# The effects of nature on creative performance

Measuring the effects of fascinating nature and nature sound on creative performance

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# Abstract

In recent years, studies have found that nature can have positive effects on performance in attention demanding tasks. Several studies suggest that nature can also positively affect creative performance. This remains a relatively unexplored area, however. This study intended to further explore the effects of nature on creative performance, focusing on fascinating nature, as described in Attention Restoration Theory (Kaplan, 1995), and nature sound. To that end, an experiment was conducted in which creative performance of participants was measured using verbal creativity tasks after the participants were exposed to nature video and/or nature sound. Participants also filled out a questionnaire concerning experienced fascination and experienced creativity. In this study, highly fascinating nature and nature sound did not improve creative performance. Nature low on fascination, however, decreased creative performance. While the current study did not find positive effects of nature on creative performance, it does add to the available research in this area in several ways.

# Introduction

Professional environments often have plants and flowers. Walls are often decorated with paintings or pictures of landscapes. People who work in these environments will most likely agree that these displays of nature are pleasant to look at, but many might not be aware of the benefits nature is bringing them. In the past few decades, the effects of nature have been widely studied. In recent years, many studies have been able to discover and confirm positive effects of natural stimuli. For example, J. Lee, Park, Tsunetsugu, Kagawa, and Miyazaki (2009) found support for the idea that forest landscapes reduce stress and increase positive emotion. Hartig, Evans, Jamner, Davis, and Gärling (2003) found that natural settings foster restoration.

## Immersion in nature

If you're stuck in an office next to a highway or in a city center, you'll have a hard time taking a walk in the park. Research has found, though, that it's not necessary for people to be immersed in nature to benefit from its effects. For example, R. Kaplan (1993) shows in two studies that a window view on an environment with natural elements positively affects job satisfaction. A study by Chang and Chen (2005) describes how a window view on nature can reduce anxiety in the workplace. The same study also focuses on the presence of indoor plants and shows that they can reduce anxiety in the workplace, as well. Raanaas, Evensen, Rich, Sjøstrøm, and Patil (2011) have also studied the benefits of indoor plants, with their research indicating that the presence of plants improved participants' performance. Nieuwenhuis, Knight, Postmes, and Haslam (2014) found that employees in offices enriched with plants were more positive about their work and were more productive than in offices without plants. Participants in a study by K. E. Lee, Williams, Sargent, Williams, and Johnson (2015) made fewer errors and showed more consistent responding on a task when they viewed a green (i.e. containing plants) roof in a city environment, compared to those who viewed a concrete roof in the same environment.

**Imitations and representations of nature**

Window views on nature and the presence of plants are not always possible or practical in professional environments. Indoor plants have to be taken care of regularly, or have to be replaced eventually, resulting in recurring costs and effort. If your office building is nowhere near nature, you can't have a window view on a natural setting. Studies have shown, though, that imitations or representations of nature can also have positive effects. For example, photographs (Berman, Jonides, & Kaplan, 2008), videos (de Kort, Meijnders, Sponselee, & Ijsselsteijn, 2006; Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2008) and murals (Felsten, 2009) have been found to have positive effects. Such representations of nature provide opportunities to benefit from nature's effects when nature is unavailable (Felsten, 2009).

**Nature sound**

The effects of nature sounds (as opposed to visual stimuli) have also been explored recently. Alvarsson, Wiens, and Nilsson (2010) found in their research that nature sounds helped facilitate recovery from stress. Ratcliffe, Gatersleben, and Sowden (2013) found that certain bird sounds provided 'welcome distractions that effortlessly removed participants from cognitive or affective demands'. Payne (2013) concluded that a rural soundscape was higher in restorative potential than an urban soundscape. These studies show that the effects of nature are not limited to visual stimuli. However, a study by Jahncke, Hygge, Halin, Green, and Dimberg (2011) suggests that a combination of visual and auditory stimuli works better than either of them separately. Jahncke, Eriksson, and Naula (2015) add to this that the visual and auditory stimuli have to match. They found that nature sounds supported restoration when participants looked at an urban nature picture, while office noise and broadband noise (ventilation, traffic noise, etc.) did not. Their findings underline the significance of environmental sound for a restorative experience.

## Theoretical explanations for nature's effects

Explanations for the positive effects of natural stimuli can be found in two theories. One of these theories is the stress recovery theory (Ulrich, 1979; Ulrich et al., 1991). According to this theory, nature is restorative, because it triggers a positive affect (Joye, Pals, Steg, & Evans, 2013), which results in a more positive emotional state (Ulrich et al., 1991). Another theory is the Attention Restoration Theory (ART) (S. Kaplan, 1993; Kaplan, 1995). In contrast to Ulrich's stress recovery theory, ART focuses on the cognitive effects of nature, mainly in the area of attention restoration. According to ART, the kind of attention required for work is directed attention, which eventually becomes depleted after sustained periods of focus (R. Kaplan, 1993). The depletion of directed attention can lead to mental fatigue. Or, in the words of Kaplan: mental fatigue is the consequence of sustained mental effort that requires focus and directed attention. According to Kaplan, this mental fatigue may lead to making errors and mistakes, but also being irritable and irresponsible. To restore from mental fatigue, ART suggests that directed attention mechanisms need to rest. This can be achieved by an involuntary kind of attention, so that directed attention is unnecessary (Kaplan, 1995).

ART is the theory that, in recent years, has become the most common theory to explain the positive effects of nature (Joye et al., 2013). Therefore, this study is based on the concepts described by it. The theory is based on work by James (1984), who described that attention can be separated into two components: involuntary attention, where attention is grabbed by intriguing or important stimuli, and voluntary attention, where attention is directed by the cognitive-control processes (Berman et al., 2008). Voluntary attention is the kind of attention required when working intensely on a project. Involuntary attention is the kind of attention you pay to something that grabs your attention in a bottom-up fashion (the sound of a car's horn, for example). In ART, the terms 'voluntary attention' and 'involuntary attention' have been replaced by 'directed attention' and 'fascination', as people seem to have found James' terminology confusing (Kaplan, 1995). Kaplan describes how fascination can be divided into hard fascinations and soft fascinations. Hard fascinations are activities such as watching a car race or a violent movie. Soft fascinations can be characteristics of certain natural settings, such as clouds, or leaves moving in the wind, but also an interesting painting. According to S. Kaplan (1993), soft fascinations may have an advantage in helping one recover from directed attention fatigue, because they do not distract and attention is effortless. In other words, soft fascinations allow for reflection, while hard fascinations do not, thus making soft fascinations more restorative (Kaplan & Berman, 2010).

Besides fascination, there are three more aspects in ART that are suggested to help restore from mental fatigue. Those three components are: being away, extent and compatibility (Kaplan, 1995). Being away is the idea that one is freed from the activity that requires directed attention. It does not mean that one has to physically be away. As Kaplan (1995) puts it: struggling with the old thoughts in a new setting does not help. Extent means that the environment must be rich and coherent enough to constitute another world. To be restorative, an environment must also be compatible with one's purposes and inclinations. Nature conveniently fulfils all four requirements: there are many (soft) fascinating stimuli, it offers extent, it can create the feeling of being away (physically and mentally), and it is often compatible with the reasons people visit nature (Herzog, Black, Fountaine, & Knotts, 1997). However, a study by Szolosi, Watson, and Ruddell (2014) found that performance on a recognition memory task improved mostly through the perception of fascination. This finding suggests that fascination plays a crucial role in nature's restorative effects and the other three ART components are not of the highest necessity for restoration to take place.

**Nature and creative performance**

Studies in the context of ART have mainly focused on the performance of participants on attention demanding tasks (Keniger, Gaston, Irvine, & Fuller, 2013). Surprisingly, a relatively unexplored area concerns the effects of nature on creative performance, a kind of performance required in many professional environments and recently suggested as a topic for further research into the effects of nature (K. E. Lee et al., 2015; Nieuwenhuis et al., 2014; Plambech & Konijnendijk van den Bosch, 2015). It's not unreasonable to assume that nature can positively affect creative performance. Consider divergent thinking, a common type of creative performance where one comes up with as many creative ideas and as many possible solutions. Divergent thinking requires spontaneity, creativity and flexibility (Horne, 1988). Horne's study suggests that divergent thinking is negatively affected by short-term sleep loss. A study by Harrison and Horne (1999) found that decision-making requiring innovation and flexibility is impaired by sleep deprivation. Arguably then, in order to perform creatively it is not helpful to be mentally fatigued. According to ART, nature helps to restore from mental fatigue and thus might help increase creative performance. Plambech and Konijnendijk van den Bosch (2015) support this idea, stating that "nature also helps us to recharge our directed-attention which is needed when analyzing and further developing ideas." Apart from restoration from mental fatigue, nature helps people 'open up' to creativity and it seems to be beneficial to have access to natural environments to support creative processes (Plambech & Konijnendijk van den Bosch, 2015). Several studies suggest that, indeed, nature can positively affect creative performance. A study by Atchley, Strayer, and Atchley (2012) showed that participants' creative reasoning performance increased after several days of immersion in nature. Shibata and Suzuki (2004) found that female participants performed significantly better on a creative task in view of a plant instead of a magazine rack. Shibata and Suzuki (2002) found that a leafy plant in the experiment room had a positive effect on the performance of males in a creative association task. Considering the outcomes of these studies, the effects of nature described by ART might not be limited to just improved performance on attention demanding tasks.

**Aim of this study**

The aim of the current study is to further expand on the limited amount of research available about the effects of nature on creative performance. In this study it is tested whether fascinating nature video and nature sound improve creative performance. The study also tests whether a combination of fascinating nature video and nature sound is more effective at improving creative performance than either of them separately. The following is proposed:

H1: Nature video high on fascination improves creative performance.

H2: Nature video low on fascination does not improve creative performance.

H3: Creative performance is better with a nature video high on fascination than with a nature video low on fascination.

H4: Nature sound improves creative performance.

H5: Nature video high on fascination including nature sound improves creative performance more than video and sound separately.

# Method

## Stimuli

In order to select the stimuli for this study, a pre-test was conducted. The stimuli in this study were sixteen videos high or low in fascination, with nature sound or without nature sound. All videos showed variations of shadows from the sun shining through a tree. Half of the videos were manipulated to become low in fascination. These videos were made to stutter heavily, or were sped up / slowed down to make movements seem unnatural. Ten respondents were asked to rate sixteen videos on a 5-point (1=”completely disagree” and 5=”completely agree”) fascination scale. Example items were ‘What I saw fascinated me’ and ‘What I saw kept my attention’. The scale proved reliable for the purpose of selecting the stimuli (see Table 1). Based on the results of the pretest (see Table 1), two videos were selected: one low in fascination and one high in fascination. Nature sound was added at a later stage and was chosen to match both videos. The sound consisted of chirping birds and rustling leaves.

*Table 1.* Mean values of fascination for nature videos

| Video | Type | *M* | *SD* | *α* |
|---|---|---|---|---|
| 1 | High fascination | 3.10 | .77 | .90 |
| 2 | High fascination | 3.28 | .73 | .90 |
| 3 | Low fascination | 3.08 | .80 | .91 |
| 4 | Low fascination | 2.93 | .97 | .96 |
| 5 | High fascination | 3.18 | .90 | .91 |
| 6 | High fascination | 2.88 | .97 | .96 |
| 7 | Low fascination | 3.20 | .73 | .86 |
| 8 | Low fascination | 2.68 | 1.09 | .95 |
| 9 | High fascination | 3.18 | .80 | .91 |
| 10 | High fascination | 3.30 | .90 | .93 |
| 11 | Low fascination | 3.05 | .61 | .75 |
| 12 | Low fascination | 3.05 | .90 | .96 |
| 13 | High fascination | 3.00 | .82 | .88 |
| 14 | High fascination | 2.63 | .83 | .92 |
| 15 | Low fascination | 3.03 | 1.02 | .96 |
| 16 | Low fascination | 2.55 | .98 | .96 |

**Participants and design**

To test the hypotheses, a 3 (high fascination video vs low fascination video vs no video) X 2 (nature sound vs no sound) between subjects design was used to test whether the factors fascination and nature sound affected creative performance. In total, 133 subjects (65 male, 68 female) participated in the experiment. The group of participants consisted of students and employees from a university and participated separately throughout a period of approximately two months. The average age of the group was 25.1 years (*SD* = 8.71). Participants were randomly assigned to one of the six conditions.

Due to practical issues, it was not possible for all participants to take part in the experiment in the same room. Therefore, it was necessary to use several different rooms for the experiment. To take possible effects of the use of different rooms into account, it was included in the dataset to be able to perform additional analyses.

**Procedure**

Participants were welcomed in a room furnished with a chair and a desk with a computer. They were asked to take a seat at the desk and make themselves comfortable. Participants were then instructed that they would, depending on the condition they were in, watch a video or listen to a sound, perform a few tasks, and answer a few questions, including a few questions about themselves. They were told that the time available for each task was a few minutes and that the tasks would advance automatically; they could not manually advance the tasks. Furthermore, participants were asked to read the instructions carefully – everything would be explained to them – and that they could call the researcher if they had any questions or wanted to quit. The researcher was located in a room next to the participants' room. Before participants began with the experiment, they had to sign an informed consent form. After participants were fully instructed and had signed the consent form, they were asked to start with the experiment.

In an attempt to maximize the effect of the videos and sound, participants watched or heard the same video or sound two times: once before the first two tasks (of four in total) and once before the last two tasks. To ensure that participants could not skip through the experiment, strategic waiting times were implemented. For example, participants had to wait at least the length of the videos (30 seconds) before they would be able to click the 'Next' button. Participants could not manually advance the tasks.

*Creative performance*

To measure creative performance, four verbal divergent thinking tasks were used. In such tasks, participants have to come up with as many creative and unusual answers they can. The tasks in this study were based on the widely used creativity tests developed by Wallach and Kogan (1965). The tasks were chosen for this research, because they are well tested and anyone can administer them: no special materials or training are required. The Wallach and Kogan tasks are usually administered with pen and paper, but in this study they were administered electronically. Electronic administration of the tasks has been found to not negatively affect the reliability and outcomes of such tasks (Hass, 2015; Lau & Cheung, 2010). The specific tasks used in this study were two *alternative uses tasks* and two *instances tasks*. In the alternative uses tasks in this study, participants had to think of alternative uses for everyday objects. For example, they were asked “Wat can you do with a brick? Think of as many creative and unusual answers you can.” Participants would then enter any answer they could think of. For the instances tasks in this study, participants were asked to name as many instances of something. For example, they were asked “What has legs? Think of as many creative and unusual answers you can.” The subjects of the tasks were chosen to not be single-purposed or too specific, so that creative performance would not be limited by the subjects of the tasks. See Table 2 for a full overview of the tasks.

*Table 2.* Verbal divergent thinking tasks used in this study.

| Type of task | Question |
|---|---|
| Alternative uses | What can you do with a brick? |
| Alternative uses | What can you do with a glass bottle? |
| Instances | What can make a loud noise? |
| Instances | What has legs? |

As suggested by Silvia et al. (2008), participants were instructed to 'think of as many creative and unusual answers' to enhance the validity of divergent thinking scores. Available time for each task was set to three minutes, as recommended by Benedek, Mühlmann, Jauk, and Neubauer (2013). Participants could not see how much time was left for a task. After all tasks were completed, participants had to pick their two most creative answers for each task separately. The answers they could choose from, were the answers they had given for each specific task. If only one answer was given, participants only had to select one answer. If no answers were given for a task, the answer picking was skipped for that specific task.

*Reported fascination*

Participants who saw a video were presented with a scale for measuring fascination in the video after they had completed the tasks. The scale was inspired by the Perceived Restorativeness Scale developed by Hartig, Korpela, Evans, and Gärling (1997) and consisted of four items. Example items are "What I saw has fascinating properties" and "What I saw kept my attention". Participants recorded their responses on a 5-point Likert scale (1="completely disagree" and 5="completely agree"). Cronbach's alpha was calculated to assess the reliability of the scale. The reliability of the scale was good ($\alpha$ = .72).

*Reported creativity*

To measure how creative participants felt, a self-report measure was included. Participants again recorded their responses on a 5-point Likert scale (1="completely disagree" and 5="completely agree"). The scale consisted of the items "I felt inspired," "I felt creative," and the reverse-coded item "I had a hard time coming up with answers". Cronbach's alpha was calculated to assess the reliability of the scale. The reliability of the scale was good ($\alpha$ = .64).

*Personal details*

To conclude, participants were asked to enter a few demographic questions. These consisted of gender, age and nationality. Participants were then thanked for completing the experiment and were instructed to call for the researcher.

*Data preparation and scoring the answers*

The scoring method (top 2 scoring) used in this study is a subjective scoring method for divergent thinking tasks, first proposed by Silvia et al. (2008) and found to outperform other scoring methods (Benedek et al., 2013). In top 2 scoring, participants pick the two most creative answers, according to them, for each task. These answers then receive a creativity score, based on scores given to the answers by several raters. Objective scoring methods for divergent thinking tasks often cause problems, because fluency (total number of answers) influences uniqueness scores (total number of unique answers) (Runco & Acar, 2012). A higher number of answers usually means that the chance of unique answers occurring increases. The top 2 scoring approach prevents the influence of fluency, because the score is not influenced by how unique the answer is in the total set of answers. The top 2 scoring method also does not penalize participants for giving many uncreative answers. A participant with 5 creative answers and 1 uncreative answers will not score significantly higher than a participant with just 2 creative answers and 6 uncreative answers. In short, the top 2 scoring method focuses more on the quality of the creative answers than on the quantity of creative answers (Silvia et al., 2008).

To prepare the data for scoring, all answers chosen by the participants were entered in a separate spreadsheet for each task. The answers were sorted alphabetically and duplicates were removed. For example, “build a house” and “build a house with it” would be reduced to “build a house”. Also, answers which were very much alike, were reduced to one entry. For example, “make music with it” and “use it as a musical instrument” were considered the same answers. Spelling errors were corrected, unless they were made intentionally for the purpose of the answer (for a play on words, for example). A final list of answers per task was prepared for the rating process. For privacy purposes, it was made sure that raters could not track back the answers to specific participants.

Three raters scored each answer for creativity (1=”not at all creative” and 5=”very creative”), keeping the tasks in mind. Raters scored the answers separately from other raters. They were told that participants in an experiment had given answers to several questions and that the they would rate these answers for creativity. The rating scale was explained and raters were instructed to include two aspects in their evaluation of the answers: remoteness and cleverness. These aspects are based on recommendations by Silvia et al. (2008). Remoteness describes how remotely linked an answer is to the subject of the question. Creative answers are more likely to be remotely linked than uncreative answers. This way, obvious ideas would be considered less creative. Raters were made aware that scoring high on remoteness does not necessarily mean that an answer is creative. An answer could be so random that a low score was more appropriate. Cleverness describes how answers can be creative because of their insightfulness and irony, or how humorous, fitting and smart they are. Raters were told that cleverness could compensate for other aspects, such as how obvious an answer was. For example, an obvious use for a brick, cleverly worded, could still be considered creative. Finally, raters were asked to first read all the answers for a task before starting the scoring procedure, so that they would get a general idea of the available answers. This was done to help the raters decide on a scoring strategy.

The interrater reliability was measured for each task using intraclass correlation (ICC). The ICC values were .58, .73, .32 and .73 for the “brick”, “glass bottle”, “loud noise” and “legs” tasks, respectively. Using Cicchetti (1994)’s guidelines for interpretation of these values, it was concluded that the interrater reliability for the “loud noise” task was poor and the task could therefore not be used in the analysis of the data. The ICC value for the “brick” task was adequate and the ICC values for the “glass bottle” and “legs” tasks were good. Therefore, these remaining tasks were used in the analysis. Creativity scores were then averaged over these tasks, resulting in an overall creativity score for each participant.

## Results

To test for effects of the different experiment rooms, a univariate analysis of variance was performed with the creativity score as the dependent variable and the experiment room as the independent variable. No significant effect of the experiment rooms was found, $F(3, 95) = .19$, $p > .05$, and it was therefore not included in the following analyses.

To make sure the videos were experienced as intended, the means for reported fascination were compared between the low and high fascination conditions. An independent sample t-test was performed to test the significance of the differences between the two conditions. The test was marginally significant, $t(87) = -1.95$, $p < 0.10$, with reported fascination being higher in the high fascination condition ($M = 2.72$, $SD = .81$) than in the low fascination condition ($M = 2.39$, $SD = .76$). This confirms that the participants in the low and high fascination conditions indeed experienced low and high fascination as intended.

### Creative performance

A 2 (nature sound vs no sound) x 3 (low fascination video vs high fascination video vs no video) univariate analysis of variance was performed with creativity score as the dependent variable to measure the effects of nature sound and fascination on creative performance.

A significant main effect on the creativity score was found for fascination, $F(2, 127) = .59$, $p < .05$. To further investigate this effect, a one-way analysis of variance was performed with the creativity score as the dependent variable and fascination as the independent variable. Post hoc comparisons using a Bonferroni correction showed that creativity scores were marginally significantly lower for participants who watched a low fascination video compared to those who watched no video ($M = 2.45$, $SD = .44$ versus $M = 2.66$, $SD = .41$, $p < .10$).

No significant difference in creativity scores was found between participants who watched a high fascination video and those who watched no video (*M* = 2.64, *SD* = .39 versus *M* = 2.66, *SD* = .41, $p > .05$). Creativity scores were marginally significantly higher for participants who watched the high fascination video, compared to those who watched the low fascination video (*M* = 2.64, *SD* = .39 versus *M* = 2.45, *SD* = .44, $p < 0.10$).

The results indicate that high fascination did not affect creative performance, compared to no fascination. High fascination was expected to improve creative performance (H1) and therefore H1 is rejected. Low fascination negatively affected performance, compared to no fascination. It was expected that low fascination would not improve creative performance (H2). As creative performance was not improved by low fascination (rather, it was worsened), H2 is accepted. Moreover, it was expected that creative performance would be better with high fascination than with low fascination (H3). There was a marginally significant difference in creative performance between participants who watched the high fascination videos and participants who watched the low fascination videos. H3 is therefore accepted, but it is worth noting that the difference exists because low fascination decreased performance.

No significant main effect was found for nature sound, $F(1, 127) = .06$, $p > .05$. This is contrary to what was expected, namely that nature sound would improve creative performance (H4). Therefore, H4 is rejected.

No significant interaction effect was found for fascination and nature sound, $F(2, 127) = .21$, $p > .05$. It was expected that a combination of fascinating nature and nature sound would improve creative performance (H5). Therefore, H5 is rejected.

**Creative performance per task**

Additional 2 (nature sound vs no sound) x 3 (low fascination video vs high fascination video vs no video) univariate analyses of variance were performed for each task separately. This was done to gain more insight in the effects of fascination and nature sound on creative performance in the several tasks. For these analyses, the creativity scores for the specific tasks were used. The analyses showed no significant main effects or interaction effect for fascination and nature sound (see Table 3).

*Table 3.* Effects of fascination and nature sound on creative performance in the tasks.

| | **Fascination** | | | **Nature sound** | | | **Fascination * Nature sound** | | |
|---|---|---|---|---|---|---|---|---|---|
| | *df* | *F* | *sig.* | *df* | *F* | *sig.* | *df* | *F* | *sig.* |
| **Task** | | | | | | | | | |
| Bricks task | (2, 127) | .25 | .78 | (1, 127) | 1.41 | .24 | (2, 127) | 2.20 | .12 |
| Glass bottle task | (2, 127) | 2.24 | .11 | (1, 127) | .04 | .84 | (2, 127) | .91 | .40 |
| Legs task | (2, 127) | 2.22 | .11 | (1, 127) | .15 | .70 | (2, 127) | .11 | .90 |

**Reported creativity**

To measure the effects of fascination and nature sound on reported creativity, a univariate analysis of variance was performed. No significant main effect of fascination on reported creativity were found, $F(2, 127) = .93$, $p > .05$. Also, no significant main effect of nature sound on reported creativity was found, $F(1, 127) = .17$, $p > .05$. Moreover, no interaction effect for fascination and nature sound was found, $F(2, 127) = .91$, $p > .05$. It seems that nature video and nature sound did not significantly influence feelings of creativity.

**Reported fascination**

To gain more insight in the effects of the amount of fascination experienced by participants, a linear regression analysis was performed to test the effects of reported fascination on the creativity. The regression analysis showed that reported fascination did not affect the creativity score ($\beta = .085$, $p > .05$). Another regression analysis was performed to see whether reported fascination affected reported creativity. The analysis was highly significant ($\beta = .308$, $p < .01$), indicating that participants felt they were more creative when they reported higher experienced fascination.

**Additional analyses**

Univariate analyses of variance were performed to test whether gender affected the creativity score. No significant effects of gender was found, $F(1, 95) = .37$, $p > .05$. The means for reported creativity were compared between males ($M = 2.64$, $SD = .87$) and females ($M = 2.31$, $SD = .72$). The difference was significant, $t(131) = 2.42$, $p < .05$, indicating that males felt more creative during the experiment. A similar comparison for reported fascination showed no significant differences, $t(87) = -.44$, $p > .05$.

A linear regression analysis was performed to test whether age affected the creativity score, but no significant effect was found ($\beta = -.033$, $p > .05$). Age also did not affect reported creativity ($\beta = .091$, $p > .05$). However, age does seem to have significantly affected reported fascination ($\beta = .24$, $p < .05$). This suggests that older participants reported higher fascination.

# Discussion

This study intended to explore the effects of fascinating nature and nature sound on creative performance. To that end, an experiment was conducted in which creative performance of the participants was measured. Inspiration for this study stems from literature and research concerning the restorative effects of nature. Studies have found that nature restores attention, helps restore from mental fatigue and improves performance on attention demanding tasks (R. Kaplan, 1993; S. Kaplan, 1993; Kaplan, 1995). The fascinating properties of nature form one of the most important aspects responsible for this restoration (Szolosi et al., 2014). Besides visual nature stimuli, nature sounds have also been found to have restorative effects (Alvarsson et al., 2010). Considering the restorative potential of nature, as described in detail in the ART (S. Kaplan, 1993; Kaplan, 1995), and the way nature helps people ‘open up’ to creativity (Plambech & Konijnendijk van den Bosch, 2015), it was hypothesized that highly fascinating nature and nature sound would improve creative performance. A combination of highly fascinating nature and nature sound was hypothesized to be more effective than either of them separately (Jahncke et al., 2011). It was also hypothesized that nature low on fascination would not improve creative performance.

## Effects of fascinating nature on creative performance

In the current study, a significant effect of fascination on creative performance was found. However, in contrast with what was expected, highly fascinating nature did not improve creative performance. Interestingly, participants did feel they were more creative when they reported higher fascination. A possible explanation for the difference between feelings of creativity and actual creative performance in this study is that the two might not necessarily be related to each other. In the context of ART, fascination might have helped restore or maintain directed attention and prevent mental fatigue, making one feel they were able to perform better creatively. However, fascination alone was perhaps not enough to warrant an actual improvement of creative performance. Comparing this study with other studies, it seems that more immersion in nature might be required to improve actual creative performance. The results from two experiments by Shibata and Suzuki (2002, 2004) showed a significant effect of a single plant on creative performance only for either males or females, respectively. However, in a study by Atchley et al. (2012), creative performance significantly increased for all participants who were immersed in nature for several days. These studies seem to speak in favor of more immersion in nature to benefit creative performance. However, there is not enough information available on the subject to draw a conclusion about why highly fascinating nature did not affect creative performance in the current study.

In this study, nature low in fascination decreased creative performance. An explanation for this can be sought in the soft and hard fascination distinction described by Kaplan and Berman (2010). Hard fascinations, as opposed to soft fascinations, demand one’s attention and are therefore not restorative in nature (S. Kaplan, 1993). The stuttering effect in the low fascination video might have been experienced as a hard fascination by the participants, thus not grabbing attention effortlessly. Combined with the instruction to carefully watch the video, the video might have mentally fatigued participants by demanding their directed attention, resulting in worse creative performance.

## Effects of nature sound on creative performance

No significant effects of nature sound on creative performance were found in this study. Due to the limited amount of research available about the effects of nature sound on creative performance, it’s hardly possible to look at other studies for a possible explanation. Except for a study by Alawad (2012), no other recent studies concerning the effects of nature sound on creative performance were found. The study by Alawad describes an experiment where art students performed better creatively on their art projects when natural sounds were played in the classroom at intervals. Perhaps then, nature sound has an effect only when it is played more frequently or longer than in the current study. However, more research into this area is necessary to explore such requirements.

## Limitations of this study

Several limitations should be taken into account. First, this study used videos with fascinating nature to research the effects of nature on creative performance. The focus on fascination and the use of videos limits the scope of the study and therefore the generalizability of the results.

Second, the used creative performance tasks were verbal creativity tasks. Creativity is a difficult concept to measure and creative performance exists in many variations. One could be very good at sculpting, but very bad at verbal creativity tasks. It would be hard to measure creativity as a whole, considering how broad the concept is, but the use of a specific task is considered a limitation as it only measures a part of creativity. Results might have been different with another type of task.

Third, a time limit was used for the tasks due to practical reasons. Even though a study by Benedek et al. (2013) suggests that the used time limit should not be an issue for performance on the tasks, participants might have felt pressure to act quickly before time ran out, resulting in less creative answers. This could be prevented by not imposing a time limit, but this would require much more time for the research to be completed and would probably require a different approach for conducting the experiment (for example, in a classroom with a beamer).

Finally, scoring methods for creative performance tasks are all subject to discussion. While the subjective top 2 scoring method used in this study is considered a good method, it depends on the ability of participants to evaluate the creativity of their own answers. This presents the possibility that participants did not actually pick the answers that otherwise would have been rated highest on creativity by the three raters. Objective scoring methods avoid this problem, but those, as discussed earlier, have their own set of problems. Scoring methods remain a difficulty in research concerning creativity.

**Implications of this study**

The current study adds to the research available about the effects of nature on creative performance in the context of ART. It indicates that highly fascinating nature does not necessarily improve creative performance and it’s suggested that more immersion might be necessary for nature to have a beneficial effect on creative performance. However, high fascination might increase feelings of creativity.

Nature low in fascination can actually decrease creative performance. It’s suggested that it might be perceived as a hard fascination, thus demanding directed attention and resulting in lower creative performance. Therefore, when using representations of nature in research or practice, it is recommended to assure that the used material is highly fascinating.

The current study also adds to limited amount of research available about the effects of nature sound on creative performance. It suggests, at least, that nature sound does not positively affect creative performance in all cases.

### Suggestions for future research

Considering the small amount of available research and the results of the current study, there is still much to learn about nature and creative performance. Therefore, it is recommended that further research is conducted in this area to explore the aspects of nature, or combinations thereof, described in ART, that affect creative performance, but also to study how much they affect creative performance. Besides ART, it is also recommended to look at other frameworks and theories describing the beneficial effects of nature. Considering the broad nature of the concept creativity, it is also recommended to experiment with different types of tasks, such as drawing tasks, consequences tasks and association tasks. However, instead of tasks, there might be many other ways to measure forms of creative performance. To conclude, there is much more to explore in the area of nature and creative performance.

## References

Alawad, A. (2012). Can we bring the natural environment into the art classroom? Can natural sound foster creativity? *Educational Research and Reviews, 7*(28), 627.

Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010). Stress recovery during exposure to nature sound and environmental noise. *International journal of environmental research and public health, 7*(3), 1036--1046. doi:10.3390/ijerph7031036

Atchley, R. A., Strayer, D. L., & Atchley, P. (2012). Creativity in the Wild: Improving Creative Reasoning through Immersion in Natural Settings. *PloS one, 7*(12), e51474. doi:10.1371/journal.pone.0051474

Benedek, M., Mühlmann, C., Jauk, E., & Neubauer, A. C. (2013). Assessment of divergent thinking by means of the subjective top-scoring method: Effects of the number of top-ideas and time-on-task on reliability and validity. *Psychology of Aesthetics, Creativity, and the Arts, 7*(4), 341-349. doi:10.1037/a0033644

Berman, M. G., 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

Chang, C.-Y., & Chen, P.-K. (2005). Human Response to Window Views and Indoor Plants in the Workplace. *HortScience, 40*(5), 1354--1359.

Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological Assessment, 6*(4), 284-290. doi:10.1037/1040-3590.6.4.284

de Kort, Y. A. W., Meijnders, A. L., Sponselee, A. A. G., & Ijsselsteijn, W. A. (2006). What's wrong with virtual trees? Restoring from stress in a mediated environment. *Journal of Environmental Psychology, 26*(4), 309--320. doi:10.1016/j.jenvp.2006.09.001

Felsten, G. (2009). Where to take a study break on the college campus: An attention restoration theory perspective. *Journal of Environmental Psychology*, *29*(1), 160--167. doi:10.1016/j.jenvp.2008.11.006

Harrison, Y., & Horne, J. A. (1999). One Night of Sleep Loss Impairs Innovative Thinking and Flexible Decision Making. *Organizational Behavior and Human Decision Processes, 78*(2), 128-145. doi:http://dx.doi.org/10.1006/obhd.1999.2827

Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Gärling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology, 23*(2), 109-123. doi:http://dx.doi.org/10.1016/S0272-4944(02)00109-3

Hartig, T., Korpela, K., Evans, G. W., & Gärling, T. (1997). A measure of restorative quality in environments. *Scandinavian Housing and Planning Research, 14*(4), 175-194.

Hass, R. W. (2015). Feasibility of online divergent thinking assessment. *Computers in Human Behavior, 46*, 85-93. doi:http://dx.doi.org/10.1016/j.chb.2014.12.056

Herzog, T. R., Black, A. M., Fountaine, K. A., & Knotts, D. J. (1997). Reflection and attentional recovery as distinctive benefits of restorative environments. *Journal of Environmental Psychology, 17*(2), 165-170.

Horne, J. A. (1988). Sleep Loss and Divergent Thinking Ability. *Sleep, 11*(6), 528-536.

Jahncke, H., Eriksson, K., & Naula, S. (2015). The effects of auditive and visual settings on perceived restoration likelihood. *Noise \& health, 17*(74), 1--10. doi:10.4103/1463-1741.149559

Jahncke, H., Hygge, S., Halin, N., Green, A. M., & Dimberg, K. (2011). Open-plan office noise: Cognitive performance and restoration. *Journal of Environmental Psychology, 31*(4), 373-382. doi:http://dx.doi.org/10.1016/j.jenvp.2011.07.002

James, W. (1984). *Psychology, Briefer Course*: Harvard University Press.

Joye, Y., Pals, R., Steg, L., & Evans, B. L. (2013). New methods for assessing the fascinating nature of nature experiences. *PloS one, 8*(7), e65332. doi:10.1371/journal.pone.0065332

Kaplan, R. (1993). The role of nature in the context of the workplace. *Landscape and Urban Planning, 26*(1-4), 193--201. doi:10.1016/0169-2046(93)90016-7

Kaplan, S. (1993). The Role of Natural Environment Aesthetics in the Restorative Experience. In P. H. Gobster (Ed.), *Managing urban and high-use recreation settings* (pp. 46 - 49). St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology, 15*(3), 169--182. doi:10.1016/0272-4944(95)90001-2

Kaplan, S., & Berman, M. G. (2010). Directed Attention as a Common Resource for Executive Functioning and Self-Regulation. *Perspectives on Psychological Science, 5*(1), 43--57. doi:10.1177/1745691609356784

Keniger, E. L., Gaston, J. K., Irvine, N. K., & Fuller, A. R. (2013). What are the Benefits of Interacting with Nature? *International journal of environmental research and public health, 10*(3). doi:10.3390/ijerph10030913

Lau, S., & Cheung, P. C. (2010). Creativity assessment: Comparability of the electronic and paper-and-pencil versions of the Wallach–Kogan Creativity Tests. *Thinking Skills and Creativity, 5*(3), 101-107. doi:http://dx.doi.org/10.1016/j.tsc.2010.09.004

Lee, J., Park, B.-J., Tsunetsugu, Y., Kagawa, T., & Miyazaki, Y. (2009). Restorative effects of viewing real forest landscapes, based on a comparison with urban landscapes. *Scandinavian Journal of Forest Research, 24*(3), 227--234. doi:10.1080/02827580902903341

Lee, K. E., Williams, K. J. H., Sargent, L. D., Williams, N. S. G., & Johnson, K. A. (2015). 40-second green roof views sustain attention: The role of micro-breaks in attention restoration. *Journal of Environmental Psychology, 42*, 182-189. doi:http://dx.doi.org/10.1016/j.jenvp.2015.04.003

Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2008). Why Is Nature Beneficial?: The Role of Connectedness to Nature. *Environment and Behavior, 41*(5), 607--643. doi:10.1177/0013916508319745

Nieuwenhuis, M., Knight, C., Postmes, T., & Haslam, S. A. (2014). The relative benefits of green versus lean office space: Three field experiments. *Journal of Experimental Psychology: Applied, 20*(3), 199-214. doi:10.1037/xap0000024

Payne, S. R. (2013). The production of a Perceived Restorativeness Soundscape Scale. *Applied Acoustics, 74*(2), 255--263. doi:10.1016/j.apacoust.2011.11.005

Plambech, T., & Konijnendijk van den Bosch, C. C. (2015). The impact of nature on creativity – A study among Danish creative professionals. *Urban Forestry & Urban Greening, 14*(2), 255-263. doi:http://dx.doi.org/10.1016/j.ufug.2015.02.006

Raanaas, R. K., Evensen, K. H., Rich, D., Sjøstrøm, G., & Patil, G. (2011). Benefits of indoor plants on attention capacity in an office setting. *Journal of Environmental Psychology, 31*(1), 99--105. doi:10.1016/j.jenvp.2010.11.005

Ratcliffe, E., Gatersleben, B., & Sowden, P. T. (2013). Bird sounds and their contributions to perceived attention restoration and stress recovery. *Journal of Environmental Psychology, 36*, 221--228. doi:10.1016/j.jenvp.2013.08.004

Runco, M. A., & Acar, S. (2012). Divergent Thinking as an Indicator of Creative Potential. *Creativity Research Journal, 24*(1), 66-75. doi:10.1080/10400419.2012.652929

Shibata, S., & Suzuki, N. (2002). Effects of the foliage plant on task performance and mood. *Journal of Environmental Psychology, 22*(3), 265-272.

Shibata, S., & Suzuki, N. (2004). Effects of an indoor plant on creative task performance and mood. *Scandinavian Journal of Psychology, 45*(5), 373-381. doi:10.1111/j.1467-9450.2004.00419.x

Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I., . . . Richard, C. A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts, 2*(2), 68-85. doi:10.1037/1931-3896.2.2.68

Szolosi, A. M., Watson, J. M., & Ruddell, E. J. (2014). The benefits of mystery in nature on attention: Assessing the impacts of presentation duration. *Frontiers in psychology, 5*. doi:10.3389/fpsyg.2014.01360

Ulrich, R. S. (1979). Visual landscapes and psychological well-being. *Landscape Research, 4*(1), 17-23. doi:10.1080/01426397908705892

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, 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

Wallach, M. A., & Kogan, N. (1965). *Modes of thinking in young children; a study of the creativity-intelligence distinction*. New York,: Holt.