Is it the green in nature videos that affects mental well-being?

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Abstract

The idea that green space/nature or simulations can benefit mental well-being appears to be widely accepted by the population. The Attention Restoration Theory by Kaplan proposed that nature could provide sufficient fascinating stimulation to restore directed attention, hence improve human's mental well-being. In this study, we investigated whether urban environments with fascinating stimulation can benefit people's mental well-being and whether green space with distracting stimulation may display a negative impact instead. We conducted an interventional experiment with four groups of participants. Each group was presented with a different interventional video. Participants' stress levels, positive affect, and negative affect were measured through questionnaires before and after watching the videos. The four different videos simulate the environments: urban environment with fascinating stimulation, urban environment with distracting stimulation, green space environment with fascinating stimulation, and green space environment with distracting stimulation. We compared the pre-and post- intervention data (stress levels, positive affect & negative affect) within each group and the changes in each measure across groups. The findings suggest that urban environment may also have positive effects on negative moods as long as it provides fascinating stimulations instead of distracting ones.

Key words: *green space, mental well-being, fascinating stimulation, negative affect.*

Introduction

Green Space and Mental Well-being

After the industrial revolution, urbanization has been increasing at a tremendous rate. According to the World Urbanization Prospects (United Nations, 2014), more than 50% of the world's population is living in urban areas, and by the year 2050, the rate is expected to increase to 66%. One problem of urbanization is that it decreases people's access to the green landscapes in which the human species evolved (Wilson, 2017). The idea that green space provides human benefits started to be generally accepted, dating back to the 1800s, when a "parks movement" called for the preservation, creation, and accessibility of open spaces and green spaces was widely promoted in London (Hickman, 2013). Since then, many studies were undertaken to investigate the benefits of nature and/or green space. Ulrich (1984) reported that the natural environments had restorative influences on people. He found that the hospitalized patients who had a window to look out with trees and nature views recovered faster after the surgery than those with only window views of buildings and walls.

Later on, subsequent studies have exhibited similar results with natural environments having positive influence on human's psychological and mental health (Chiesura, 2004). In the past 35 years, there has been an accumulation of empirical evidence indicating a positive correlation between green space and mental well-being (Collins et al., 2020). For example, a study using panel data of more than 10,000 individuals from the UK demonstrates that people have a higher level of mental well-being and lower level of distress when living in areas with more green space (White et al., 2013). Another study in the US explains that the expansive park networks with sizeable green space are associated with multiple aspects of mental well-being and positively impact the quality of life (Larson et al., 2016). Also, a study in Beijing,

China, which investigated how urban green spaces impact people's mental well-being, demonstrates that green space has a very positive impact on individuals' mental well-being and provides support for their further promotion (Ma et al., 2019). Moreover, the results of a study with 3060 Finnish participants aged 15-74 years reported that participating in nature-based activities is linked to experiencing vitality, peacefulness, reducing stress, and anxiety (Korpela et al., 2014). Green space exposure has associations with an abundance of health benefits in both interventional and observational studies. The results of studies suggest that green space brings beneficial influence to people's well-being on a wide range (Twohig-Bennett & Jones, 2018).

Furthermore, worldwide organizations and various local governments also attach great importance to green space and mental well-being. For example, the United Nations Sustainable Development Goals (2017) stated that the green space could "foster prosperity and quality of life for all". The World Health Organisation (2016) emphasizes the importance of urban green spaces as a "necessary component for delivering healthy, sustainable, liveable conditions." In the UK, local authorities hold the responsibility for providing their citizens with access to the natural environment (Local Government Association, 2017) and a standard of living within 300 meters of at least 2 hectares of green space was recommended by government guidelines (Natural England, 2010).

Picture/Video of Green Space and Mental Well-being

As the idea that green space can positively affect human mental well-being is getting tested more and accepted, researchers also investigated whether nature simulations could yield similar benefits. Beute and de Kort (2018) conducted a study to explore whether exposure to nature images could reduce people's stress levels and improve mood. The results showed that

watching 3 minutes of nature photos slideshows twice a day for a week could increase participants' positive affect and reduce self-reported worry and lower autonomic activity. Moreover, there is growing evidence from brain imaging studies about the influence of green space on human brain. Grassini et al. (2019) used electroencephalogram (EEG) to scan the participants' brains while presenting them with a series of photos delineating urban or natural scenery and asked them to rate the photos for their subjective relaxing value. The results showed that, compared to viewing the photos with urban scenery, viewing nature photos were rated to be more relaxing. EEG showed that images of natural scenery call for lower attentional and cognitive demands in one's brain than urban ones, hence viewing natural images could improve individual's relaxation. Another study using videos with different levels of biodiversity (both flora and fauna) investigated how it may affect people's mental well-being differently (Wolf et al., 2017). The results suggested that exposure to higher levels of biodiversity causes a higher improvement in mental well-being. Moreover, a student project of Glasgow University (Erdinc, 2021) explored whether watching a short (4 minutes) natural video of green space could improve people's mental well-being. The results indicated stress levels were reduced significantly, along with negative affect, confirming the outcomes of previously discussed studies.

Potential Psychological Mechanism

As being more and more accepted, there are multi-dimensional aspects of benefits that green space could bring about to humans. For example, a study suggests that green space increases the quality of air and biodiversity as well as serves as a platform for leisure activities, physical exercise, and social cohesion (Mensah et al., 2016). However, Van den Berg et al. (2017) pointed out that physical exercise and social cohesion just mediate 25% of green space

and well-being association, suggesting further psychological explanations. What is the potential psychological mechanism behind the mental benefits of green space?

Ulrich et al. (1991) demonstrated a Stress Reduction Theory which suggests that the stress recovery was faster and more complete when participants were exposed to environments with more green than urban settings. Exposure to a green environment could evoke positive emotions and reduce negative emotions (Jackson et al., 2013). Stress Reduction Theory suggests that humans generate immediate reactions to environments as an unconsciously triggered affective response. The affect is positive when the environment contains major natural elements (e.g., water, vegetation), structural aspects of natural landscapes (depth, even surface texture), and no threatening stimuli (Honold et al., 2015). Positive affect can regulate neurophysiological activation to an ideal level. This process triggers adaptive action impulses, which may lead to physical movement or exercise. Physical movement could bring about additional health benefits (Phillips et al., 1998). Researchers also propose that the tendency of positive affective reactions towards natural environments may be associated with human evolution, since human's well-being in the early stage was highly dependent on abundant landscapes with diverse resources, such as open water and a variety of vegetation, which provide human with food, goods, refuge and protection (Appleton, 1975; Orians & Heerwagen, 1992). Compared to monocultural green space, landscapes with different natural elements and species diversity may have a better effect on stress reduction, because they are more likely to provide relevant resources to different needs for different behavioral aims (Honold et al., 2015).

Another influential and widely-cited theory is Kaplan's Attention Restoration Theory (Kaplan & Berman, 2010; Kaplan, 1995). While the Stress Reduction Theory focuses on people's

immediate reactions to the environments as a driver of restoration, the Attention Restoration Theory zooms in on the potential cognitive benefits that can derive from the interactions with natural environments (Kaplan & Berman, 2010; Kaplan, 1995). There is a critical notion in the Attention Restoration Theory called "directed attention," which indicates the effortful process of focusing or concentrating on objects or events and blocking out distracting stimulations in the meantime. The Attention Restoration Theory believes that directed attention is a limited resource that can be exhausted after an intensive and/or long use, eventually resulting in mental fatigue, such as distractibility, impulsivity, and irritability (Basu et al., 2018). However, it also can be recovered/recharged from certain environments – especially natural environments, since the natural environment can often sufficiently provide fascinating stimuli (also known as “soft fascination”), which could capture people's attention in an automatic, relaxing, and bottom-up way and allow the directed attention to rest and restore itself (Basu et al., 2018).

Is the Green What Affects Mental Well-being?

As suggested in the Attention Restoration Theory, interaction with natural environments can allow the directed attention to relax and recover. However, with urban settings, which often contain dramatically distracting stimulation (e.g., car horns, billboards, other people's movement), directed attention may need to be further occupied to block out the stimulation, leading to potential directed attention fatigue (Kaplan & Berman, 2010; Kaplan, 1995). Therefore, Attention Restoration Theory concludes that exposure to nature has recovery effects, and nature facilitates replenishing an initially depleted resource, i.e., directed attention. However, logically speaking, it is the environment which could provide soft fascination that brings about the recovery effects, unnecessarily to be from the natural settings. What if the urban environments can also provide soft fascination like the natural

ones? For example, an urban environment without loud noise, speedy transportations, shining billboards, or passing-by pedestrians? On the other hand, do the green or natural environments containing many distracting stimulations (e.g., a green park with many people walking and producing loud noise) still facilitate the replenishment of directed attention and improve people's mental well-being? There is insufficient existing literature discussing this. Therefore, this study aims to investigate whether urban settings with fascinating stimulation can have positive effects on people's mental well-being, and whether green space with distracting stimulation can have negative effects.

We used four different videos as the interventional stimuli to create the specific environments. For an urban setting with fascinating stimulation, we used a webcam video for a distant street view with no green space but vehicles and pedestrians going by silently, named as *Group 1-Urban Distant*. For the green space with distracting stimulation, we used the video of a close-up view of a green park with people walking by, named as *Group 4-Green Close-up*. We also used two other comparison groups. One is a pure green space distant-viewed video serving as a green space environment with fascinating stimulation, named as *Group 3-Green Distant*. Another one is urban close-up street-view video with many people walking by, serving as an urban setting with distracting stimulation, named as *Group 2-Urban Close-up*. Our hypotheses are:

1. Watching Group 1-Urban Distant video can have positive effects on people's mental well-being;
2. Watching Group 2-Urban Close-up video cannot have positive effects on people's mental well-being;
3. Watching Group 3-Green Distant video can have positive effects on people's mental well-being;

4. Watching Group 4-Green Close-up video cannot have positive effects on people's mental well-being;
5. Watching Group 1-Urban Distant video brings better positive effects than watching Group 4-Green Close-up video.

Mental Well-being Measure in Our Study

Even though considerable evidence has shown that natural environment/green space can improve human's mental well-being, the term "mental well-being" was applied differently in different studies. Mental well-being consists of two components: hedonic well-being and eudaimonic well-being. Hedonic well-being refers to happiness and life satisfaction, while eudaimonic well-being refers to fulfillment, functioning, and purpose in life (Henderson & Knight, 2012; Ryan & Deci, 2001). According to a systematic study, only 27% of the studies used a measure of mental well-being that applied both hedonic and eudaimonic dimensions, whereas the rest 73% measured aspects such as life satisfaction, happiness, and quality of life (Houlden et al., 2018). Since mental well-being involves two aspects and requires a multi-dimensional measure, it will be too complex for a student's dissertation project. Therefore, the researcher of this study decided to measure participants' stress level, positive affect, and negative affect as the indicators of mental well-being, by applying the Stress Visual Analogue Scale (Stress-VAS) and the International Positive and Negative Affect Schedule (PANAS) Short Form (I-PANAS-SF) (Thompson, 2007). PANAS is a 20-item self-report measure of positive and negative affect (Watson et al., 1988). The PANAS has been widely used in psychological research as one important measure of participants' mental well-being. The I-PANAS-SF, tested to be as adequate as PANAS, is a brief, reliable, valid, and efficient psychological research tool applicable in cross-cultural English-based studies (Crawford & Henry, 2004). Negative Affect and Positive Affect reflect dispositional dimensions. High

Negative Affect represents subjective distress, and unpleasurable engagement, and low Negative Affect represents the absence of these feelings. In contrast, Positive Affect reflects the extent to which an individual experiences pleasurable engagement with the environment.

Methods

Ethical Statement

This study was designed based on the BPS ethical guidelines. The participants had the right to withdraw their data at any time, including retroactively after completing the experiment until the 13th of August 2021. The study was ethically approved by the School of Psychology at the University of Glasgow (See Appendix B).

Participants and Assignment to Groups

Participants were recruited through researcher's personal connections and advertisements on social media. The requirements for eligible participants were being 18 or more years old and being proficient in English. There was no upper age limit for participants. There were 129 people (85 females, 40 males, and 4 with gender not mentioned) participating in the experiment in total, and they were randomly assigned across 4 independent groups:

- *Group 1-Urban Distant,*
- *Group 2-Urban Close-up,*
- *Group 3-Green Distant,*
- *Group 4-Green Close-up*.

On entering the website containing the experiment, participants were randomly assigned to one of the four experimental groups still needing participants. After leaving the website the participant was excluded if they did not complete the experiment satisfactorily or failed to meet other conditions. The first 25 participants in each condition to complete the experiment satisfactorily were used in the analysis, and any others were excluded. (To avoid purposeless data collection, each condition was withdrawn from the random pool after 25 were found to have completed it satisfactorily.) The 100 eligible participants were 65 females and 35males.

The age range was 18-81, the median age was 32, the mean age was 33.96 and the standard deviation of age was 10.15. Figure 1 illustrates the age distribution of participants. Participants affiliated mainly with the United Kingdom, Indonesia and China (see Table 1). 66% percentage of them were nonstudents and 72% of them used a phone to complete the experiment.

Figure 1

The Age Distribution of Participants

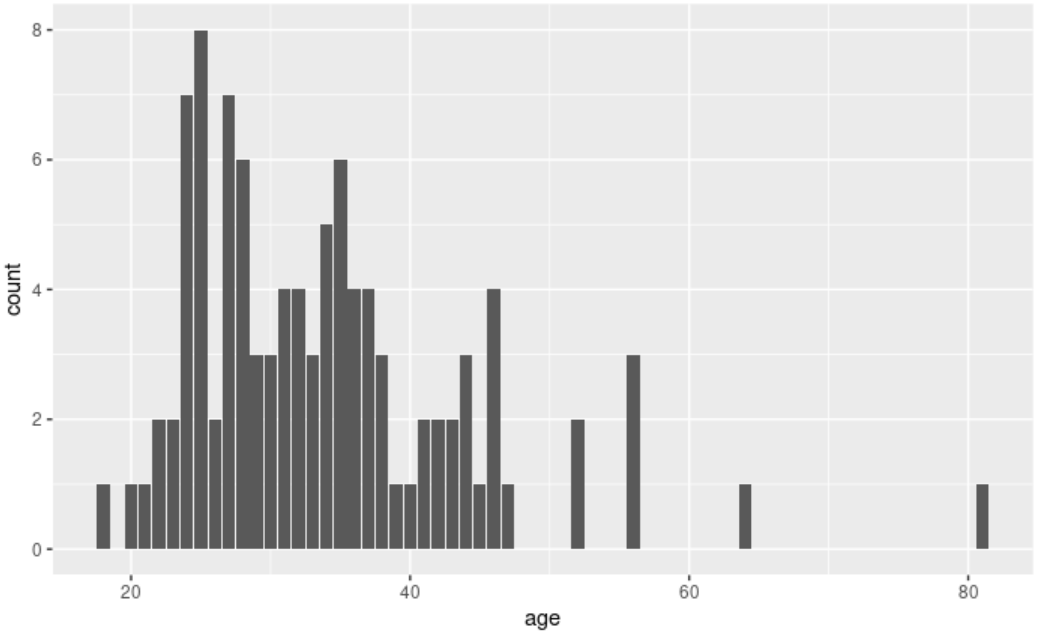


Table 1

Country/Region Affiliations of Participants

Country/Region	Frequency	Percentage (%)
Australia	1	1
Bulgaria	1	1
Canada	3	3
Chile	1	1
China	30	30
Germany	1	1
United Kingdom	14	14
Hong Kong	6	6
Indonesia	16	16
Ireland	2	2
Indian	3	3
South Korea	5	5
Lithuania	1	1
Malaysia	1	1
Philippines	4	4
Poland	1	1
Portugal	1	1
Romania	1	1
Taiwan	2	2
Ukraine	1	1
America	3	3
South Africa	1	1
Zimbabwe	1	1

N=100

Materials

We used the Stress Visual Analogue Scale (Stress-VAS) and the International Positive and Negative Affect Schedule (PANAS) Short Form (I-PANAS-SF) (Thompson, 2007) to measure the participants' stress level and mood before and after watching the interventional video. We used the Experimentum platform (DeBruine et al., 2021) to host the experiment for participants and to access and retrieve the data from https://github.com/debruine/experimentum.

Stress-VAS ranges from 0 to 100 with 1-point increments. The accurate numbers remain unknown to the participants and only the two extreme descriptions of stress levels shown, which are "Not at all stressed" and "Extremely stressed". It offers a quick and simple assessment of perceived stress and is discriminatory of differences (Lesage et al., 2012). I-PANAS-SF was created by Thompson (2007) from the original Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988). I-PANAS-SF contains 10 item mood scale (5 positive and 5 negative) rather than 20 items, which provides more clarity on the content of the items, reduces ambiguities and addresses the limitations of the original PANAS form. Therefore, it provides a shorter, yet valid and reliable scale to be implemented effectively on an international level. I-PANAS-SF includes 5 positive and 5 negative affect words as following: 5 positive affect words are "Attentive", "Alert", "Strong", "Proud" and "Determined"; 5 negative affect words are "Hostile", "Upset", "Afraid", "Nervous" and "Ashamed". It is measured through the Likert scale (1-5). "1" represents "Not at all or very slightly" and "5" represents "Extremely" (Crawford & Henry, 2004). Positive and Negative Affect scores (between 0-25) are calculated by the sum separately. The 10 affect words were randomized for both the pre- and-post use of PANAS before and after the video assigned to their group.

There were also demographic questions including participants' age and gender, as well as :1) The country they are from; 2) what type of screen they use to attend this experiment; 3) If they are students; 4) If they are proficient in English.

There was also an additional question to measure how much effort it was for participants to focus on watching the video rather than looking at something else. The question came with a slider with “0” represents “not difficult at all” and “100” represents “a big effort to keep my attention on the video”.

Procedure

The study was conducted online through the Experimentum platform (DeBruine et al., 2021) and took about 14 minutes for each participant. A recruitment advertisement was promoted through the researcher’s personal connections and social media. Participants were assigned to one of the 4 different groups and presented with an information form and consent form which offers the information of the study and their rights as participants before taking part in the experiment. Then they were encouraged to offer their demographic-information and answer the pre-video Stress-VAS and I-PANAS-SF questionnaires. They were then presented with their assigned video, followed by a slider question to indicate how much efforts they needed to pay to focus on watching the video. Then, they were asked to fulfil the post-video Stress-VAS and I-PANAS-SF questionnaires. At the end of the experiment, participants were debriefed and asked to give comments.

Design and data analysis

The study used a mixed design: the overall design is a between-groups design, where each group watches a different video. And the procedure for each group is a within-subjects

repeated-measures design using the questionnaires of Stress-VAS and I-PANAS-SF two times (pre and post the stimulus).

We performed Wilcoxon Signed Rank tests to test our first four hypotheses since the data are non-parametric, ordinal and paired (Woolson, 2007). And we performed the Welch Two Sample T-test for our fifth hypothesis because the data are independent-samples and normally distributed. All of the analyses were conducted using R (V.4.0.2) through RStudio (V.1.3.1093) with the packages tidyverse (Wickham et al., 2019) and the Wilcoxon Signed Rank Test calculator from Statistic Kingdom (*Wilcoxon Signed-Rank*, 2021).

Stimulus

The stimuli were 4 videos (https://drive.google.com/drive/folders/1gVQEvTO0OIjFVD7-X9rwaa9I-iB_PyQf?usp=sharing) that were created for this experiment which are "Urban Distant", "Urban Close-up", "Green Distant" and "Green Close-up" videos. Each video is composed of several clips obtained from the internet. See Table 2 and Figure 2 to 5 for the details of each video.

Table 2

The Length and Clips of Each Video

	Group 1 Urban Distant	Group 2 Urban Close-up	Group 3 Green Distant	Group 4 Green Close-up
Length	3:56	3:47	3:34	3:46
clips	1	3	11	8

Figure 2

Example Scenes from the Video of Group 1-Urban Distant

Figure 3

Example Scenes from the Video of Group 2-Urban Close-up

Figure 4

Example Scenes from the Video of Group 3-Green Distant

Figure 5

Example Scenes from the Video of Group 4-Green Close-up

Results

Within each group, the differences in Stress, Positive Affect and Negative Affect between pre and post the interventional video were computed. We ran the Wilcoxon Signed Rank test since our samples are paired, ordinal and non-parametric (Woolson, 2007). The results of each group will be presented separately and the comparison across groups will be presented at the last. We calculated the observed standardized effect size ($Z/\sqrt{n}$) and represented them in the tables.

Group 1-Urban Distant

As the figure and statistics illustrate (see Table 3 & 4, Figure 6), after watching the video of urban distant view, the stress increased whilst the positive affect and negative affect both decreased. Wilcoxon Signed Rank tests (see Table 4) revealed a non-significant result for stress and positive affect, but significant results for negative affect with medium effect sizes. Therefore, our first hypothesis “Watching urban distant video can also have positive effects on people's mental well-being” is partially accepted. The results indicate that watching the urban distant video could have significant effect on reducing negative mood.

Table 3

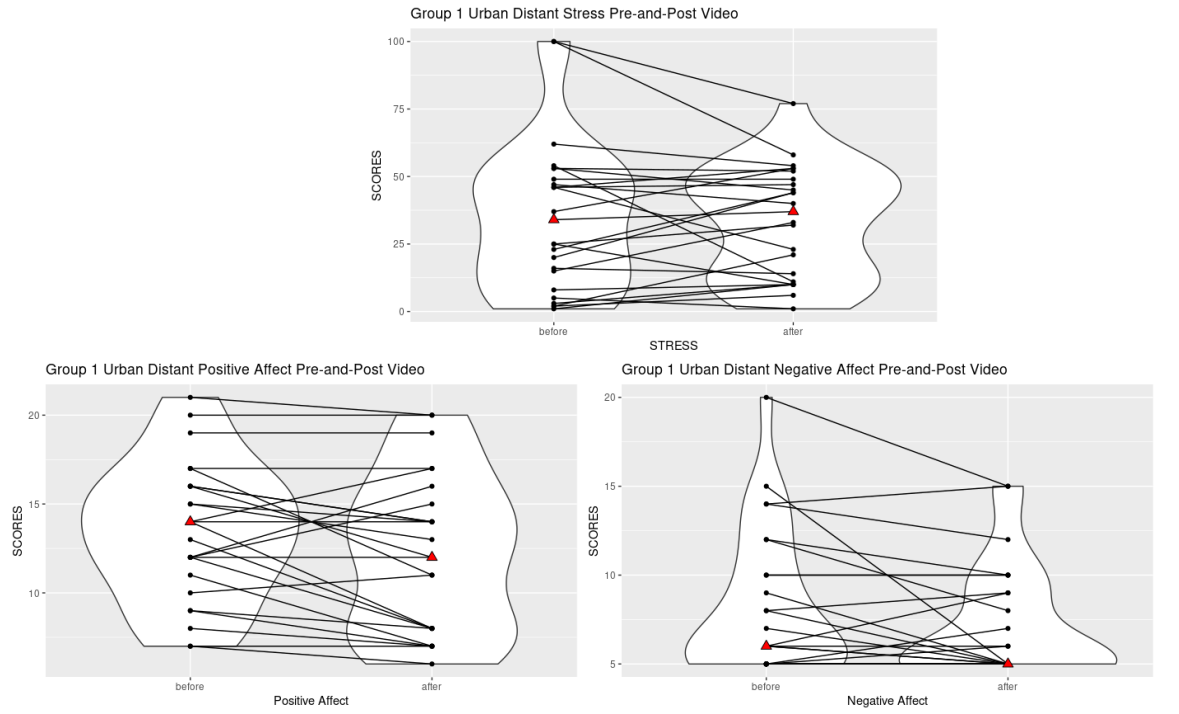
Group 1-Urban Distant: Mean, Standard Deviations, Median, Minimum, Maximum, and Skew

	Mean	SD	Median	Min	Max	Skew
Pre-Stress	34.88	27.55	34	1	100	.79
Post-Stress	33.36	20.43	37	1	77	.06
Pre-Positive Affect	13.44	3.87	14	7	21	.07
Post-Positive Affect	12.20	4.43	12	6	20	.24
Pre- Negative Affect	8.32	4.09	6	5	20	1.23
Post-Negative Affect	7.28	3.17	5	5	15	1.25

N=25

Figure 6

The Distribution of Scores Pre-and-post Video of Group 1-Urban Distant



Note. Triangles represent the median scores. Each small dot represents a participant, with lines illustrating how individual scores have changed.

Table 4

The Wilcoxon Signed Rank Test Result of Group 1-Urban Distant

	Z	*p*	Effect size
Stress	-.043	.52	.009 *(small)*
Positive Affect	2.21	.98	.510 *(large)*
Negative Affect	1.86	.03	.480 *(medium)*

N=25

Group 2-Urban Close-up

As the figure and statistics illustrate (see Table 5 & 6, Figure 7), after watching the video of urban close-up view, the stress decreased whilst the positive affect and negative affect both increased. Based on the Wilcoxon Signed Rank tests (see Table 6), the stress and positive affect changes of pre- and post- intervention are non-significant and the negative affect change is significant. Therefore, our second hypothesis "Watching the urban close-up video cannot have positive effects on people's mental well-being" is partially accepted. The results indicate that watching the urban close-up video could increase people's negative affect significantly.

Table 5

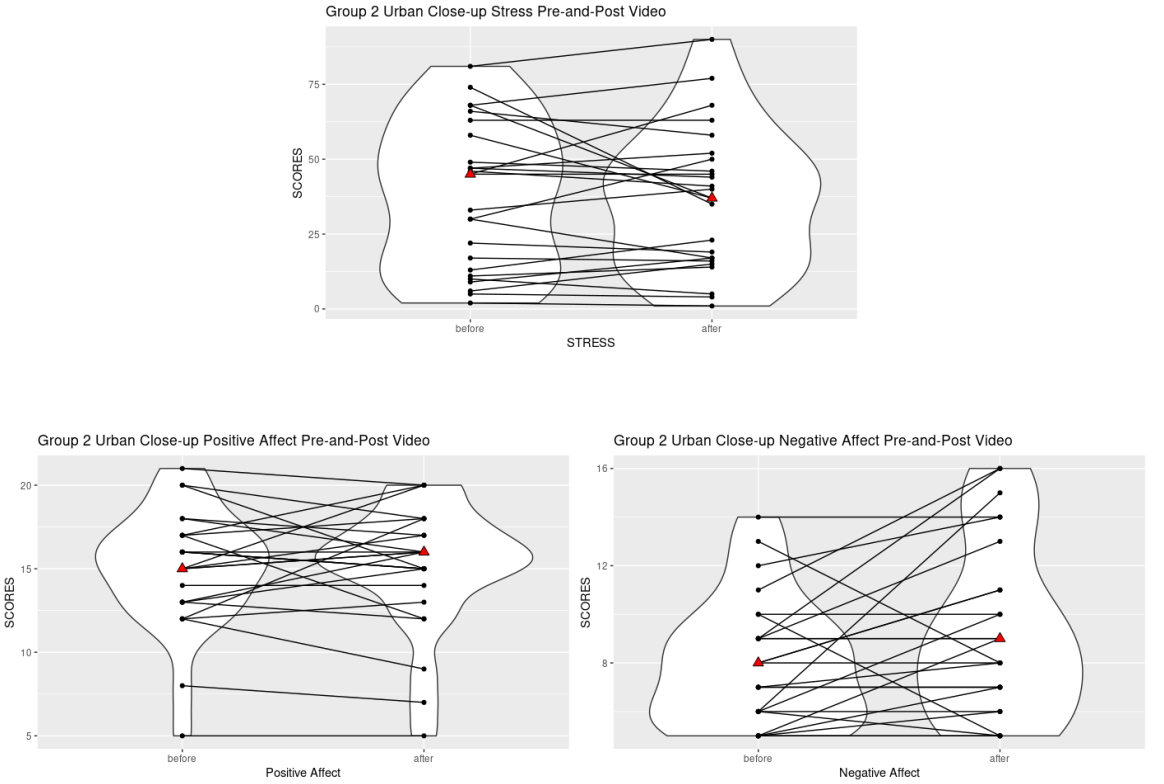
Group 2-Urban Close-up: Mean, Standard Deviations, Median, Minimum, Maximum, and Skew

	Mean	SD	Median	Min	Max	Skew
Pre-Stress	37.80	24.53	45	2	81	.08
Post-Stress	36.56	23.52	37	1	90	.40
Pre-Positive Affect	14.96	3.59	15	5	21	-.80
Post-Positive Affect	15.00	3.75	16	5	20	-1.06
Pre- Negative Affect	8.00	2.60	8	5	14	.68
Post-Negative Affect	9.36	3.56	9	5	16	.54

N=25

Figure 7

The Distribution of Scores Pre-and-post Video of Group 2-Urban Close-up



Note. Triangles represent the median scores. Each small dot represents a participant, with lines illustrating how individual scores have changed.

Table 6

The Wilcoxon Signed Rank Test Result of Group 2-Urban Close-up

	Z	*p*	Effect size
Stress	-.05	.480	.010 *(small)*
Positive Affect	-.033	.510	.007 *(small)*
Negative Affect	-1.91	.028	.490 *(medium)*

N=25

Group 3-Green Distant

As the figure and statistics illustrate (see Table 7 & 8, Figure 8), after watching the video of green distant view, positive affect increased slightly, although not enough to suggest a significance. On the other hand, negative affect and stress both decreased. Wilcoxon Signed Rank tests (see Table 8) revealed a non-significant result for positive affect, but significant results for negative affect and stress, both with large effect sizes. Therefore, our third hypothesis "Watching the green distant video can have positive effects on people's mental well-being" is also partially accepted. The results suggest that watching green distant-viewed video can restore people's negative mood and stress.

Table 7

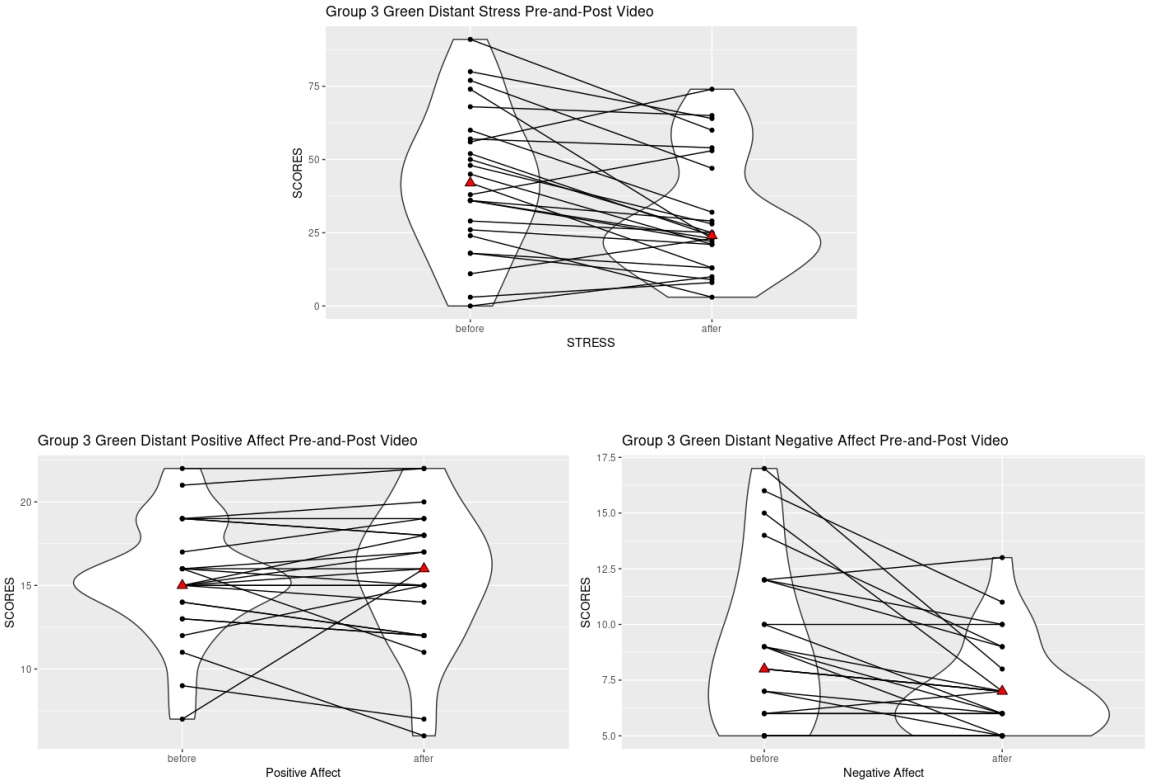
Group 3-Green Distant: Mean, Standard Deviations, Median, Minimum, Maximum, and Skew

	Mean	SD	Median	Min	Max	Skew
Pre-Stress	43.00	24.13	42	0	91	.10
Post-Stress	30.76	20.10	24	3	74	.74
Pre-Positive Affect	15.32	3.47	15	7	22	-.29
Post-Positive Affect	15.36	4.02	16	6	22	-.52
Pre- Negative Affect	9.04	3.66	8	5	17	.71
Post-Negative Affect	7.08	2.16	7	5	13	1.11

N=25

Figure 8

The Distribution of Scores Pre-and-post Video of Group 3- Green Distant



Note. Triangles represent the median scores. Each small dot represents a participant, with lines illustrating how individual scores have changed.

Table 8

The Wilcoxon Signed Rank Test Result of Group 3-Green Distant

	Z	*p*	Effect size
Stress	2.96	.0015	.590 *(large)*
Positive Affect	.17	.5680	.038 *(small)*
Negative Affect	3.29	.0005	.800 *(large)*

N=25

Group 4-Green Close-up

As the figure and statistics illustrate (see Table 9 & 10, Figure 9), after watching the video of green close-up view, the stress, positive affect and negative affect all decreased. Wilcoxon Signed Rank tests (see Table 10) shows non-significant results for stress, positive affect, and negative affect. Therefore, the result cannot support our fourth hypothesis "Watching the green close-up video cannot bring positive effects to people's mental well-being" to be accepted.

Table 9

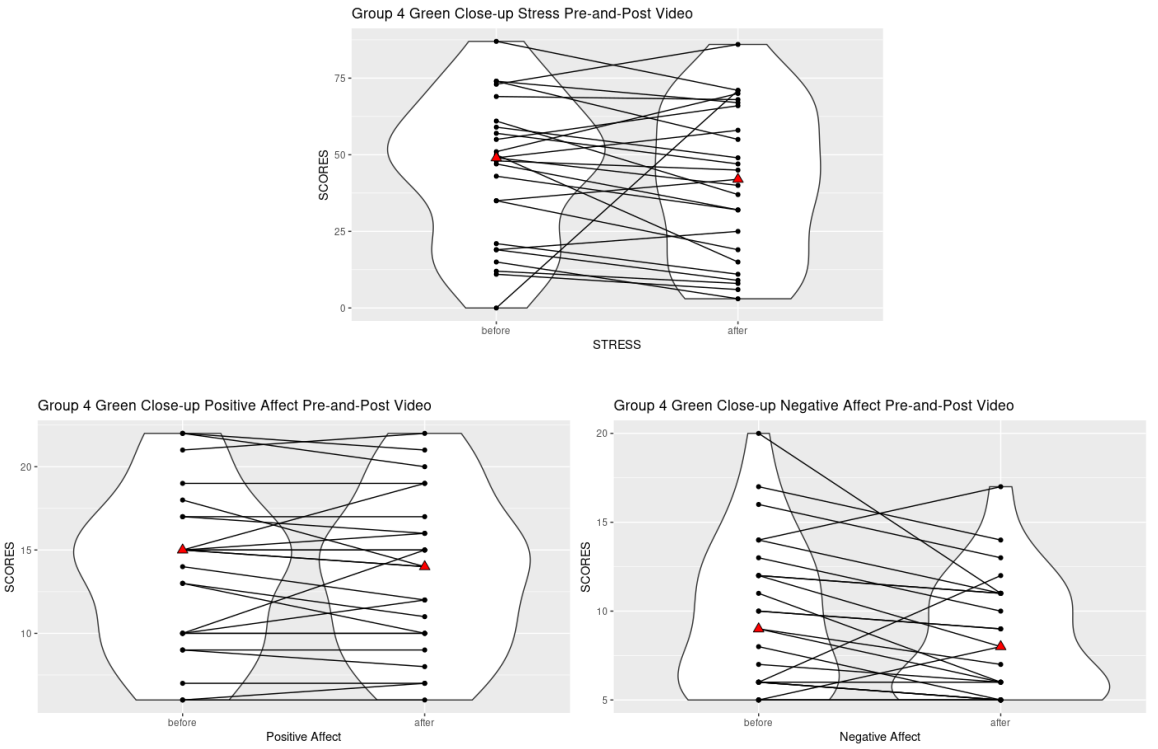
Group 4-Green Close-up: Mean, Standard Deviations, Median, Minimum, Maximum, and Skew

	Mean	SD	Median	Min	Max	Skew
Pre-Stress	44.52	23.19	49	0	87	-0.19
Post-Stress	41.28	24.64	42	3	86	-0.02
Pre-Positive Affect	13.72	4.71	15	6	22	.08
Post-Positive Affect	13.56	4.57	14	6	22	.11
Pre- Negative Affect	9.76	4.25	9	5	20	.66
Post-Negative Affect	8.40	3.39	8	5	17	.76

N=25

Figure 9

The Distribution of Scores Pre-and-post Video of Group 4-Green Close-up



Note. Triangles represent the median scores. Each small dot represents a participant, with lines illustrating how individual scores have changed.

Table 10

The Wilcoxon Signed Rank Test Result of Group 4-Green Close-up

	Z	*p*	Effect size
Stress	1.72	.96	.35 *(medium)*
Positive Affect	.68	.25	.17 *(small)*
Negative Affect	2.43	.99	.53 *(large)*

N=25

Comparison across Groups

To test our fifth hypothesis, we calculated the difference scores of pre- and- post video for stress, positive affect and negative affect. See Table 11 and Table 12 for the descriptive statistics of two groups.

Table 11

Descriptive Statistics of the Changes in Group 1-Urban Distant

	Mean	SD	Max	Min
Difference of Stress	-1.52	17.38	24	-43
Difference of Positive Affect	-1.24	2.60	4	-6
Difference of Negative Affect	-1.04	2.65	3	-10

N=25

Table 12

Descriptive Statistics of the Changes Group 4-Green Close-up

	Mean	SD	Max	Min
Difference of Stress	-3.24	19.72	71	-35
Difference of Positive Affect	-.16	1.93	5	-4
Difference of Negative Affect	-1.36	2.86	6	-9

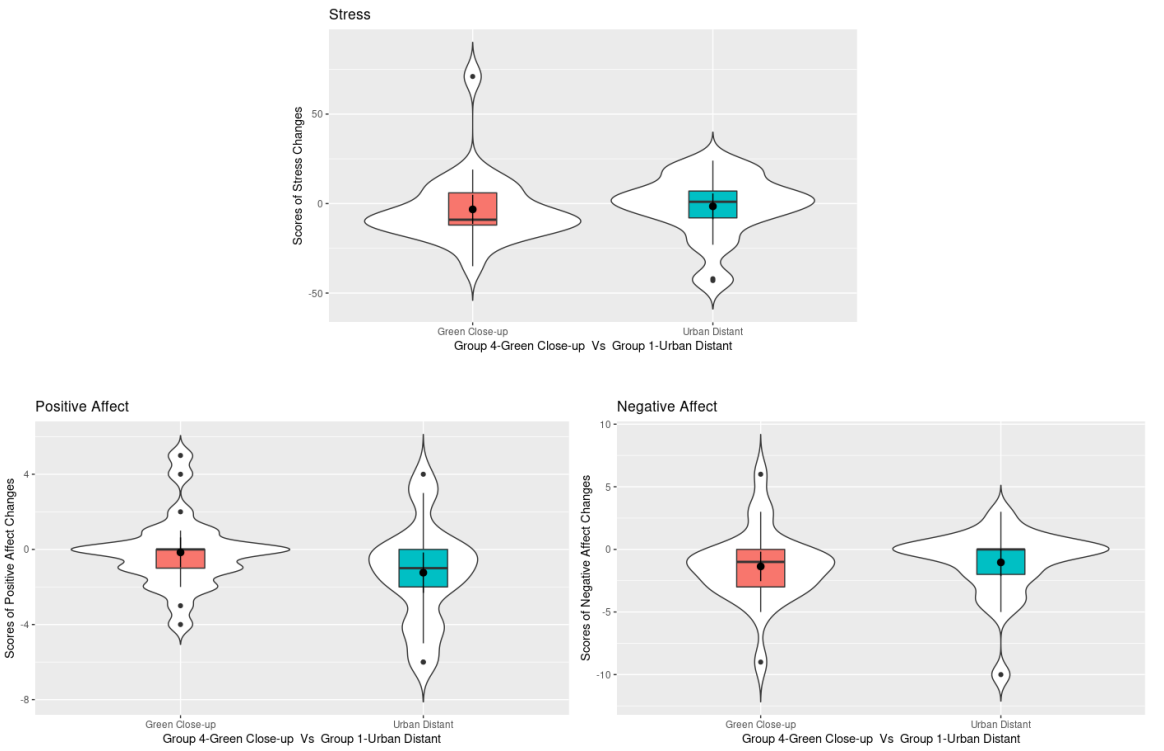
N=25

The difference in the three measures between Group 1-Urban Distant (N_1=25) and Group 4-Green Close-up (N_4=25) was computed. We ran the Welch Two Sample T-test and found that: 1) Watching video of urban environment with fascinating stimulation (M=-1.52, SD=17.38) had no significant higher changes in stress than watching video of green space with distracting stimulation (M = -3.24, SD = 19.72, t (23) = 0.32, p > .05, see Figure 10); 2) Watching video of urban environment with fascinating stimulation (M=-1.24, SD=2.60) had no significant higher changes in positive affect than watching video of green space with

distracting stimulation (M = -.16, SD = 1.93, t (23) = -1.67, p > .05, see Figure 10); 3) Watching video of urban environment with fascinating stimulation (M=-1.04, SD=2.65) had no significant higher changes in negative affect than watching video of green space with distracting stimulation (M = -1.36, SD = 2.86, t (23) = .41, p > .05, see Figure 10). Therefore, our fifth hypothesis "Watching the urban distant video brings better positive effects than watching green close-up videos" is not accepted.

Figure 10

Comparison of Changes in Stress, Positive Affect & Negative Affect between Group 4 & 1



Additional measure

Do the results have association with how difficult participants found it to keep focusing on the video? We calculated the mean score of self-reported difficulties to keep them watching the video (see Table 13). Participants who watched the Green Distant video found the least

effort needed to pay to keep them focused on the video, whereas watching Urban Distant Video needed the most efforts. The rank shows no significant association with the findings of each group.

Table 13

Mean Score of the Difficulties to Keep Watching the Videos

	Mean	Rank
Group 1-Urban Distant	58.44	1
Group 2-Urban Close-up	46.20	3
Group 3-Green Distant	38.36	4
Group 4-Green Close-up	49.16	2

Discussion

Key findings

This present study investigated 1) whether watching a short video of urban environments with fascinating stimulation can have positive effects on people's mental well-being, and 2) whether watching a short video of green space with distracting stimulation can have no positive effects on mental well-being. For mental well-being, we measured participants' self-reported stress levels, negative affect, and positive affect. We conducted an online experiment where four groups were randomly assigned to watch four different videos: Group 1-Urban Distant watched the video of the urban environment with fascinating stimulation; Group 2-Urban Close-up also watched the video of the urban environment but with distracting stimulation; Group 3- Green Distant watched a video of green space with fascinating stimulation, and Group 4-Green Close-up watched a video of green space with distracting stimulation. Before and after watching the videos, participants were asked to answer a set of questionnaires. We found that 1) Watching a short video of green spaces/natural environments with fascinating stimulations has restorative effects on people's stress and negative mood; 2) Watching a short video of urban environments with distracting stimulations could increase people's negative mood; 3) Watching a short video of urban environments with fascinating stimulations could reduce people's negative mood.

Some findings of the study are in alignment with the existing literature. For example, the research conducted by Beute and de Kort (2018) suggests that after viewing a week of nature photos slides, participants reported lower worrying levels, which is similar to the result from Group 3-Green Distant in our study: exposure to green spaces/natural environments fascinating stimulations decrease negative affect and stress levels. This finding also corresponds to the results of the student project of Glasgow University (Erdinc, 2021), which

reported that watching a short natural video of green space could reduce people's stress and negative affect significantly, underlining that nature blocks negative emotions, as suggested in the Stress Restoration Theory (Ulrich, 1991). However, our study and the student project (Erdinc, 2021) did not find a significant change in positive affect, which contrasts with the study by Schutte et al. (2017) using virtual reality to simulate the natural environment. Their study found an increase in positive affect but no change in negative affect. This may be explained by the different experiences that videos and virtual reality might bring to people differently, which requires further investigation. In a study that compared the difference between virtual reality and video training in the acquisition of laparoscopic skills, the researchers found that the virtual reality training system, although not as realistic, was more effective in training residents than the video training system (Hamilton et al., 2001). Another study found no difference in the pedestrian behavior between the virtual reality and the real environment for most of the tasks (Bhagavathula et al., 2018). This may indicate that the different types of simulations of nature may affect the results in the research field of green space and mental well-being. However, it is still meaningful and promising to know that watching green space videos with fascinating stimulation could have restorative effects on people's mental well-being. Especially because videos are still more accessible and more frequently used media than virtual reality nowadays. Moreover, during the Covid-19 pandemic lockdown, many people's access to the real green space was limited, whereas the levels of mental well-being was reduced (e.g., Meo et al., 2020; O'Connor, et al., 2021). According to our findings, watching a short video of green space with fascinating stimulation could serve as an easy, low-cost, effective, and efficient way to restore people's stress and negative mood. However, future research is needed to determine how long-lasting the effects are.

After comparing our second and third findings, "Watching a short video of urban environments with distracting stimulations could increase people's negative mood" and "Watching a short video of urban environments with fascinating stimulations could reduce people's negative mood," and comparing our first and third findings "Watching a short video of green spaces with fascinating stimulations could reduce people's negative mood and stress" and "Watching a short video of urban environments with fascinating stimulations could reduce people's negative mood", we could conclude that the type of stimulation in a video matters in terms of mediating people's negative affect, instead of the green elements in the video. This is in line with our critical review of the application of the Attention Restoration Theory. It is pretty common for environmental psychologists to simply apply the Attention Restoration Theory and conclude that exposure to green space would benefit human's mental well-being (e.g., Twohig-Bennett & Jones, 2018; Collins et al., 2020; Korpela et al., 2014). However, it calls for a second consideration of this statement. Firstly, the usage of "mental well-being" is very ambiguous, which has been discussed above. Secondly, according to the Attention Restoration Theory, what could capture people's attention in an automatic, relaxing, and bottom-up way and allow the directed attention to rest and restore itself is the fascinating stimulation, also known as soft fascination (Basu et al., 2018). As found in this study, exposure to soft fascination without any green space or elements, participants' negative effect reduced, suggesting that it is not the green that affects the negative mood. However, future studies are necessary to investigate other mental well-being properties and the real environment.

Limitations and Implications

Regarding limitations, three issues seem noteworthy. Firstly, there is the issue of the ecological validity of instructional manipulations. Our reading of the literature on this issue

suggests that cognitive sets induced by instructional manipulations in environment-behavior research have some validity beyond the laboratory settings (Leff & Gordon, 1979). Secondly, there is the issue of Participants Bias – the participants respond in the ways they believe correspond with what the researchers are looking for (Smith & Noble, 2014). Since the topic of green space bringing benefit to one's mental well-being is comparatively broadly accepted by the population, some participants may have this cognition implanted in mind, thus answered the questionnaires with bias. Clues can be found from participants' comments (see Appendix A), such as "I was looking forward to the green space video so I could relax!" Thirdly, there is the issue of the videos. We muted all the videos to control variables across groups, which may affect the viewers' experience and failed to simulate the different environments optimally. Clues also can be found from the comments (see Appendix A), such as "I think I found it more difficult to access the video fully with only visual stimuli" and "Maybe if it would be better with the sound." Evidence was found that auditory signals can also influence visual information processing (Doyle & Snowden, 2001). Future research can consider it while designing stimuli.

Despite the limitations, our findings have important implications. Since watching a short video with fascinating stimulations could reduce people's negative moods regardless within urban or natural environments, when feeling negative mood and having no access to real environments with fascinating stimulations, we could simply watch a short simulation video. This could also apply to the new phenomenon of online learning due to Covid-19. Online learning may bring extra stress and anxiety to students (Kecojevic et al., 2020). To help students reduce stress and negative mood, teachers or lecturers can play some short videos of green space with fascinating stimulations during break time. Such videos could also be played in some waiting rooms (e.g., in hospitals or restaurants), where people may get

stressed or negative after long waiting. Moreover, the findings also suggest a way to restore negative mood in the city with little green space – expose oneself to somewhere sufficient in fascinating stimulation, such as looking out from the windows of a higher floor of a tall building.

Conclusion

Green space has been known to have positive impacts on humans' mental well-being, while urban environments have negatives. However, the results of this study show that what affects the mental well-being may not be the elements of green but the type of stimulations. The fascinating stimulations could reduce people's negative moods, no matter in urban environments or green spaces. The study also found that watching a short (less than 4 minutes) video of green space with fascinating stimulations could significantly reduce stress and negative moods.

Appendix A

Participant Comments

The list of the participants' comments, prompted by the question: "Please write any comments you may have about the study, particularly the video." Comments such as "no" or "NA" have been removed and grammar errors or typos have not been corrected.

Group 1-Urban Distant

1. I was very happy that the man crossing the road holding the umbrella, made it across the bus.
2. I was looking forward to the green space video so I could relax! Was that the green space video?
3. The video honestly reminds me the days in Scotland...just want to go back.
4. I found it difficult to watch the urban scene video from the high up angle.
5. That is great.
6. Thank you for inviting.
7. Confused.
8. The video is a bit gloomy, but there is no sound, which does not make me concent.
9. The same scene is a little too long
10. The video is boring.

Group 2-Urban Close-up

1. The narrow walk way and crowded people make me a little uncomfortable.
2. This sounds very interesting, hope there are solid results!
3. Thank you taking me to a short virtual trip. I enjoyed watching the view and the people walking.

4. I felt a little more anxious after watching the video, maybe there were too many people and cars in the video.
5. Good luck!
6. That was so interesting! Although the road stressed me out, pure chaos.
7. That video was so long! All the best.
8. The video was quite boring, some sounds may help to make it easier to engage with.
9. Nice video, quite exotic looking places.
10. The video has no sound?
11. It's interesting video but no sound.
12. Good luck with your study!

Group 3-Green Distant

1. I think I found it more difficult to access the video fully with only visual stimuli.
2. Shorter video, perhaps.
3. It is very good, let us know the earth appearance.
4. Seeing green is very soothing.
5. I love seeing the greenery and large natural space. It gave my brain some relaxation.
6. The video makes me want to travel there now.
7. I was imaging what if I lived there!
8. I like watching the different sceneries. It relaxes my mind.
9. Thank you for the little escape of the mind!
10. I loved the scenery.
11. The video was very relaxing to watch and I imagined myself flying in the air with it.
12. Green lands made me relax and keep my attention there. The places in the video were so beautiful.

13. If there has a lovely bagpipe music background in the video, will definitely make it much more fun.
14. I like the greens, trees, grassland and flowers. So, the video is pleasant for me.
15. I like the tranquility feeling of the video.
16. The personal information gathering and login process was buggy and confusing.

Group 4-Green Close-up

1. You may add a question about how anxious you feel, it may or may not be relevant.
2. Nice video, quite calming. Reminds me of nature and what we used to be able to enjoy.
3. It's interesting but I found it hard to keep watching the video.
4. This was interesting to watch.
5. When shooting a video, the camera moves too fast, which can make you feel dizzy.
6. People are interesting scenes.
7. The scene in the video was peaceful and I wanted to take a walk in a green park like this.
8. I hope my answers help you.
9. It's a great place to refresh your mind.
10. Not sure watching only the video help or not. Maybe if it would be better with the sound.

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