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): Evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine*, *15*(1), 18–26.
- Phillips, L.H., Bull, R., Adams, E., Fraser, L., (2002). Positive mood and executive function: evidence from Stroop and fluency tasks. *Emotion* (Washington, D.C.) *2* (1), 12–22.
- Pribadi, A. (2018). Improving science learning achievement and creativity through surrounding natural environment approach. *Jurnal Prima Edukasia*, *6*(1), 56. doi: 10.21831/jpe.v6i1.14279
- Reese, R. F., & Myers, J. E. (2012). EcoWellness: The missing factor in holistic wellness models. *Journal of Counseling & Development*, *90*(4), 400–406.

- Rose, K. A., Morgan, I. G., Ip, J., Kifley, A., Huynh, S., Smith, W., & Mitchell, P. (2008). Outdoor activity reduces the prevalence of myopia in children. *Ophthalmology*, *115*(8), 1279–1285.
- Ryan, R. M., Weinstein, N., Bernstein, J., Brown, K. W., Mistretta, L., & Gagné, M. (2010). Vitalizing effects of being outdoors and in nature. *Journal of Environmental Psychology*, *30*(2), 159–168.
- Scopelliti, M. & Giuliani, M.V. (2004). Choosing restorative environments across the life span: A matter of place experience. *Journal of Environmental Psychology*, *24*(4), 423–437.
- Smith, A. (1968). The Symbol Digit Modalities Test: A neuropsychologic test for economic screening of learning and other cerebral disorders. *Learning Disorders*, *3*, 83-91.
- Sternberg, R. J., & Lubart, T. I. (1999). The concept of creativity: prospects and paradigms. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 3–15). Cambridge: Cambridge University Press.
- Tennessen, C. M., & Cimprich, B. (1995). Views to nature: Effects on attention. *Journal of Environmental Psychology*, *15*(1), 77–85.
- Ulrich, R. (1984). View through a window may influence recovery from surgery. *Science*, *224*(4647), 420-421. doi: 10.1126/science.6143402
- Ulrich, R. S. (1993). Biophilia, Biophobia and Natural Landscapes. In S. R. Kellert & E. O. Wilson (Eds), *The Biophilia Hypothesis* (pp. 73-137). Washington, DC: Island Press.
- Ulrich, R. S., Simons, R. F., Losito, B. D., Fiority, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*(3), 201-230. DOI: 10.1016/S0272-4944(05)80184-7
- Wakefield, S., Yeudall, F., Taron, C., Reynolds, J., & Skinner, A. (2007). Growing urban health: Community gardening in south-east Toronto. *Health Promotion International*, *22*(2), 92–101.
- Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063–1070.
- Wechsler, D. (1955). *Manual for the Wechsler Adult Intelligence Scale*. New York, NY: The Psychological Corporation.
- Weinstein, N., Przybylski, A. K., & Ryan, R. M. (2009). Can nature make us more caring? Effects of immersion in nature on intrinsic aspirations and generosity. *Personality and Social Psychology Bulletin*, *35*(10), 1315–1329.
- Zelenski, J. M., Dopko, R. L., & Capaldi, C. A. (2015). Cooperation is in our nature: Nature exposure may promote cooperative and environmentally sustainable behavior. *Journal of Environmental Psychology*, *42*, 24–31.