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The regulatory role of soft fascination with nature and Nature Relatedness in improving the voluntary attention

Regulacyjna rola miękkiej fascynacji przyrodą i pokrewieństwa z przyrodą w zwiększaniu efektywności uwagi dowolnej

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Introduction

According to the concept of *biophilia*, humans are a part of nature and experience positive feelings towards organisms, species and habitats that ensured their adaptation and development (Wilson 1984). Therefore, people tend to prefer natural rather than urban landscapes, and enjoy resting in nature (Frumkin 2001; Ulrich 1981). Empirical research supports the beneficial effects of communing with inanimate and animate nature in reducing physiological and psychological stress as well as improving well-being (Brown et al. 2013; von Lindern et al. 2017; Vanaken and Danckaerts 2018). Contact with nature also fosters personality development in terms of emotional and cognitive sensitivity and empathy towards all living organisms (Feral 1998; Kaplan 1995).

The restorative role of nature for attention, short and long-term memory (knowledge acquisition) and processing speed has also empirical support both with young and older adults (Vella-Brodrick and Gilowska 2022; Hartig et al 2014; Astell-Burt and Feng 2020). For example, increase in voluntary attention (both sustained and selective attention) and working memory as an effect of exposure to green space was documented in a number of studies (Amicone et al. 2018; Johnson et al. 2019; Mason et al. 2021). Similarly, spatial working memory (Flouri 2019) and academic performance (Li et al. 2019) was related to green space experience. However, the majority of these studies were based on a correlational or quasi-experimental, between-subject research design, making it difficult to establish cause-and-effect relationships (Montoya 2019). Therefore, it was decided to conduct an experimental study of the within-subject design model.

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The facilitating role of nature in cognitive recovery is most often explained with reference to two theories: Attention Restoration Theory (ART; Kaplan 1995) and the Stress Reduction Theory (SRT; Ulrich 1981). The first approach points that the natural environment elicits soft fascination that can release the need for relentless goal-voluntary attention processes, and subsequently facilitates cognitive restoration. However, the second one proves that stress reduction induced by the natural environment can, in turn, enhance cognition (with mediating role of tension/relaxation, mood state) (Wallner et al. 2018).

According to the ART, improvement in cognitive performance can be explained by the regenerative role of soft fascination with nature, as evidenced by the greater engagement with landscape exploration observed in eye-tracking studies (Stevenson et al. 2019). According to Kahneman's (1973) concept, attention is not an unlimited resource. However, compared to exogenous (involuntary) attention, endogenous (voluntary) attention depletes more mental resources which require replenishment. According to the ART, both types of attention act interchangeably, i.e. the engagement of involuntary attention "frees" voluntary attention and vice versa (Kaplan and Kaplan 1989; Kaplan 1995). Thus, regeneration of voluntary attention is possible by "switching on" involuntary attention through, for example, a specific experience of the so-called *soft fascination* derived from nature. Fascinating elements of the natural environment such as birds singing, the sound of wind blowing through the trees, the sight of clouds, sunrise or sunset, or a flowing stream or river, trigger *soft fascination*, as contrasted with *hard fascination*, which is engaged while watching a sporting event or a suspenseful movie and requires full concentration of voluntary attention.

Environmental factors that support *soft fascination* are characterized by a low intensity of change and a distinct component of aesthetic experiences (Kaplan and Kaplan, 1989). Natural stimuli triggering involuntary attention are characterized by awe, relief, safety and geographical fit (the opposite poles: repetition, overload, anxiety, unfamiliarity with the environment). The experience of awe is aroused by an environment based on harmonious change, while monotonous, repetitive environment, conversely, fosters boredom. The feeling of relief is evoked by "being away" and separated from everyday thoughts and worries, while excessive stimuli generated by the environment overwhelm and overload people. A sense of security is fostered by a predictable environment, devoid of sudden, unusual, or unexpected phenomena; anxiety, on the other hand, is generated by the environment loaded with threat factors. Geographical fit is based on an individual's biographical connection to a particular type of natural ecosystem, while unfamiliarity with the environment refers to unknown

and unfamiliar surroundings. However, it can be assumed that the readiness to experience fascination with nature is moderated by a number of individual factors, especially by the intensity of personal relatedness to nature.

The concept of nature relatedness (NR) is considered "trait-like" because it is relatively stable over time and across situations, yet not precisely defined (Nisbet et al. 2009). Nature relatedness refers to the extent to which nature is part of a person's human identity or cognitive representation. Its predictive role has been shown in a few studies so far. For example, individuals with high levels of NR are more likely to behave in an ecological way and care about the environment (Perkins et al. 2010). Such individuals are much more concerned with the impact they have on nature, and the resulting environmental implications such as pollution and nature protection (Nisbet et al. 2009; Restall and Conrad 2015). It can be inferred from this that they derive tangible personal benefits from contact with the natural environment. Some research show that NR directly facilitates the positive affect, life satisfaction, happiness and indirectly affects the relation between the exposure on natural environment and vitality (Nisbet et al. 2011; Capaldi et al 2014; Zelenski and Nisbet 2014). Therefore, NR increases the susceptibility to the regenerative influence of nature on emotional health. However, the role of NR in increasing the efficiency of voluntary attention followed the *soft fascination with nature* is yet unknown. Hence, the purpose of this study was to explore the impact of natural environment on the restoration of voluntary attention resources considering the individual differences in NR.

Following the above analysis, the following research hypotheses can be put forward:

1. *The soft fascination with nature environment increases the voluntary attention, whereas the opposite experience of urban-built environment decreases the voluntary attention.*
2. *A nature relatedness is positively associated with the improving of the voluntary attention after experiencing the soft fascination with nature.*

Method

2.1. Participants

Overall, 99 respondents aged 18 to 70 years (M = 33.32; SD = 12.04) participated in the study, with men (n = 59; 59.6%) constituting a majority compared to women (n = 40; 40.4%). Half of the study participants had a college degree

(n = 50; 50.5%), and more than 40% of the sample had a high school education (n = 46; 46.5%). The completion of the secondary education ensured that the participants could efficiently add in the range 0–100. The sample size was determined by the algorithm (50 + n x 15) as proposed by Tabachnik and Fidell (2007). As there were three variables (measurement of the speed and accuracy of counting and the intensity of NR), the sample size of 99 was sufficient in this study. We used the snow-ball technique to recruit the adult respondents.

2.2. Tools – Videos and NR Scale

The selection of videos with urban and natural scenes was based on eight expert judges' decisions (5th year psychology students – familiar with Kaplan's Attention Restoration Theory and the criteria of the *soft fascination*). They rated each 2–3 minute video considering the following dimensions: awe vs. repetition (1), relief vs. overload (2), safety vs. anxiety (3) and geographical fit vs. unfamiliarity with the environment (4) on a 7-point Likert-type scale (the lower rank the more negative characteristic and the higher the more positive ones, with 4 – neutral) (table 1).

Table 1. The ranks of urban and natural environment videos in terms of: awe vs. repetition (1), relief vs. overload (2), safety vs. anxiety (3) and geographical fit vs. unfamiliarity with the environment (4) and the level of agreement among experts

Titles and links to the video footages	1	2	3	4	W	P
Rush Hour Traffic https://www.youtube.com/watch?v=1ZupwFOhjl4	3.12	0.62	2.0	1.37	.66	.001
Lagos City https://www.youtube.com/watch?v=SU5LtF3DCz4	2.62	2.75	4.12	3.75	.22	.14
Incredible Indian Traffic https://www.youtube.com/watch?v=KnPiP9PkLAs	4.12	0.5	0.87	1.62	.01	.97
Daily Life in India https://www.youtube.com/watch?v=mDLCd70iTeE	3.75	1.75	2.0	1.62	.02	.94
Taiwan Taipei https://www.youtube.com/watch?v=Ufq_F0doylI	1.37	1.62	3.12	2.37	.51	.007
Rainforest Animals https://www.youtube.com/watch?v=STWVMl_cGuc	4.25	4.86	5.75	5.88	.28	.08
Walking bird singing https://www.youtube.com/watch?v=K-Vr2bSMU7o	3.88	4.63	6.0	5.75	.55	.004

Walk in forest Kneip https://www.youtube.com/watch?v=71lHOXRTJSU	6.0	6.5	6.5	6.38	.81	.0002
Jog in woodlands https://www.youtube.com/watch?v=u52PaO9PWCc	5.13	5.0	5.0	4.87	.52	.006
Calming Virtual Forest https://www.youtube.com/watch?v=ZNjT5jOJPiA	5.88	5.5	4.6	3.5	.17	.25

Source: W Kendall Test

The *Rush Hour Traffic* video received the highest experts' rank and agreement (p = .001) on properties such as repetition, overload, anxiety, and unfamiliarity with the environment, while the *Walk in forest Kneip* video received the highest rank and agreement (p = .0002) on properties such as awe, relief, safety, and geographic fit. Therefore, these two video footages were used in the study to facilitate the soft fascination with nature and the opposite experience.

The *Nature Relatedness Scale* assesses the overall level of connectedness to nature and the intensity of each of its three dimensions: *NR-Self*, *NR-Perspective*, *NR-Experience*. *NR-Self* represents internalized identification with nature, reflecting feelings and thoughts about personal connection to nature. *NR-Perspective* reflects an external, nature-related worldview, a sense of agency with respect to individual human actions and their impact on all living things. Finally, *NR-Experience* reflects physical familiarity with the natural world, comfort level, and desire to be in nature. The tool obtained satisfactory psychometric properties (Nisbet et al. 2009).

2.3. Procedure

The hypotheses were tested online with a multimedia computer program: "Nature as an ally in arithmetic", designed specifically for the purpose of this study. The experiment was based on a within-subject design with a triple measurement and alternating intervention, as presented in Figure 1.

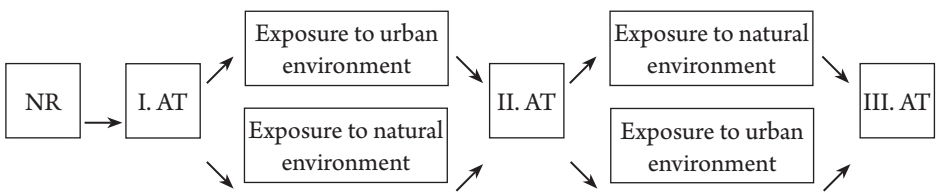

Fig. 1. A schematic of experimental within-subject design

Voluntary attention (dependent variable) was assessed on the basis of performance accuracy and solving time separately for three series of ten randomly generated arithmetic tasks (AT – addition of two-digit numbers exceeding the decimal threshold, e.g. 24+38). This task limits the role of such cognitive functions as perception, memory, reasoning and speech, since numbers are constantly presented on the monitor and addition is routine for adults. Most adults do not use complex cognitive functions for the majority of simple number addition or subtraction because of the availability of efficient procedural methods (Cambell and Xue 2001). The task is therefore not difficult for them, but it does require concentration of voluntary attention. Many researches prove that the sustained attention is a strong predictor of arithmetic achievement (Orbach and Fritz 2022). For this reason, some attention tests measurements apply the design based on digit arithmetic operations (e.g. German instrument Konzentrationstest 3–4 R by Nell et al 2006). We decided to adopt the idea as well.

The independent variable was the specific video footage (a three-minute video showing the natural environment or the urban environment), and the predicting variable was the individual's level of the Relatedness to Nature (NR).

The alternating experimental model was used to control for the practice effects of the counting performance. Therefore, the order of the experimental factor was reversed, i.e., a randomly selected half of the respondents were exposed to the urban environment first and then to the natural environment, and the other half were exposed to a reversed sequence of videos.

The experimental procedure was preceded by an invitation (online via Facebook portal) to participate in the study based on voluntary recruitment. After getting acquainted with its purpose and course, the candidate made a decision whether to participate in the study or not. Therefore, the participants either exited the program, if they did not want to take part in the experiment, or moved to the next page of the survey, if they agreed to participate (to respect the ethics rules of the research). At that point, the participants responded to the items of the NR Scale. After that they were confronted with arithmetic tasks in particular conditions (natural and next urban, or inversely) using the multimedia computer program "*Nature as an ally in arithmetic*" (the program title was masked for the respondents to avoid any prejudice). The within-person design was implemented to control the influence of individual differences of the respondents on the effectiveness of attention after different environment exposure (Montoya 2019). Due to the lockdown associated with the SARS-CoV-2 pandemic, the procedure was carried out remotely.

To test the research hypotheses ANOVA, Student's t-test and linear regression were used in the analysis.

Results

1. Task performance accuracy and task solving time as well as NR

First, descriptive statistics were calculated for task solving accuracy and time across series and conditions as well as for the NR subscales and total score (table 2).

Table 2. Descriptive statistics of task solving accuracy, task solving time, and NR (n - 99).

The variables	R	M	SD	Sk	Kurt	K-S
First series task solving accuracy	0-10	9.43	1.28	-4.72	30.36	0.35**
First series task solving time	28–158	70.09	23.74	1.25	2.26	0.11
Second series task solving accuracy	0–10	9.31	1.29	-4.41	27.69	0.30**
Second series task solving time	20–120	61.94	16.84	0.50	1.24	0.08
Third series task solving accuracy	0–10	9.38	1.24	-4.89	33.84	0.31**
Third series task solving time	24–108	59.79	16.64	0.60	0.62	0.08
Task solving accuracy (total)	0–0	28.13	3.36	-6.27	50.33	0.29**
Task solving time (total)	76–386	191.82	53.00	0.84	1.83	0.08
Task solving accuracy in the urban condition	0-10	9.34	1.27	-4.57	29.72	0.30**
Task solving time in the urban condition	20–120	62.71	16.83	0.63	1.29	0.08

Task solving accuracy in the natural condition	0–10	9.35	1.26	-4.71	31.35	0.30**
Task solving time in the natural condition	24–108	59.02	16.52	0.47	0.47	0.06
The *Self* component of NR	18–40	32.14	5.50	-0.44	-0.48	0.12
The *Experience* component of NR	10–35	25.47	6.35	-0.55	-0.51	0.10
The *Perspective* component of NR	10–30	23.77	4.00	-0.92	0.73	0.15*
Total score of NR	53–103	81.38	12.95	-0.11	-0.91	0.09

Source: *K-S* (Kolmorogow-Smirnov test of the normality distribution)
* $p < .05$; ** $p < .01$

The statistics showed that the distribution of arithmetic tasks' accuracy was left-skewed. which means that most of the respondents performed arithmetic calculations correctly. On the other hand, the task solving time data in each series was normally distributed, which indicates that the speed of work varied in the sample. The NR data was not particularly skewed or kurtic, only the distribution of results on the *NR-Perspective* dimension was slightly left-skewed and platykurtic. Given these findings, comparative analyses were run in terms of counting speed mediated by a situational factor (exposure to nature vs. city) and an individual factor (NR).

2. Effects of exposure to the natural and urban environments and NR on the functioning of voluntary attention

Prior to conducting the main analyses, we additionally examined whether there was a practice effect in the arithmetic performance. For this purpose, the within-subjects factor was included in the analyses (first, second, and third measurement), ignoring the between-subject factor (natural vs. urban environment). In other words, only the sequence of tasks performed was taken into account in the analyses so as to check whether there was a progression in solving successive tasks that would indicate the occurrence of practice effects. These analyses were calculated for both dependent variables, i.e., task performance accuracy (Table 3) and task performance time (Table 4).

Table 3. The effect of measurement order on task performance accuracy

		M	*SD*	*F*	*p*	η^2	*Post-hoc*
A	First measurement	9.43	1.28	0.69	.50	.007	*Ns*
B	Second measurement	9.31	1.29				
C	Third measurement	9.38	1.24				

Table 4. The effect of measurement order on task solving speed

		M	*SD*	*F*	*P*	η^2	*Post-hoc*
A	First measurement	70.09	23.74	31.73	.000	0.242	B < A
B	Second measurement	61.94	16.84				C < A
C	Third measurement	59.79	16.64				

It was found that task performance accuracy did not increase with subsequent performance [$F(2, 194) = 0.69$; $p = .502$; $\eta 2 = .007$]. In contrast, statistically significant differences were observed in time taken to complete subsequent tasks [$F(2, 194) = 31.73$; $p < .001$; $\eta 2 = .242$]. Simple effects tests with Bonferroni's correction, comparing individual pairs of means, showed that in the second and third measurements, the time to solve arithmetic tasks was significantly shorter than the time needed to solve the first task ($p < .001$). Despite this, in order to control for the non-significant effect of skill between the 2nd and 3rd measurements, respondents solved the tasks in a mixed variant (50% continued solving the tasks after exposure to the city and then to nature and 50% vice versa).

To verify the hypothesis regarding the differences in addition speed in the two experimental conditions (nature vs. urban), a Student's t-test was used (table 5).

Table 5. Two-digit-numbers addition time after seeing natural and urban scenes

Addition time	M	SD	T	*df*	*P*
Urban	62.71	16.83	3.00	98	.003
Nature	59.02	16.52			

A comparison of mean scores in the two experimental conditions indicated lower counting speed after the urban condition compared to the nature condition ($p = .003$). Thus, the subjects performed the tasks faster after viewing the nature scenes than the city scenes. The ANOVA analysis (based on parameterization with sigma restrictions) showed that the improvement did not depend on education level ($F(3.78) = 0.17$; $p = .94$) or gender ($F(1.80) = 3.36$; $p = .07$), although there was a discernible statistical tendency to increase the counting speed among women.

To test the role of NR as an explanatory variable for shorter addition time in the Nature condition compared to the Urban condition, a simple linear regression was performed. To maintain the homoscedasticity condition, only one outlier was removed from subsequent analysis, based on the residuals normality plot (Table 6).

Table 6. The effect of NR on increasing the counting speed in the Nature condition relative to the Urban condition

NR	R	R^2	*B*	F	*P*	t	*p*
The *Self* component	.048	.002	.048	.186	.67	.078	.93
The *Experience* component	.174	.030	.174	2.50	.12	- .77	.44
The *Perspective* component	.096	.009	.096	.738	.39	- .37	.71
The total level of NR	.138	.019	.138	1.56	.21	- .77	.45

However, the analysis showed no statistically significant effects of individual components (*Self*, *Experience* or *Perspective*) or the general index of NR on

the improvement of addition speed in the Nature condition compared to the Urban condition.

Discussion

1. Main findings

The results showed significant improvement in speed of adding two-number digits after remote natural exposure (compared to urban). Similar effect was observed by Stevenson et al. (2019) who reported faster and more stable responses on the Attention Network Task after a green walk relative to an urban walk. Generally, the outcomes confirm the facilitating role of nature on attention processes restoration (Vella-Brodrick and Gilowska 2022). The obtained outcomes are consistent with the ART and previous studies, emphasizing direct impact of nature on cognitive performance (van den Berg et al. 2016; Li and Sullivan 2016). These results may confirm the species-characteristic, primary role of nature as a factor contributing to the renewal of cognitive performance in human being (as every person belongs to nature system). According to the ART, the restoration of voluntary attention may be explained in terms of the "wandering mind" hypothesis, according to which, allowing the mind to freely follow a meaningful object or freely explore a safe and interesting space facilitates performance in cognitive tasks (Baird et al. 2012; Sio and Ormerod 2009). Alternatively, according to the SRT, contact with nature may also serve as stress reduction factor which facilitates the emotional homeostasis in individuals (Hansmann, et al. 2007; Martyn and Brymer 2016), and thus increases the efficiency of voluntary attention. Moreover, the study confirmed the phenomenon of practice effects in calculating, as the participants showed an increase in the speed of performing subsequent arithmetic activities.

However, the predictive role of individual NR in voluntary attention was not confirmed in the presented research. It may be explained with eco-anxiety effect. Since the persons with higher NR are nowadays more alarmed about the issue of global warming and climate change and are more likely to feel afraid, depressed, angry and disgusted (Maibach et al. 2009). These individuals reported symptoms of sleeplessness, loss of appetite, weakness, irritability, and panic attacks (Coffey et al 2021). Therefore, the exposure on beautiful nature may generate not only the restorative but the overload influence (mainly the threat of losing it) as well. The varied effect may depend on the particular as-

pects of NR. According to Dean et al (2018), the aspects of NR reflecting enjoyment of nature are associated with reduced ill health and with widespread evidence of the health and well-being benefits of experiencing nature. However, the aspects of NR reflecting self-identification with nature, and a conservation worldview, are connected with increased depression, anxiety or stress, after accounting for potential confounding factors. The ambivalent emotional experiences may affect the restorative role of nature on cognition, and therefore, may better explain the influence of nature on voluntary attention. Therefore, NR as a personality tendency may not directly affect the routine cognitive functioning (adding numbers) after nature exposure. Various studies have shown a predictive character of NR but this influence referred to ecological involvement, so it concerned a similar mental domain (Perkins, 2010; Restall and Conrad 2015). Nevertheless, they do not exclude the moderating role of individual factors (van Dijk-Wesselius et al. 2018; Greenwood and Gatersleben 2016), setting the context for nature's influence on voluntary attention. Especially, investigating the mediating role of emotional well-being in regulating attention performance in individuals with biophilic tendencies still presents a research challenge.

A separate issue is the type of passive vs. active involvement in the natural surroundings, and the type of desiring objects (fauna vs flora) that may play a significant role in the renewal of individual cognitive resources.

2. Limitations

Although the study showed the facilitating role of nature in attention restoration and, simultaneously, put into question the role of NR in this process, some limitations of the study should be noted. Firstly, the selection of specific urban and nature movies should be pointed. The concept of NR is a very broad category, as it includes a generalized attitude towards diverse natural phenomena (e.g., observation of thunderstorms and observation of birds or flowers are treated equally). However, an individual's personal biophilic preferences may be more diverse and the chosen video may have varied impact. Secondly, individual NR was examined on the basis of self-reported rather than objective methods; the measurement had therefore an indirect character, and may have reflected the „declarative" rather than the „actual" self. Thirdly, the experiment was conducted in a laboratory setting and it lacks ecological validity; in other words, it was not real and multisensory in nature. Also, the sample size does not allow for generalization beyond the scope of this study.

3. Practical significance of the study

This study was designed with the aim of finding answers and solutions that would improve life quality. It has shed light on the positive aspect of human-nature relationship in regenerating voluntary attention. Being close to nature enhances attention resources of the individuals, regardless of how they perceive their NR. This encourages the development of various models of soft fascination with nature, i.e. incorporation of some elements of nature in everyday life, according to individual preferences. Hence, the findings are an encouragement to put more effort to have direct contact with nature, especially in the current built-up living areas and cybernetic work environment. The threat of increasing human alienation, including that of the younger generation, prompts special concern for urban planning policies. The creation of green spaces in workplaces as well as study and leisure spots is a condition for the recovery of cognitive efficiency and, thus, more effective functioning. Simultaneously, personal benefits resulting from contact with nature may be an important factor in the development of biophilic tendencies and pro-environmental behavior (Kellert 1997; Schultz 2000).

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STRESZCZENIE

Celem niniejszej pracy było zbadanie możliwości poprawy uwagi dowolnej poprzez doświadczenie miękkiej fascynacji przyrodą z uwzględnieniem predykcyjnej roli pokrewieństwa z naturą. Oczekiwane zależności wyprowadzono z perspektywy Teorii Przywracania Uwagi i Teorii Redukcji Stresu. Zastosowano intra-indywidualny model badawczy. W badaniu 99 osób (w wieku od 18 do 70 lat) wykorzystano serie zadań dodawania w zakresie 100, po obejrzeniu na przemian krótkich filmików, kontrastujących w zakresie doświadczenia miękkiej fascynacji (krajobraz naturalny vs miejski). Ponadto zastosowano samoopisową Skalę Pokrewieństwa z Naturą. Wyniki pokazują facylitujące znaczenie kontaktu z przyrodą dla zwiększenia szybkości liczenia niezależnie od indywidualnego nasilenia pokrewieństwa z naturą. Zatem doświadczenie miękkiej fascynacji naturą zwiększa efektywność uwagi dowolnej. Artykuł kończy się dyskusją.

SŁOWA KLUCZOWE: środowisko miejskie i przyrodnicze; pokrewieństwo z naturą; doświadczenie miękkiej fascynacji; przywracanie uwagi dowolnej

SUMMARY

The aim of this study was to examine the possibility of improving voluntary attention through the experience of soft fascination with nature considering the predictive role of nature relatedness (NR). The influence was analyzed from the Theory of Restoring Attention and the Stress Reduction Theory. The within-subject design was used to in two alterable contexts: a virtual experience of urban and nature. The Nature Relatedness Scale and series of addition tasks within 100 after exposure to short videos depicting nature vs urban was performed by a group of 99 persons (aged 18 to 70). To test the research hypotheses, ANOVA model, Student's t-test, and linear regression were used in the analysis. The results showed the importance of contact with nature for increasing the counting speed irrespectively to the intensity of NR. The article ends with the discussion and some practical conclusions.

KEYWORDS: urban and nature environment; nature relatedness; soft fascination experience; restoration of voluntary attention

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