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Effects of nature exposure on prosocial values and behavior
under conditions of stress

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Introduction

Imagine going home from your office in the city, you have had an exhausting day, people have annoyed you and your boss is putting you under a lot of pressure. You are feeling stressed, and you cannot stop focusing on that mental ache the stress is giving you. Suddenly, you encounter a person in need of help. What are the chances that you would help this person? Now imagine you are going home from your office with the same mental trouble, stress at work and pressure from your boss but this time you are walking through a park. Again, you see a person in need of help. Would the chances of you helping him or her be different here?

Relevance and Theoretical Background

Nature

Why are so many people visiting nature when they need a time out or go on vacation? There has been strong support for nature to have a very positive impact on humans, as studies have shown how it has a positive effect on both our physical health and our well-being. White et al. (2019) have examined the amount of time people spent in nature in a week, as well as their self-reported health and subjective well-being. It could be shown that the more time a person spends in nature, the better they feel both physically and mentally. Nature connectedness as well as engaging with nature seem to also play a big role in nature's effect on people's well-being and mental health (Richardson et al., 2021). Additionally, people participating in a prospective cohort study who moved to areas with more natural environment experienced better health benefits (Kivimäki et al., 2021), and there has been evidence about a lower risk of stroke mortality for people with more exposure to natural environments (Yuan et al., 2021) as well as an anti-inflammatory immune profile as a result from nature exposure (Andersen et al., 2021).

Nature and Stress

Not only does nature provide positive impacts on physical and mental health in general, but it can also act as a helpful factor for people dealing with stress. Systematic reviews have provided evidence that nature exposure (vs. control) helps to reduce stress related emotions (Corazon et al., 2019) and that nature promotes positive emotions (McMahan & Estes, 2015), as well as creative coping when being threatened (Fredrickson, 2001). Furthermore, children who live in neighborhoods with more (compared to less) natural environment have shown to be more resilient when faced with stressful events (Wells &

Evans, 2003). Moreover, people in nature conditions recovered faster physiologically from a stressful video compared to participants in the urban condition (Ulrich et al., 1991).

Nature and Prosocial Behavior

Besides the advantages of nature for physical and mental well-being and reducing stress, it also affects social behavior (Hartig, 2021). People have been found to be more helpful after shortly being exposed to nature (Guéguen & Stefan, 2016), and Reyes-Riveros et al. (2021) were able to show that nature and green spaces improve different aspects of human well-being, one of them being having good social relationships. Additionally, Weinstein et al. (2009) conducted a study in which participants were taking part in a resource allocation game. The results showed that immersion in natural environments leads to a higher valuing of intrinsic aspirations, thus reflecting prosocial and other-focused value orientations. Furthermore, Zelenski et al. (2015) could show that participants were behaving more cooperatively and that they showed more sustainable behavior after they were exposed to nature.

Stress and Prosocial Behavior

Prosocial behavior itself also seems to be regulated by stress. It has been shown that distress in social settings can lead to tend-and-befriend responses, displayed in nurturant activities promoting safety and reducing distress, and social networking (Taylor et al, 2000). In another study conducted by von Dawans et al. (2012), participants presented more prosocial behavior such as sharing, trust, and trustworthiness under social stress than participants with no acute social stress. They supported the tend-and-befriend hypothesis as their findings provided support for social approach behavior when being exposed to stress, acting as a buffer against stress. However, Passarelli and Buchanan (2020) did not find the same results. They had participants take part in a stress test and decide afterwards how much money they would be willing to donate. Neither time pressure nor psychological stress increased the participants' prosocial behavior. There are different papers opposing the idea that stress significantly increases prosocial behavior among humans (Passarelli and Buchanan, 2020; Nitschke et al, 2022). These different results point out that further research is necessary investigating the impact of stress on social behavior.

Nature, Stress, and Prosocial Behavior

Bringing these topics together, it seems necessary to investigate nature, stress, and social behavior in a combined setting. For instance, stressful neighborhoods with more nature such as grass and trees have shown to have less incidents of physical and psychological

violence and aggression (Kuo & Sullivan, 2001). Moreover, ostracized participants showed less aggressive and more prosocial and empathetic tendencies after having viewed natural compared to urban scenes (Poon et al., 2016).

The presented studies explain how closely the topics of nature, stress, and prosocial behavior are connected. What has not yet been clarified is whether nature can have a positive effect on prosocial behavior under the influence of stress, especially since studies about the influence of stress on prosocial behavior provide divided findings. Given the idea that nature has positive effects on a person's well-being (White et al., 2019) and prosocial behavior (Weinstein et al., 2009), it seems important to examine the effects of stress since studies have come to different conclusions. As different factors such as family, work or school, and societal issues create a lot of stress in people's life nowadays, it is important for us to create an environment in which people tend to show prosocial behavior and encounter more people showing empathy.

A Model of a Nature-based Biopsychosocial Resilience Theory

The model of a nature-based biopsychosocial resilience theory by White et al. (2023) combines (resilience to) stress, effects of nature on stress, and human reactions (biological, psychological, and social). It proposes that a human's homeostasis can be disrupted by a variety of environmental, socioeconomic, and personal factors causing stress which leads to a stress response and later a stress recovery which both can be observed in biological, psychological, and social manners. However, these responses can be altered with built-up resilience that underlies observable behavior before, during and/or after a stressful event. Influenced can be the resistance towards and the dealing with sources of stress (preventive resilience), the response to the stress (response resilience) and/or the recovery from the stress (recovery resilience). Social-ecological resilience, consisting of a person's communities and infrastructure, plays a big role in the response resilience, influencing the stress response. Furthermore, biopsychosocial resilience (consisting of biological, psychological, and social factors) which interacts with social-ecological resilience, has an impact on the recovery resilience, influencing the stress recovery. In this model, nature, nature contact, and nature-based solutions are integrated as essential factors influencing our stress response and recovery underlying the mechanisms that lead to resilience (see Appendix, Figure A1).

Hypotheses

Based on the literature and the presented model (White et al., 2023), there are two hypotheses concerning the social aspect of that model which will be investigated in this study.

The first hypothesis relates to the possibility that exposure to nature shortly before a stressful event may mitigate any subsequent negative impacts on prosocial behaviors (i.e. preventive resilience). The second hypothesis relates to the possibility that exposure to nature shortly after a stressful event may also mitigate potential negative (pro)social behaviors and promotes/increases prosocial behavior (i.e. response resilience). Although I had no clear hypothesis of which of the nature exposures (pre vs post stress) would have the most beneficial effects, this is something that I will explore by comparing the two.

Study Overview

In the proposed study, the plan was to investigate the effects of nature on prosocial behavior under the influence of pain. Based on the model of the nature-based biopsychosocial resilience theory by White et al. (2023), a study was conducted measuring in which way nature exposure can create preventive resilience when people are exposed before a stressful and painful event, and response resilience when people are exposed after a stressful and painful event. It was examined how these types of resilience induced by nature influence people's biological, psychological, and social stress responses and stress recovery. Physiological measures, psychological and social tests were used to compare the different outcomes depending on nature exposure before or after a stressful event.

Methods

Participants

An a-priori power analysis was conducted resulting in a planned sample size of $N = 100$ participants. The sample size was calculated using G*Power 3.1.9.7 with a power analysis conducted for an ANOVA model with repeated measures and a within-between interaction for prosocial values and ANOVA model with repeated measures between factors for prosocial behavior. The sample size was determined through a review of existing studies researching the effects of nature on prosocial values and behavior. For the prosocial value of community and relationships, reported effect sizes (Cohen's $d = 0.34$) researching the influence of nature exposure on intrinsic aspirations were used (Weinstein et al., 2009). For the analysis of the prosocial value altruism no paper could be found for a fitting effect size with similar analyses and methods which is why for this variable it will be relied on the effect size used for community and relationships. For the analysis of prosocial behavior, reported effect sizes researching the effects of nature on cooperative and sustainable behavior (Zelenski et al., 2015) were used (Cohen's $d = 0.60$). The calculation applying a type-I error probability of $\alpha = .05$, a power of $1 - \beta = .80$ and a number of 4 groups, resulted in an

estimated target sample size of $N = 100$ for prosocial values and $N = 68$ for prosocial behavior. Due to limited time and for the purpose of this master thesis, the analysis of this paper was done with $N = 68$ leading to the study being underpowered for prosocial values. However, testing is still being continued. Participants were selected based on specific criteria and excluded if one of them was not fulfilled (see Appendix, Table A1). As being part of a bigger study by Maximilian Eder, the target number of participants for that study was 160 (80 female, divided equally in all conditions) of which I tested 58 myself. The analysis for this master thesis was done with a smaller sample to complete on time. All in all, 139 people were screened, 69 participants were able to participate and planned to be analyzed of which one had to be removed as they did not finish the whole experiment but ended the study shortly after the beginning. Therefore, 68 participants between the ages 18 and 40 ($M = 24.46$, $SD = 4.40$; 25 male, 43 female), of which I tested 38 myself, participated for monetary compensation and were randomly distributed to one of four conditions. In these 4 groups there were 18 in group 1 (11 female, 7 male), 18 in group 2 (10 female, 8 male), 16 in group 3 (12 female, 4 male), and 16 in group 4 (10 female, 6 male). Written consent was given by each participant prior to the experimental session.

Table 1

Descriptive Statistics of the Aspiration Index and Value Orientations scale measuring values of Altruism, Community, and Relationships

Condition	Altruism		Community		Relationships	
	M	SD	M	SD	M	SD
Baseline						
Pre						
Nature	7.50	0.58	3.02	0.55	3.77	0.28
Office	8.00	0.84	3.35	0.59	3.73	0.36
Post						
Nature	8.34	1.63	3.19	0.48	3.76	0.40
Office	7.13	1.53	3.11	0.82	3.66	0.45
T1						
Pre						
Nature	7.53	1.38	3.07	0.56	3.71	0.19
Office	7.88	0.71	3.38	0.50	3.60	0.31

Post						
Nature	8.33	0.55	3.31	0.50	3.65	0.31
Office	7.48	1.42	3.21	0.93	3.66	0.27

Note: M = Mean, SD = Standard deviation, Pre = Video Exposure before stress task, Post = Video Exposure after stress task

Table 2

Descriptive Statistics of the Prosocial Effort Task questionnaire measuring Prosocial Behavior

Prosocial Behavior		
Condition	M	SD
Self		
Pre		
Nature	25.89	5.16
Office	28.76	3.38
Post		
Nature	27.93	4.79
Office	24.82	7.94
Other		
Pre		
Nature	20.63	7.19
Office	25.76	5.87
Post		
Nature	18.40	9.23
Office	24.24	6.51

Note: M = Mean, SD = Standard deviation Pre = Video Exposure before stress task, Post = Video Exposure after stress task

Study Design

In this study, there were four conditions under which the effects of nature and stress were perceived and analyzed (see Figure 1). In the first condition, participants would experience an office situation via a video before the stress task including listening to noises typical for an office. The second condition had the same procedure as the first one with the difference that participants experienced nature exposure via a video and sounds of nature before the stress task, based on the idea of preventive resilience preventing stress and view a fixation cross after the stress task. In the third condition, participants would experience the office exposure after the stress task and in the fourth condition, participants would experience the nature exposure after the stress task, based on the idea of response resilience.

Material

To measure prosocial values, participants received the Aspiration Index (Kasser & Ryan, 1993) and the Value Orientations scale (DeGroot & Steg, 2008). For the analysis of the difference between conditions of these values, specific items were chosen to be included in the analysis. For altruism values, participants were given four items from the Value Orientation scale devoted to attitudes towards altruism (DeGroot & Steg, 2008) to be rated on a 4-point Likert scale (from 1: “not important” to 4: “very important”, Cronbach’s α : pre = 0.88: post = 0.80). For community and relationship values, participants were given five items devoted to attitudes towards community and five items devoted to attitudes towards relationships from the Aspiration Index (Kasser & Ryan, 1993) to be rated on a 9-point Likert scale (with 1: “against my principles” and then ranged from 2: “do not agree” to 9: “completely agree”) (Cronbach’s α : pre = 0.85: post = 0.88 for community value items, Cronbach’s α : pre = 0.79: post = 0.66 for relationship value items).

Procedure

Arrival. The participant was upon arrival first given consent information and instructed verbally. The participant would then attach the ECG sensors to themselves and then, as shown in Table 1, filled out different questionnaires including the Aspiration Index (Kasser & Ryan, 1993) and the Value Orientations (DeGroot & Steg, 2008). They were then asked to fill out a Social Value Orientation questionnaire for five minutes during which baseline measures could be assessed.

First Intervention. In the following first intervention, participants of group 2 would here watch a video of a nature scenery with a transition from sunrise to sunset, listen to a natural soundscape and be told to imagine themselves being there (see Smalley & White,

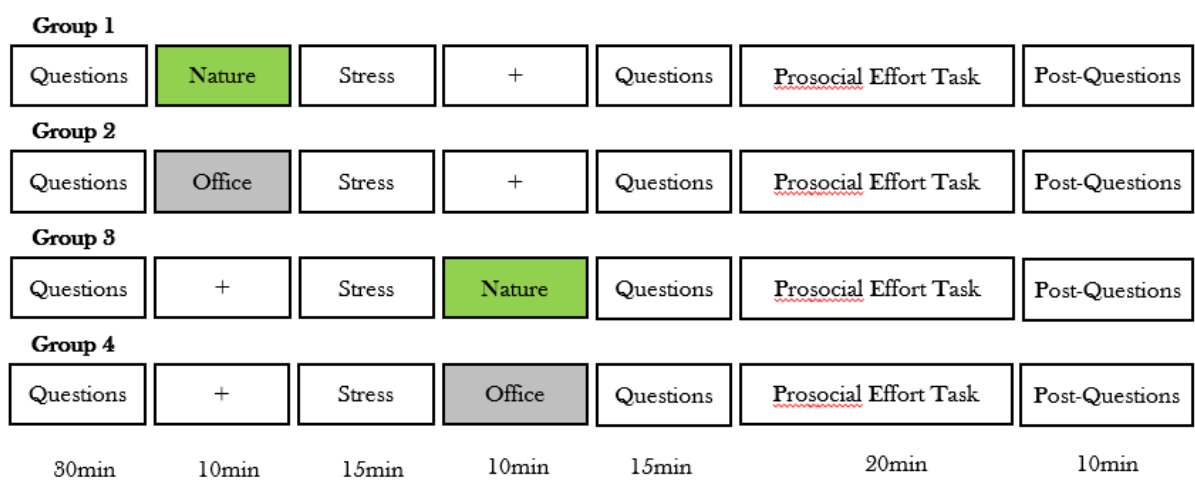
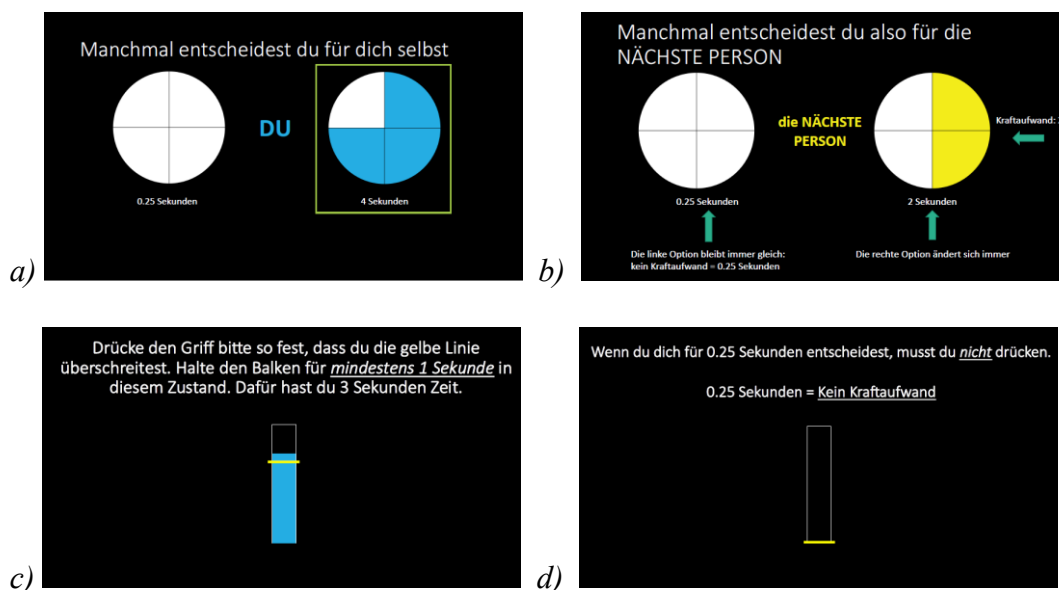
2023). Participants of group 1 were given a different intervention at the same time, watching a video with a windowless office containing a desk, a computer, and a fan, and listening to corresponding soundscapes with the instruction to imagine themselves to be in that environment. Participants of group 3 and 4 would watch and be told to focus on a fixation cross during that time, which were ten minutes for each group. The fixation cross was installed in all groups before or after the stress task (depending on the group) so that each had the same amount of time between the different measurements (saliva samples, values, etc). This was important to determine afterwards if one of the videos (nature, office or just time passing) before or after the stress task has an impact. Additionally, it might have been that the office situation had a negative impact that in comparison nature seems like a positive stimulus. Therefore, fixation crosses were included to also compare an office and a nature exposure to a neutral situation. Subjective measures were taken from participants in all groups after that concerning mood, stress, and anxiety states as well as saliva samples for an analysis of cortisol levels.

Stress Task. After this step, people in all groups would experience the cold pressor task as a pain task and the Maastricht Acute Stress Task (MAST) (Smeets et al., 2012) serving as the stress task, where elements of both tasks would alternate. This part of the experiment was executed by a third person acting as an expert for physiological measurements. In the cold pressor task, participants were asked to keep their hand in ice cold water for specific periods of time. In the MAST, participants would be asked to count backwards from different high numbers in steps of 17 while being told that they are being videotaped and rated by evaluators. Subjective mood ratings would be measured during this step, as well as pain and anticipation ratings.

Second Intervention. Following these tasks, participants of group 4 experienced the nature video and corresponding soundscape with the instruction to imagine themselves to be in this scenery, while group 3 were given the video showing the office and listen to the corresponding soundscape with the instruction to imagine themselves to be in that environment. Participants of groups 1 and 2 would watch and be told to focus on a fixation cross during that time, which again were ten minutes for each group. After that second intervention, measures of the subjective ratings were taken again as well as saliva samples. In the following step, participants of all groups completed different questionnaires including the Aspiration Index (Kasser & Ryan, 1993) and Value Orientation (DeGroot & Steg, 2008) questionnaires again, filled out subjective ratings and another saliva sample were taken.

Prosocial Effort Task. After that, the participants would complete the Prosocial Effort Task (Lockwood et al., 2017). At the beginning of the experiment, they were told that they had to do the MAST and cold pressor task twice, once in between the interventions and once at the end of the experiment. For the Prosocial Effort Task, they were told they had the chance to reduce seconds of the time that they had to put their hand in the cold water during the second run and had the chance to reduce time that the next participant had to put their hand into water during their first run. For reducing that time, they had to press a dynamometer and reach a certain level of strength for the presented seconds to actually be reduced (see Figure 2). The task had 64 trials in total during which participants were given the information whether they had the chance to reduce time for themselves or the next participant, they were presented the option to wait (where they would not have to put in strength and reduce 0.25 seconds for sure) and the option to put in strength (where they were presented one of four difficulty levels and seconds possible to reduce from one to four, whereas difficulty level and number of seconds were independent from each other). If they chose the option to press the dynamometer and put in strength, they had to keep that level of effort for a whole second and then win the announced number of seconds to be reduced. If they could not keep up the required effort, they received a reduction of zero seconds. After this task, subjective ratings were taken, as well as saliva samples and ratings of the remembered pain.

Post-questions and Debriefing. Following that, participants would rewatch short versions of the video and rate the stimuli on their perceived restorativeness, pleasantness and how much they would help them to deal with specific situations in their everyday life. Participants would additionally be asked to indicate their assumptions on the aim of the study, what they thought how the videos would impact their performance, and what they thought the experimenter believes on how the videos will impact the performance. Finally, the experimenter would debrief the participant. This part of the experiment was not included in the analysis of this paper but will be in the final analysis in the paper by Maximilian Eder.

Figure 1*Design Overview***Figure 2***Prosocial Effort Task Measurement*

Note. **a**, Decision for oneself. **b**, decision for other person. **c**, effort for large reward (more reduced seconds for hands in water in 2nd MAST). **d**, no effort for small reward (less reduced seconds).

Statistical Analysis Approach

To concentrate on the effects of nature under the influence of stress on prosocial values and behavior, this analysis will focus on these aspects of the study. For the whole statistical analysis, SPSS version 29 was used.

To statistically analyze the findings of this study, a mixed models ANOVA with repeated measures was conducted to analyze the prosocial values of altruism, community, and relationships, as well as to analyze the results of the Prosocial Effort Task for the prosocial behavior. For both analyses, the results were analyzed as such that the within-subjects aspect compared the results of the baseline and T1 (before stress task and nature/neutral exposure and after both) and the between-subjects aspect compared the results of the different groups. For the analysis of the data of the Prosocial Effort Task with the Generalized Mixed Model, only those decisions with the data “decisions = 1 or 2” (“I show no effort” or “I show effort”) were analyzed and data where participants were not fast enough in their decision whether they wanted to press or not was taken out since in these cases it was unclear how they would have decided and therefore could not be compared with the other data (all in all a number of 41 data points). As for model requirements, the sphericity of the model was given.

Results

Altruism

To analyze the altruism value data, I conducted a 2(Environment: Office/Nature) x 2 (Video Exposure Timepoint: Pre-stressor/post-stressor) x 2 (Time of Measurement: baseline/end) mixed effects ANOVA with repeated measures on the third factor. The analysis showed that there was no difference in the value of altruism between the different types of environments being shown, $F(1, 64) = 0.499, p = .482$. The value of altruism did not change between environments being shown before or after the stress task, $F(1, 64) = 1.771, p = .188$. There was also no interaction effect of altruism, environment being shown, and exposure before or after, $F(1, 64) = 2.52, p = .117$. An analysis of an interaction effect between environment and timing of the video showed significant results, $F(1, 64) = 7.169, p = .009$ (see Appendix, Figure B1). However, an investigation into this interaction showed that this appears mainly due to the large difference in means across conditions before the interventions. Participants in the office conditions who watched the video before the stress task had overall higher means compared to participants who watched a video after the stress task (see Appendix, Figure B2). However, participants in nature conditions who watched the video after the stress task had overall higher means compared to participants who watched the video before the stress task (see Appendix, Figure B3). The significant interaction effect therefore is not due to a significant interaction of environment and video exposure timepoint but to significant differences in the baseline measurement. This leads to the conclusion that all hypotheses for the prosocial value of altruism are not supported.

Community

To analyze the community value data, I conducted a 2(Environment: Office/Nature) x 2 (Video Exposure Timepoint: Pre-stressor/post-stressor) x 2 (Time of Measurement: baseline/end) mixed effects ANOVA with repeated measures on the third factor. The analysis demonstrates a significant increase in the value of community over time (Ms pre = 3.16 : post = 3.24, SDs pre = 0.62 : post = 0.64). However, further analyses showed that there was no difference in the value of community between the different types of environments being shown, $F(1, 64) = 0.136, p = .713$. Also, the value of community did neither change between environments being shown before or after the stress task, $F(1, 64) = 1.032, p = .313$. Furthermore, there was no interaction effect of community, environment being shown, and exposure before or after, $F(1, 64) = 0.001, p = .978$. This leads to the conclusion that all hypotheses for the prosocial value of community cannot be supported.

Relationships

To analyze the relationship value data I again conducted another 2(Environment: Office/Nature) x 2 (Video Exposure Timepoint: Pre-stressor/post-stressor) x 2 (Time of Measurement: baseline/end) mixed effects ANOVA with repeated measures on the third factor. The analysis demonstrates a significant decrease in the value of relationships over time (Ms pre = 3.73 : Post = 3.66, SDs pre = 0.37 : post = 0.27). However, further analyses showed that there was no difference in the value of relationships between the different types of environments being shown, $F(1, 64) = 0.145, p = .705$. The value of relationships neither changed between environments being shown before or after the stress task, $F(1, 64) = 0.434, p = 0.512$. There was no interaction effect of relationships, environment being shown, and exposure before or after, $F(1, 64) = 2.164, p = .146$. This leads to the conclusion that all hypotheses for the prosocial value of relationships cannot be supported.

Prosocial Behavior

To analyze the prosocial behavior data I conducted a 2(Setting: Office/Nature) x 2 (Time: Pre-stressor/post-stressor) x 2 (Agent: self/other) mixed effects ANOVA with repeated measures on the third factor. The analysis showed significant results for the variable agent $F(1, 64) = 19.962, p < .001$ implying that participants in all conditions showed more self-serving behavior than prosocial behavior towards others, and there was a significant difference in the prosocial behavior for others between the different types of environments being shown, $F(1, 64) = 7.419, p = .008$ (see Appendix, Figure B4), meaning that participants in the nature conditions showed significantly less prosocial behavior than participants in the office conditions. The prosocial behavior for others did not change between environments

being shown before or after the stress task, $F(1, 64) = 0.204, p = .653$. There was no interaction effect of prosocial behavior for others, environment being shown, and exposure before or after, $F(1, 64) = 2.637, p = .109$. This leads to the conclusion that all hypotheses for the prosocial behavior cannot be supported. However, the results show a tendency towards the other direction that less experienced nature increases prosocial behavior.

Discussion

As no relevant significant results could be found between the different groups for altruism, community, and relationships, it must be concluded from the analysis of this data that nature did not have an increasing or a decreasing effect on participants' prosocial values under the influence of stress. A reason for these findings might be that the chosen analyzed values are rather stable traits instead of states and are not likely to significantly change over such a short period of time as it was in the experiment. This might be due to specific traits in people's personalities being associated with altruistic values which therefore could explain why no short term changes could be observed (Argan & Argan, 2017). However, limitations will be further discussed in the next section of this paper.

The results of the Prosocial Effort Task indicate that nature did not promote prosocial behavior but in reverse might have led to a more egoistic behavior as participants in the nature conditions were more likely to press more for themselves and less for others. The descriptive data proposes also that participants viewing a video before the MAST show more prosocial behavior than participants who view the same video after the MAST.

Reason for this could be a calming effect of nature and more stress for the participants in the office conditions plus maybe a small stress-releasing effect of viewing any kind of video after a stress-inducing task. It seems that nature works better for stress release than an office (no matter if it is seen before or after a stressful event). In both cases, the video after a stress task might be better for relaxing than before a stress task as in the second case there is no distraction from stress between the stress factor and the potential prosocial behavior.

This behavior follows the tend-and-befriend theory that people under stress tend to react more prosocially to promote safety and reduce distress (Taylor et al., 2000). Prosocial behavior also acts as a buffering strategy against stress (von Dawans et al., 2012). The data from the present study shows support for this theory as people with potentially more stress demonstrated a higher amount of prosocial behavior during the Prosocial Effort Task.

White et al. (2023) expected an influence of nature on the social factor for people being under stress. However, this data shows that in fact instead of increasing prosocial behavior, the opposite turned out to be true. When being under stress participants did not behave more prosocially when they were shown nature but when they were not. Additionally, following stated ideas about the reasons for the data, nature contact had a great impact on the Recovery Resilience (less stress afterwards, less prosocial behavior) as in condition 4 (nature video after stress) participants showed the least prosocial behavior, potentially due to the release of stress. Nature also seemed to have a just slightly less impact on the Preventive Resilience as participants in condition 2 (nature video before stress) showed slightly more prosocial behavior than in condition 4 (nature video after stress) but still not as much as participants in the office conditions did. This analysis therefore supports White et al.'s thesis (2023) that nature acts as a resilience-building mechanism against stress but the result of this seems to be less instead of more prosocial behavior, unlike the hypotheses of this here paper presumed.

Finally, the hypotheses of this paper cannot be supported as nature did not lead to either higher prosocial values or a higher amount of prosocial behavior. Stress seemed to lead to the expected behavior people usually express under stress (being more prosocial) but it seems that in the combination of nature exposure and stress the positive effects of nature on prosocial behavior were disrupted.

In conclusion, the tend-and-befriend theory offers a good start for a possible reason to explain the observed behavior. However, for a certain answer as to why people were more prosocial in the office compared to nature conditions and more prosocial when they got to view a video before than video after the stress task, a detailed analysis incorporating stress levels and questionnaires should be implemented for a supported data-based explanation of the demonstrated behavior. However, this is beyond the scope of the current thesis.

Limitations and future directions

The experiment in its whole and the presented results had some limitations that should be mentioned and will be explained in the following with possible improvements to implement in further studies, as well as ideas to decrease issues and find out further information about the here discussed topic.

One point that should be considered as a possible limitation is the choice of methods. Since the experiment took part in a laboratory, the range of possible methods was limited to tasks that did not require too much space or involve too many people. Therefore, the

contemplation on which task would work best testing the effects of nature exposure on prosocial behavior resulted in a task that involved a hypothetical second person which was anonymous to the participant and whose experience of the consequences due to the participants' behavior the participants would know of but never witness. Different measures were discussed but the Prosocial Effort Task got chosen for it being linked to the MAST, therefore another task in the experiment and thus creating personal relevance for the participants themselves. In further studies, it would make sense to use an actual situation in which a real (and not hypothetical anonymous) second person is in need of help and is present so that they would not only be unknown figures and participants might actually see the impact they might have on them, similar to the study by Lockwood et al. (2017) stating that meeting the other person might increase prosocial behavior compared to situations where a second person stays anonymous. In this case, it would be important to investigate which relationship between the participant and the second person would make the most sense in this kind of experiment and what kind of impact helping the other person would have on the participant in terms of feelings through that interaction as helping others might also have positive effects on people's emotions and vice versa (prosocial behavior being enhanced through positive emotions). One could furthermore conduct a separate experiment to explore how different relationships increase or decrease the likelihood of prosocial behavior, including different kinds or levels of needed and/or given help with and without different stress stimuli following the example of the study by Passarelli and Buchanan (2020).

Since the nature and office experience in this experiment could not take place in these actual environments but were only shown via videos, future studies could look into different approaches and examine whether the effects might be greater or different in actual natural, office or other environments. Additionally, as a more active way of exposure for participants instead of watching videos of the environment on a computer screen, one might make use of virtual reality glasses to compare the effects different environments have on people's experiences and behavior, comparable to the study by Annerstedt et al. who focused on stress release through nature via virtual reality and its effects on physiological recovery (2013).

The aspect of motivation is another point that could have had an influence on the results. Since participants had to be collected and therefore be motivated with a reason why they should participate, a reward of approximately 25 Euros was handed out for a completed session to each participant. As studies have shown, external motivation reduces internal motivation (Deci et al., 1999) which can be observed in less time spent on tasks (Cameron & Pierce, 1994). Since it cannot be ruled out that some participants just came and took part to

receive the reward money, a possibly questionable (motivation for the) completion of the tasks and questionnaires should be taken into account when interpreting the results.

A factor that should also be taken into consideration is the effect that the experimenters might have had on the participants. Since the study was carried out by multiple different people as well as the stress task due to multiple students working on the project acting as experimenter and stressor, it cannot be ruled out that the included experimenters and stressors had different influences on the participants that they worked with. A possible avoidance of that issue would be to always use the same two people acting as the experimenter and stressor since in case the person made a difference and had an effect, it would always be the same.

Another factor that limits these results is the small number of prosocial values that were analyzed. In this analysis, only three kinds of values were included. Other studies might consider including more or different prosocial values in their analyses.

Additionally, as already mentioned before, a limitation for no relevant significant results of the prosocial values analysis might have been that the items measured stable traits rather than quicker changing states that are not likely to significantly change over a such short period of time as it was in this experiment.

Lastly, we have no knowledge about possible effects of the office exposure on stress or prosocial values or behavior from previous studies. Therefore, another study should be conducted to investigate these influences.

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Appendix A

Figure A1

Model of nature-based biopsychosocial resilience theory (White et al., 2023)

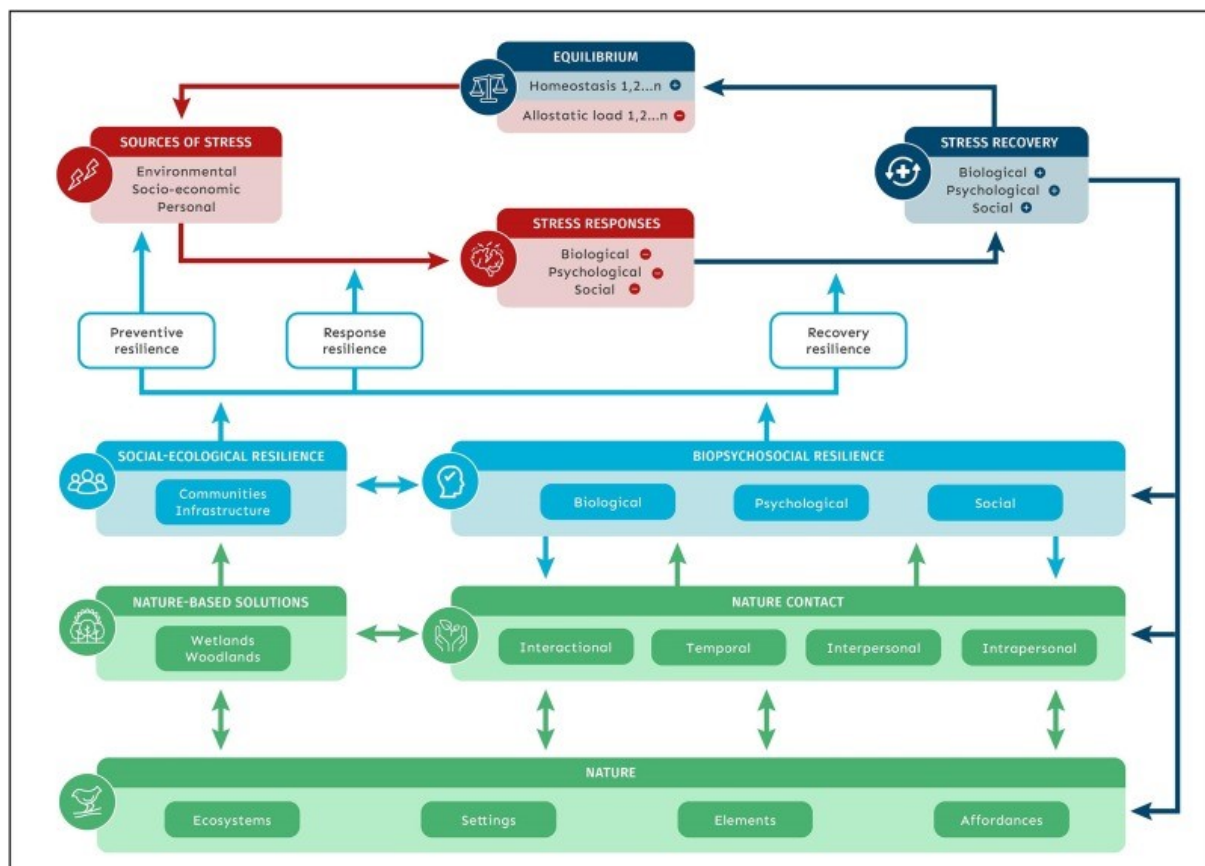


Table A1

Exclusion Criteria

Variable	Frage	Kriterium	Erklärung
Serial	-	Keines	Gibt einen personenspezifischen Code an mit dem die TeilnehmerInnen den Terminen am Scanner zugewiesen werden können.

Questnnr	-	Muss „pre-screen“ sein	Es gibt potenziell noch einen anderen Fragebogen. Der müsste dann natürlich ignoriert werden.
info_consent = IN02	1 = Ich habe die Informationen zum Ablauf dieser Studie gelesen und bin mit der Teilnahme einverstanden. -9 = Not answered	Muss „1“ sein	Nur bei Zustimmung geht Teilnahme. Fragebogen kann aber eigentlich nicht ausgefüllt werden wenn das nicht bestätigt wird.
PCODE = IN03_01	Geben Sie bitte als Erstes Ihren individuellen Teilnehmercode ein.	Keines	Eine von der Person erstellte ID die aus Anfangs- und Endbuchstaben des Namens + Geburtsjahr besteht
gender = SD01	"Welchem Geschlecht ordnen Sie sich zu?" 1 = weiblich 2 = männlich 3 = nicht-binär 5 = keine Angabe -9 = Not answered	Muss „1“ oder „2“ sein	Leider werden bei gängigen Stress-Studien nur „normative Personen“ eingeschlossen. Ich finde es diskriminierend, aber leider ist es Standard.
birthday = SD06_01	„Wann sind Sie geboren?“	Keines	Gibt Geburtstag an.
work = SD10	„Was machen Sie beruflich?“ 1 = Schülerin 2 = In Ausbildung zum	Sollte „3“ sein	Da wir nur Studierende testen (wegen Versicherung) sollte hier 3 angekreuzt

	3 = Studentin im Studienfach 4 = Angestellter als 5 = Selbstständig als 6 = Arbeitslos / Arbeit suchend 7 = Sonstiges		sein. Es kann aber sein, dass eine Person eine andere Beschäftigung hat und nebenbei studiert. Das sollte in den folgenden Feldern mit freier Antworteingabe work_specXXX überprüft werden.
work_spec1-5 = SD10_02 – SD10_05	Spezifikation was genau gemacht wird als Beschäftigung	Sollte auf irgendeine Art die Angabe eines Studiums beinhalten.	Wir dürfen nur Studierende testen.
language = SD35	„Wie gut sind Ihre Deutschkenntnisse?“ “ 1 = nicht gut 2 = mäßig gut 3 = ziemlich gut 4 = sehr gut	Muss „3“ oder „4“ sein.	Um die Instruktionen und den Ablauf zu verstehen ist ein gewisses Ausmaß an Deutschkenntnissen notwendig.
hand = AK01	"Welche ist Ihre dominante Hand?" 1 = Links 2 = Rechts 3 = Beide -9 = Not answered	Kein Kriterium	-
contracept = AK33	„Benutzen Sie zur Zeit Verhütungsmittel?“ 1 = Nein 2 = Ja	Kein Kriterium	Typ des Verhütungsmittels ist relevant

contracept_spec = AK34	„Welches Verhütungsmittel verwenden Sie?“ 1 = Die Pille 2 = Spirale (nicht hormonell) 3 = Spirale (hormonell) 4 = andere hormonelle Verhütungsmittel 5 = Andere 6 = Weiß ich nicht 7 = Ich benutze keine	Darf nicht „1“, „3“ oder „4“ sein. Sollte nicht „6“ sein.	Hormonelle Verhütung ist Ausschluss. Falls „6“ angegeben wurde nochmal bei Person nachfragen.
neuro_disorder = AK20	"Waren Sie in der Vergangenheit oder sind Sie aktuell in ärztlicher Behandlung wegen einer Gehirnschädigung, einer Gehirnerkrankung oder anderer neurologischer Erkrankungen?" 2 = Nein 1 = Ja, und zwar: -1 = keine Angabe -9 = Not answered	Muss „2“ sein.	Gehirnschädigungen beeinflussen Verarbeitung und damit die letztendlichen Ergebnisse.
neuro_disorder_whic h = AK20_01	Ja, und zwar	Keines	-

psych_disorder = AK18	"Leiden Sie an irgendeiner psychiatrischen oder psychischen Krankheit oder wurde eine solche bei Ihnen jemals diagnostiziert?" 2 = Nein 1 = Ja, und zwar: -1 = keine Angabe -9 = Not answered	Muss „2“ sein.	Psychische Störungen können Verarbeitung beeinflussen und damit die Ergebnisse verändern.
psych_disorder_which = AK18_01	Ja, und zwar	Keines	-
chronic_disorder = AK23	"Waren Sie in der Vergangenheit oder sind Sie aktuell in ärztlicher Behandlung wegen einer schwerwiegenden oder chronischen körperlichen Erkrankung?" 2 = Nein 1 = Ja, und zwar: -1 = keine Angabe -9 = Not answered	Muss „2“ sein.	Gerade bei Schmerzstudien sollten chronische Erkrankungen ausgeschlossen werden.
chronic_disorder_which = AK23_01	Ja, und zwar	Keines	-
pain_disorder = AK22	"Hatten Sie in der Vergangenheit oder haben Sie aktuell eine Krankheit	Muss „2“ sein.	Gerade bei Schmerzstudien sollten Schmerzkrankungen

	welche die Schmerzwahrnehmung beeinflusst?"		n ausgeschlossen werden.
	2 = Nein		
	1 = Ja, und zwar:		
	-9 = Not answered		
pain_disorder_which = AK22_01	Ja, und zwar	Keines	-
chronic_pain = AK21	"Hatten Sie in der Vergangenheit oder haben Sie aktuell chronische Schmerzen?"	Muss „2“ sein.	Gerade bei Schmerzstudien sollten Schmerzerkrankungen ausgeschlossen werden.
	2 = Nein		
	1 = Ja, und zwar:		
	-9 = Not answered		
chronic_pain_which = AK21_01	Ja, und zwar	Keines	-
regular_meds = AK29	"Nehmen Sie regelmäßig Medikamente"	Sollte „2“ sein.	Wenn „1“ muss geprüft werden welche das sind und wie beeinträchtigend diese wirken können.
	2 = Nein		
	1 = Ja, und zwar:		
	-9 = Not answered		
regular_meds_which = AK29_01	Ja, und zwar	Keines	Siehe Spezifikation oben.
pain_meds = AK08	"Nehmen Sie zur Zeit Schmerzmittel oder Schmerzpflaster?"	Muss „2“ sein.	Schmerzmittel beeinflussen die Schmerzwahrnehmung.
	2 = Nein		
	1 = Ja, und zwar:		
	-9 = Not answered		

pain_meds_which = AK08_01	Ja, und zwar	Keines	-
weed = AK06_01	"Wenn Sie an die letzten drei Monate zurückdenken, wie oft haben Sie die folgenden Substanzen konsumiert?" - Cannabis - Kokain - Amphetamine - Inhalantien - Beruhigungsmittel - Halluzinogene - Opiate 1 = nie 2 = 1-2 mal 3 = monatlich 4 = wöchentlich 5 = täglich oder fast täglich -9 = Not answered	Nicht mehr als zwei der genannten Drogen und nicht häufiger als 1-2 Mal in den letzten drei Monaten. Kann im Bedarfsfall diskutiert werden.	Es sollte kein exzessiver Drogenkonsum vorkommen. Dieser kann sich auf Verarbeitung auswirken.
cocaine = AK06_02			
amphet = AK06_03			
inhalant = AK06_04			
tranquil = AK06_05			
halluci = AK06_06			
opiate = AK06_07			
tobacco = AK07_01	"Geben Sie bitte an, wie häufig Sie folgende Genussmittel konsumieren:"	Keines	-

- Tabak
- Alkohol
- Kaffee
- Energydrinks
- 1 = nie
- 2 = weniger als 1
mal wöchentlich
- 3 = 1-3 mal
wöchentlich
- 4 = täglich oder fast
täglich
- 5 = mehrmals
täglich
- 9 = Not answered

alcohol = AK07_02

coffee = AK07_03

energy_drink =

AK07_04

pharma_study =
AK05

"Nehmen Sie
momentan an
pharmakologischen
Studien teil?"

2 = Nein

1 = Ja

-9 = Not answered

Muss „2“ sein.

Pharmakologische
Studien können mit
Substanzen assoziiert
sein, die für die
Studie
Ausschlussgrund
sind.

past_study = AK17

"Haben Sie schon
einmal an einer
ähnlichen Studie
oder einem
ähnlichen
Forschungsprojekt
teilgenommen bzw.
nehmen Sie aktuell

Wenn „1“
schauen
welche Studie
es war und ob
diese sehr
ähnlich zur
aktuellen ist.

Wenn Protokoll der
vorherigen Studie
sehr ähnlich ist, kann
das bisherige Wissen
die Studienergebnisse
beeinträchtigen.
Beispielsweise gibt
es ein paralleles
Projekt auf der Uni-

	an einer anderen Studie teil?" 2 = Nein 1 = Ja, und dabei ging/geht es um: -9 = Not answered		Wien das die Veränderung der Schmerzwahrnehmung durch Kunst untersucht.
past_study_which = AK17_01	Ja, und dabei ging/geht es um	Siehe oben	
email = AK24_01	-	Email der TeilnehmerInnen	-
tobacco_regular = AK31	“Rauchen Sie regelmäßig?” 1 = Nein 2 = Ja pro Tag etwa xxx Zigaretten	Wenn „2“ dann in nächster Frage prüfen wie viele Zigaretten Person raucht.	Tabak wirkt sich auf Hormonmessung aus.
tobacco_regular_quantity = AK31_02	„Ja pro Tag etwa xxx Zigaretten“	Muss unter 5 pro Tag sein.	Zu viele Zigaretten pro Tag sind problematisch für Cortisolmessung.
alcohol_regular = AK32	„Wie häufig konsumieren Sie in der Regel pro Woche Alkohol?“ (in Einheiten) 101 = 0 1 = 1 2 = 2 ...Usw.	Darf nicht größer als „10“ sein. (ACHTUNG 101 ist ok da gleich 0 Einheiten)	Personen mit Alkoholproblem müssen ausgeschlossen werden.

period = AK35_01	„Wann war der erste Tag Ihrer letzten Monatsblutung (vor wie vielen Tagen, ca.)?“	Keines	Wird als Kontrollvariable verwendet
period_dur = AK36_01	„Wie lange dauert Ihr Zyklus normalerweise? (vom Anfang der Monatsblutung bis zum letzten Tag vor Beginn der nächsten Monatsblutung; z.B. 28 Tage)“	Keines	Wird als Kontrollvariable verwendet
circulation = AK37	„Haben Sie regelmäßig Probleme mit Ihrem Kreislauf (z.B. Schwindel, niedriger Blutdruck, Schwarz/Flimmern vor Augen)“ 1 = Nein 2 = Ja	Muss „1“ sein	Wir hatten in der Pilotierung Probleme mit einer Person, der bei MAST schwarz vor Augen wurde. Deshalb Kreislaufprobleme ausschließen.
ice_bath = AK38	„Gehen Sie regelmäßig Eisbaden / Kaltwasserbaden (z.B. Kneippen, Wim-Hof-Methode)?“ 1 = Nein 2 = Ja	Muss „1“ sein	Eisbaden und Gewohnheit mit kaltem Wasser führt potenziell zu Wirksamkeitsproblemen beim MAST.

Appendix B

Figure B1

Differences in Value of Altruism between Video Exposure Before and After Stress Task

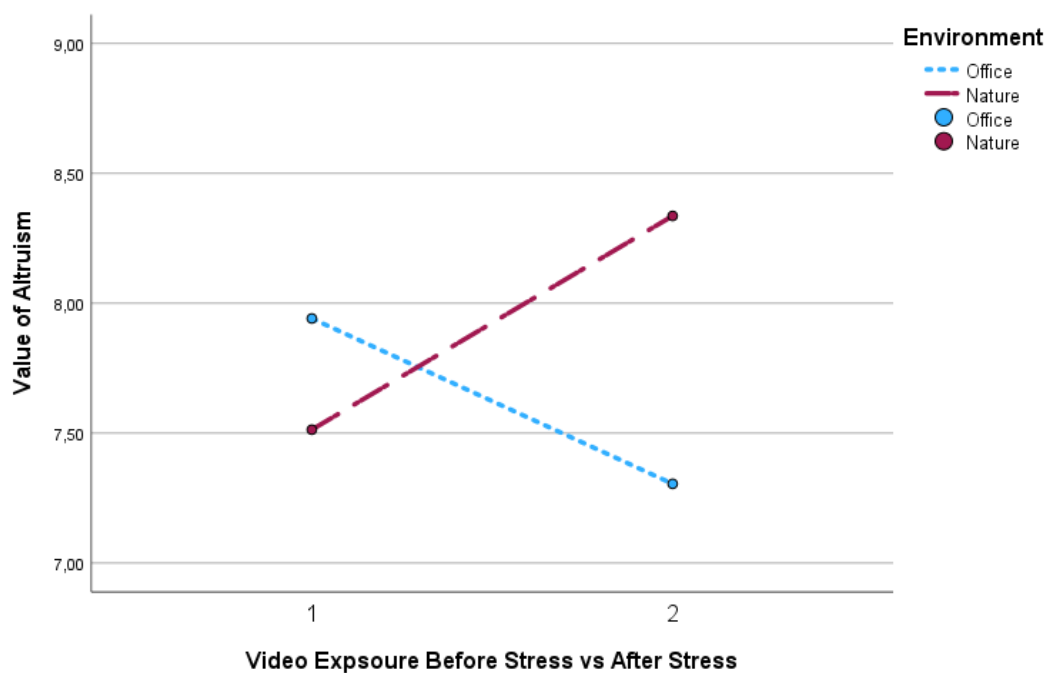


Figure B2

Changes in value of Altruism with Office Exposure

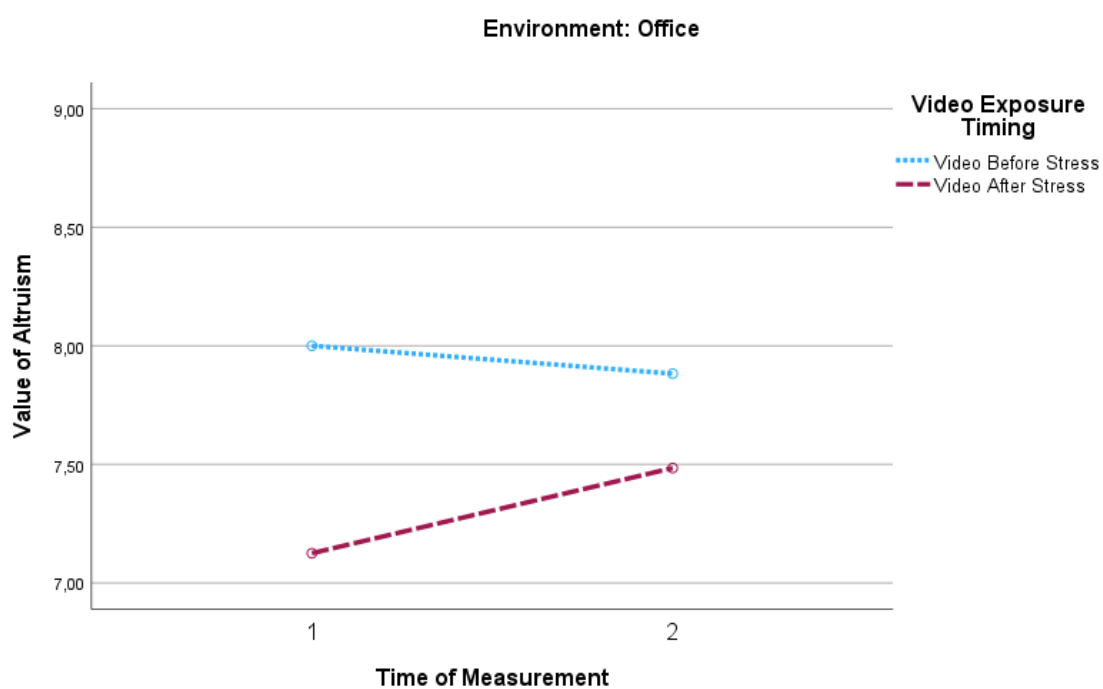
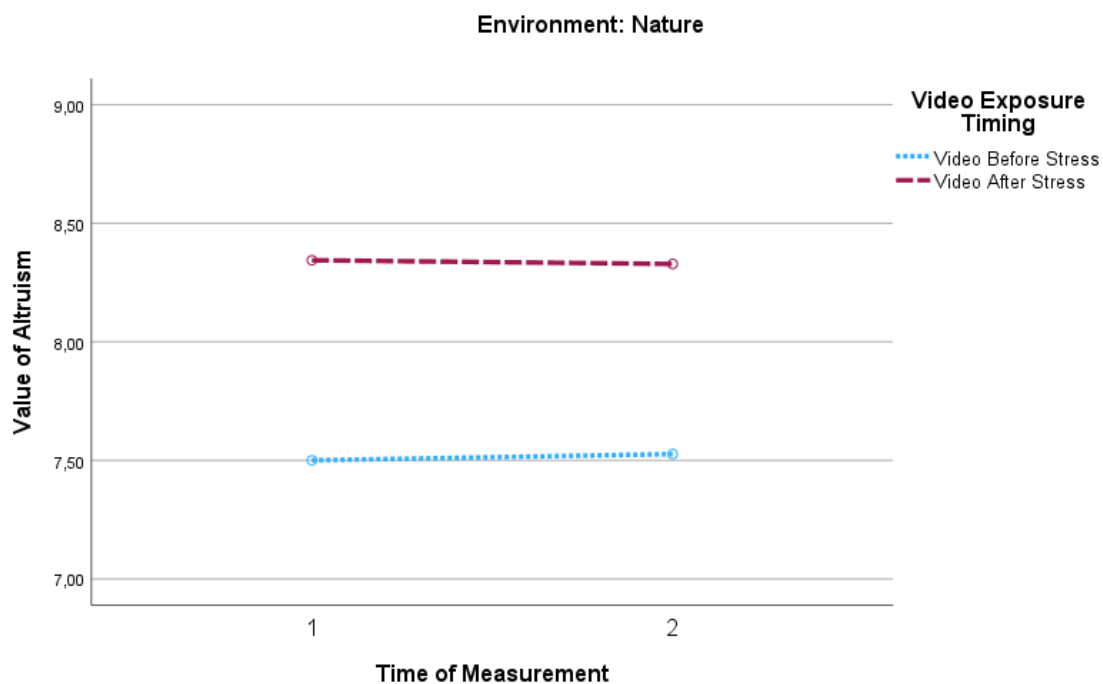
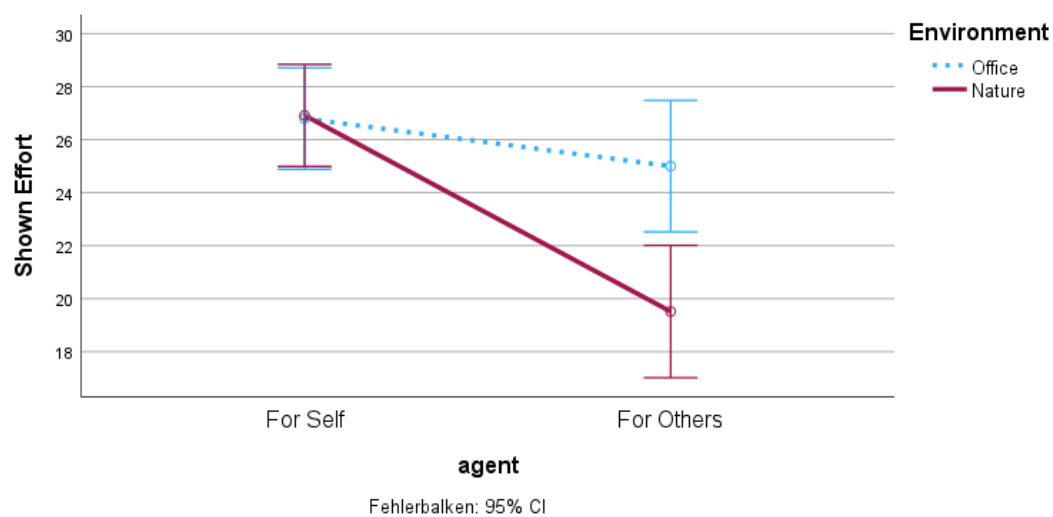


Figure B3*Changes in value of Altruism with Nature Exposure***Figure B4***Differences in Prosocial Behavior for Self vs. for Others*

Abstract

Effects of nature have been shown to be very strong when it comes to well-being, calming effects, and prosocial behavior. In this study, the goal was to examine the effects of nature exposure on prosocial values and behavior in a situation where a person would be experiencing stress before or after being exposed to nature. This was based on the recently published Nature-Based Biopsychosocial Resilience Theory which addresses nature effects on stress, including social, psychological, and physiological aspects, focusing here on the social aspect. Data of 68 participants was collected who took part in the study in which they would experience stress in the form of a cold pressor task and the Maastricht Acute Stress Task and be exposed to nature or an office as a control group via a video. To ascertain the participants' prosocial values and behavior, an Aspiration Index and Value Orientation tests and a Prosocial Effort Task were applied. Based on previous literature it was expected that nature exposure has positive effects on participants' prosocial values and behavior when experiencing stress. This relates to nature exposure both before and after a stressful event compared to no nature exposure at all. As an additional exploratory research question, it was tested whether there is a difference of the effect of nature exposure on prosocial behavior depending on people being exposed to nature before or after stress. Analyses showed no statistically significant differences in any of the participants' tested prosocial values (analyzed were items for altruism, community, and relationships) between the exposure groups before and after stress and exposure. Contrary to beliefs, the analysis showed an increase of prosocial behavior in the office conditions. It is discussed whether in accordance with the tend-and-befriend theory participants were calmed in nature conditions but looked out for others when being more stressed.

Keywords: nature, resilience, stress, prosocial behavior, prosocial values

Zusammenfassung

Die starken Effekte von Natur auf die Gesundheit, prosoziales Verhalten und ihre beruhigende Wirkung konnten schon vielfach belegt werden. Das Ziel dieser Studie war, die Effekte von Naturerleben auf prosoziale Werte und prosoziales Verhalten in einer Situation zu untersuchen, in welcher eine Person Stress ausgesetzt ist, bevor oder nachdem sie Natur beobachtet hat. Der Aufbau der Studie basiert auf der kürzlich publizierten Nature-Based Biopsychosocial Resilience Theory, welches sich mit den Effekten von Natur auf Stress, inklusive sozialen, psychologischen und physiologischen Aspekten auseinandersetzt. In dieser Arbeit liegt der Fokus auf dem sozialen Bereich. 68 Teilnehmer*innen nahmen an einer Studie teil, bei der sie Stress in Form eines Cold Pressor Tasks und des Maastricht Acute Stress Tasks erlebten und ein Video gezeigt bekamen, das ihnen entweder Natur oder ein Büroraum zeigte. Um die prosozialen Werte und ihr prosoziales Verhalten zu messen, wurden ein Aspiration Index und Value Orientation Test, sowie ein Prosocial Effort Task angewendet. Basierend auf bestehender Literatur wurde angenommen, dass das Naturerleben (sowohl vor als auch nach Stresserleben) positive Effekte auf die prosozialen Werte und das prosoziale Verhalten hat im Vergleich dazu, wenn man keine Natur beobachtet. Als zusätzliche exploratorische Forschungsfrage wurde untersucht, ob es Unterschiede in den Effekten von Naturerleben (auf prosoziale Werte und prosoziales Verhalten) gibt abhängig davon, ob Teilnehmer*innen vor oder nach dem Stress ein Naturvideo sehen. Analysen zeigten keine signifikanten Unterschiede bezüglich der getesteten prosozialen Werte (analysiert wurden Items zu Altruismus, Gemeinschaftsgefühl und Beziehungen) zwischen den Gruppen. Im Gegensatz zu den Annahmen zeigte die Analyse ein gesteigertes prosoziales Verhalten in den Gruppen, welche ein Video von einem Büro sahen. Im Zusammenhang der tend-and-befriend Theorie wird diskutiert, ob Teilnehmer*innen durch Natur entspannter waren und jene in Büro-Bedingungen sich durch mehr Stress mehr für andere einsetzten.

Stichwörter: Natur, Resilienz, Stress, prosoziales Verhalten, prosoziale Werte