ORIGINAL RESEARCH

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Restorative Effects of Virtual Nature on the Emotional Well-being of Community-dwelling Older Adults

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Abstract

Objective: Given the loss of direct nature contact due to urbanisation and demonstrated psychological benefits of nature, the question arises as to whether direct nature contact can be virtually substituted or supplemented in the elderly living in isolation from nature. Although a number of studies have demonstrated the restorative effects of virtual nature in old age, their results are inconclusive and complicated by the novelty of virtual reality (VR) experience, participants' nature connectedness and their previous nature contact. Therefore, a study was conducted for increasing our limited understanding of the subject.

Materials and Methods: Community-dwelling older adults living in highly urbanised areas of Turkey volunteered for the study. After excluding the ineligible volunteers and collecting information on sample characteristics, 60 participants, who were assigned to two study groups, watched 6-minute 360° videos of nature and urban settings on two separate occasions. On these occasions, they reported on their affective states, the restorativeness of the environments in those videos and their nature visit frequency.

Results: VR experience was new and tolerable for the majority of the participants. Unlike the urban video, the nature video significantly improved participants' affective states and was reported to be more restorative and favourable. Neither participants' nature connectedness nor their nature visit frequency, which was found to be generally low, did not have a moderating effect on the results.

Conclusion: Virtual indirect contact with nature can be effectively used, especially for those living in heavily urbanised areas, to maintain or improve psychological well-being in old age.

Keywords: Affect, aged, nature, psychological gerontology, virtual reality

Introduction

Direct contact with nature is strongly associated with marked improvements in psychological well-being (1-5). Given this effect, it is disquieting that urbanization has been increasing globally at an alarming rate (6) and has resulted in our disconnection from nature and its entities (7-9). Therefore, it is necessary to address how nature contact can be promoted in urbanized populations, including the elderly. The relevant literature indicates that some of the psychological benefits attributable to direct contact with nature can be derived from realistic nature representations using immersive virtual environment (IVE) technology. 360° videos in natural settings can be emotionally restorative and improve mood within short viewing periods among young adults (10-13). Despite these potential benefits of natural IVEs, relatively little research has been undertaken in older populations with very limited access to nature (14-16).

While it has been demonstrated that natural IVEs may not significantly improve mood and even induce fear and anxiety in the elderly (17,18), there is a growing body of empirical evidence for the restorativeness of virtual nature contact (VNC) in old age (19-22). The problem with the latter studies is that the observed restorative effects can be attributed to not only VNC but also the novelty of virtual reality (VR) experience.

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Apart from the possible confounding effect of novelty, none of those studies with the aged examined whether individual differences in nature connectedness and exposure could have a moderating effect on the psychological benefits of natural IVEs. While feeling less connected to nature may weaken positive emotional reactions to simulated nature in young adults (23), there is no evidence to suggest this relationship in old age. It is also unclear whether the daily interaction of the elderly with nature alters the potency of spending additional time in virtual nature. Given that the frequency of nature visits is connected with psychological well-being (24), frequent visitors to nature who are expected to be in an elated mood state may not further benefit from VNC. Although this possibility cannot be excluded to understand the true value of natural IVEs, especially for those living isolated from nature, it has received no attention so far.

Given the absence of compelling evidence, the research question arises whether natural IVEs may substitute for or augment nature contact and support emotional restoration in older adults. Until we have a better understanding of the extent to which virtual nature contributes to the psychological well-being of the elderly, additional studies should be undertaken. Therefore, this study was conducted by recruiting elderly participants living independently in three different cities in Turkey. The current paper presents the results of this study testing three hypotheses: 1) Nature and natural environments are rarely visited by the elderly who are living in highly urbanised areas; 2) Natural IVEs can compensate for the limited or lack of direct contact with nature and restore emotional well-being in old age unlike urban IVEs; and 3) There is a moderating effect of both nature connectedness and visit frequency on the restorative effects of virtual nature in the elderly.

Materials and Methods

Participants

Due to the difficulties in finding eligible participants during the Coronavirus disease-2019 (COVID-19) pandemic, a snowball sampling method was employed. A total of 66 community-dwelling elders, living in the highly urbanized areas of Aydın, İzmir and Kocaeli, volunteered for the study. As per the ethical clearance issued by Yaşar University (decision number: 13878, date: 27.10.2021), all volunteers consented to participate after being thoroughly informed about the study protocol and the potential side effects of viewing IVEs. Two volunteers were excluded because they did not meet the inclusion criteria for medication use and cognitive functioning. Additionally, four volunteers withdrew because of scheduling constraints. The remaining 60 participants included in the analyzes were as follows: a) aged 65 or older; b) literate; c) were cognitively intact. All volunteers were screened for cognitive impairment using the standardized mini-mental state examination (SMMSE) (25). The SMMSE was translated into Turkish and validated by Güngen et al. (26). SMMSE scores <23/24 were reported to be indicative of dementia. Therefore, the volunteers who scored <24 were excluded from the study to meet the inclusion criteria; d) were able to live independently and perform the activities of daily living; e) had normal or corrected to normal vision; f) had no auditory impairment; g) did not have restricted head and neck movement as per the inclusion criteria; and h) were not taking psychotropics or more than five prescribed medications in accordance with the inclusion criteria (see Table 1 for further details on the participants).

Nature and Urban Videos

Two 360° videos were filmed in nature and urban settings. The nature video was recorded at Balçova Therapy Forest and included the main features of the environment, such as moderately dense vegetation, water, and animals. The urban video was recorded on two busy streets in Bornova, İzmir. Although there were scattered trees in the video, they constituted a negligible fraction of the content. All videos were shot from a static position to minimize visual-vestibular conflict (27). The camera height was adjusted to 120 cm to provide a natural egocentric viewpoint and a greater sense of presence in both settings (28). The edited 6-minute videos with sound were watched in a seated position using a head-mounted display (HMD) system composed of a smartphone inserted into a pair of VR goggles.

Table 1. Demographic characteristics and health status of the participants

		n		%	
Gender	Female	36		60	
	Male	24		40	
Education level	Literate	1		1.67	
	Primary school	7		11.67	
	Middle school	4		6.67	
	High school	12		20.00	
	University	36		60.00	
Chronic diseases	None	15		25.00	
	Cardiovascular	40		66.67	
	Endocrine and metabolic	19		31.67	
	Gastrointestinal	2		3.33	
	Genitourinary	3		5.00	
	Musculoskeletal and connective tissue	6		10.00	
	Neurologic	2		3.33	
	Pulmonary	4		6.67	
		Mean	**SD**	**Min**	**Max**
Age (years)		70.62	5.99	65	90
SMMSE score		28.25	1.13	25	30

Max: Maximum, Min: Minimum, SD: Standard deviation, SMMSE: Standardized mini-mental examination

Measures

The positive and negative affect schedule (PANAS) (29) was administered to track participants' affective states. The PANAS consists of 20 items rated for a given period on a 5-point scale. The responses to these items are summed to yield positive (PANAS PA) and negative affect (PANAS NA) scores. Gençöz (30) adapted the PANAS for use in Turkish and demonstrated that the psychometric properties of the scale were acceptable.

Participants' perceptions of environmental restorativeness were evaluated by using the perceived restorativeness scale (PRS) (31,32) to complement the PANAS results. PRS determines the presence of four environmental attributes (being away, coherence, compatibility, and fascination) promoting restoration of psychological and other individual resources required for effective functioning. It is composed of 26 items rated on a 7-point scale. Four PRS scores were calculated by averaging the item scores for each attribute. Özçifçi et al. (33) translated the PRS into Turkish and showed that the translated version was reliable and valid.

Since nature connectedness may impact the psychological benefits of viewing natural IVEs (23), the nature relatedness scale (NRS) (34) was also administered. The NRS measures the strength of respondents' perceived connection with nature using 21 items rated on a 5-point scale. An NRS score is calculated by averaging item scores. Çakir et al. (35) adapted the NRS for use in Turkish and demonstrated that the psychometric properties of the adapted version were satisfactory.

For assessing nature exposure, or more specifically, visit frequency in the past week, the participants were asked to choose one of three response options ("never," non-visitors; "once or twice a week," occasional visitors; and "three or more times a week," frequent visitors) and report on how often they had been outdoors in nature or natural environments. Moreover, to determine the novelty of the IVE experience, the participants were asked whether they had previously used the IVE technology.

Data Collection

Between January 24 and 30, 2022, all volunteers were evaluated on their cognitive functioning and nature connectedness using the SMMSE and NRS, respectively. In addition, they provided information about their demographic characteristics, chronic diseases, impairments, medication, and IVE experience. After screening the ineligible volunteers the remaining older adults were randomly assigned to study groups (group 1 and 2) and contacted for scheduling the video-viewing sessions. Between 31 January and 20 March 2022, each group visited their homes and watched the nature and urban videos on two separate occasions that were one week apart to eliminate any carry-over effects. While group 1 watched the nature video on the first occasion, group 2 watched it on the second occasion to minimize any bias from the novelty of using the IVE technology. On each occasion, all groups were asked to complete the PANAS before watching either the nature or urban video. Following the video-viewing session, they reported on their affective states for a second time using PANAS, completed PRS, and provided information on their nature visits during the preceding week. In addition, verbal statements of the participants and their qualitative feedback about their VR experience were recorded during the video-viewing sessions.

Statistics

To assess the normality of the data, the Kolmogorov-Smirnov and Shapiro-Wilk tests were used. Apart from these tests, skewness and kurtosis values were examined to identify the presence of non-normality. While the paired-samples t-test was used to analyze the changes in participants' PANAS PA scores, the Wilcoxon signed-rank test was used to determine the changes in PANAS NA scores and differences in PRS scores. To assess the correlates of affective responses, Spearman's correlation coefficients were computed. Additionally, Cohen's Kappa coefficients were calculated to determine the inter-rater reliability of the participants' verbal statements or feedback. All statistical analyzes were performed using the Statistical Package for the Social Sciences (version 25.0). The level of significance was set at $p<0.05$.

Results

Nature Visits

The results of our participants' nature visit frequency analysis (Figure 1) support the first hypothesis. Most of the participants, who were living independently highly urbanized areas, were non- or occasional visitors to nature. In the first video-viewing session, 42% of the participants reported that they had often visited nature or natural environments outdoors over the last week. Although the number of frequent visitors rose by 5% in the week preceding the second session, no or occasional visits were made by 53% of the participants.

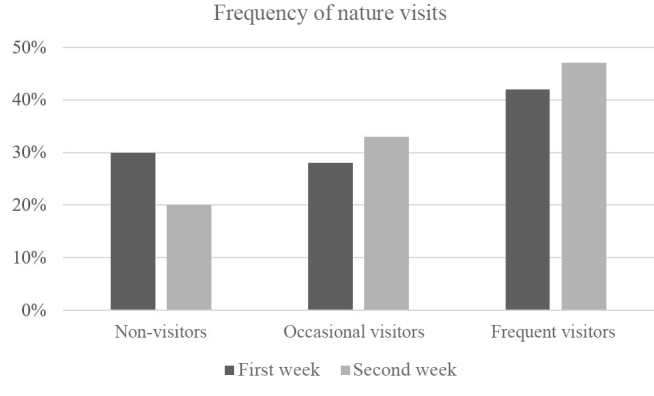

Figure 1. Frequency of participants' nature visits over two weeks

Positive and Negative Affect

To test our second hypothesis, the study groups' combined PANAS pre-test and post-test scores were compared with each other for both IVEs. The results confirmed the potential psychological benefits of interacting with nature virtually. Participants' initial pre-test PANAS PA score was found to be significantly lower [t(59)=-5.74, p<0.001] than their post-test PANAS PA score obtained after watching the nature video (Table 2). The difference between the pre-test PANAS NA and post-test PANAS NA scores was also statistically significant (Z=-3.93, p<0.001) (Table 3). Watching the urban video had a negative impact on the participants' affective states. There was a significant decrease [t(59)=5.05, p<0.001] in the PANAS PA scores following video viewing (Table 2). Moreover, being in the urban setting resulted in a significant increase (Z=-1.99, p=0.046) in the PANAS NA scores (Table 3).

Perceived Restorativeness

To validate our findings on participants' affective responses to the IVEs, the PRS scores obtained in the video-viewing sessions were compared. The results were consistent with our findings and suggested that the forest setting shown in the nature video was more restorative. There were statistically significant differences between participants' PRS scores for all four environmental attributes (being away: Z=-6.74, p<0.001; fascination: Z=-6.68, p<0.001; coherence: Z=-5.63, p<0.001; compatibility: Z=-6.30, p<0.001) (Table 4).

Table 2. Mean ± SD PANAS PA scores and paired-samples t-test results for the PANAS PA scores

		Nature		
		Mean ± SD	t	p
PANAS PA	Pre-test	35.37±6.68	-5.74	<0.001
	Post-test	39.38±6.77		
		Urban		
		Mean ± SD	**t**	**p**
PANAS PA	Pre-test	37.45±5.59	5.05	<0.001
	Post-test	33.03±8.21		

SD: Standard deviation, PANAS PA: Positive and negative affect schedule positive affect

Table 3. Median, minimum and maximum PANAS NA scores and Wilcoxon signed-rank test results for the PANAS NA scores

		Nature				
		Median	Min	Max	Z	p
PANAS NA	Pre-test	10.00	10.00	21.00	-3.931	<0.001
	Post-test	10.00	10.00	15.00		
		Urban				
		Median	**Min**	**Max**	**Z**	**p**
PANAS NA	Pre-test	11.00	10.00	23.00	-1.99	0.046
	Post-test	12.00	10.00	29.00		

PANAS NA: Positive and negative affect schedule negative affect

Correlations for the NRS Scores and Nature Visit Frequencies

To test our third hypothesis, the correlation between participants' NRS scores (mean ± standard deviation: 4.15±0.44) and the changes in their PANAS PA and NA scores (PANAS post-test scores-PANAS pre-test scores) because of the nature video viewing was calculated. The correlation was not statistically significant. Another analysis was performed to identify the correlation between participants' nature visit frequency and PANAS score differences. The results also demonstrated that there was not a significant correlation.

IVE Experience and Participant Feedback

Most (92%) participants reported that they did not use the IVE technology before. Almost none of the participants reported any adverse effects of the IVEs or complained about the HMD system. Only 5% of the participants found the HMD system heavy or reported mild nausea. However, they did not want to remove the system prematurely.

During the sessions, most participants commented on the videos. In total, 90 statements were made. These statements were categorized as positive, neutral, and negative by two assessors who were unfamiliar with the study. The level of agreement between these assessors was perfect for all categories, with Kappa coefficients in the range of 0.92 to 0.98 (p<0.001). For a perfect agreement, a third assessor, who was also not involved in the study, adjudicated the existing discrepancies. While 79% of the 48 statements made for the nature video were positive, 67% of the 42 statements about the urban video were negative. In addition, neutral statements were more (11 versus 4) for the urban video.

Discussion

Our study had both confirmatory and exploratory objectives. First, we sought to confirm the restorative effects of VNC on

Table 4. Median, minimum and maximum PRS scores and Wilcoxon signed-rank test results for the PRS scores

		Median	Min	Max	Z	p
Being away	Nature	5.40	3.00	6.00	-6.74	<0.001
	Urban	0.20	0.00	4.80		
Fascination	Nature	5.38	3.50	6.00	-6.68	<0.001
	Urban	1.19	0.00	3.75		
Coherence	Nature	6.00	2.00	6.00	-5.63	<0.001
	Urban	2.00	0.00	6.00		
Compatibility	Nature	4.44	0.89	6.00	-6.303	<0.001
	Urban	2.00	0.00	5.44		

PRS: Perceived restorativeness scale

emotional well-being in the elderly whose direct contact with nature was expected to be limited. Previous literature did not examine the role of nature connectedness and contact frequency in assessing how IVEs might affect emotional states. Therefore, to provide the first empirical evidence, we also investigated whether natural IVEs could have a beneficial effect on emotional well-being irrespective of nature connectedness and visit frequency.

Our findings confirmed that old age might account for spending no or only a very limited time outdoors in nature, and they were consistent with those of earlier studies on VNC in the elderly that did not consider the novelty of VR experience (18-22). Although our participants, who were mainly non-or occasional visitors to nature, were in a positive affective state before the video-viewing sessions, there were statistically significant improvements in their mood after watching a short nature video. Unlike the nature video, the urban video resulted in emotional degradation. Moreover, the participants found the nature video more restorative and made more positive comments. This finding supports the PANAS results and in complete accordance with the fact that individuals' evaluative judgements are congruent with their current affective state (36).

Although it seems reasonable to expect that VNC over a period of time <10 minutes is potent enough to restore psychological functioning according to our above-mentioned results and those of other research groups, it is difficult to reach any conclusions on the optimal duration and frequency of video viewing. Although 95% of our participants did not report any adverse effects of the IVEs, it is not possible to state that increasing the time spent in natural IVEs by increasing video length or viewing frequency would yield much more favorable outcomes. Given this gap in the literature, further studies on longer and more frequent video viewing sessions are required to fully understand the potential benefits of VNC in old age.

Another aim of our research was to explore whether participants' nature connectedness and frequency of nature visits had a significant effect on their self-reported affective responses because their possible effects had not been investigated in earlier studies on the elderly. Unlike McMahan et al. (23), we found that individual differences in nature connectedness did not moderate the observed effects of the natural IVE in our remarkably old sample. Since the reported levels of nature orientation may vary greatly by country (37), not only age but also cultural differences can account for the discrepancies in the obtained results. While it is not possible to generalize our results to culturally diverse elderly populations, they are of interest to other researchers for cross-cultural replication and further exploration of the mediating role of nature connectedness. Moreover, we demonstrated that there was not a significant correlation between participants' nature visit frequency and changes in their PANAS scores. This finding contradicts our expectation that frequent visitors may not benefit from the nature video because of their elevated affect in response to being in regular contact with nature. However, it is novel in terms of suggesting that natural IVEs can alter mood independently of nature contact frequency or that frequent visitors of nature can emotionally benefit from VNC. Given the novelty of these two findings, future studies on the possible moderating effects of being connected to nature and the frequency of direct nature contact should be conducted in elderly adults to verify our results.

Study Limitations

There are two limitations that should be considered when interpreting our results. First, due to the negative effect of the COVID-19 pandemic on recruiting participants, the participants aged >80 years comprised 8% of our sample. Although the oldest elderly are at a greater risk of losing their functional independence (38) and experiencing depression (39), it is erroneous to conclude that VNC may elicit highly favorable therapeutic responses in this age group. Therefore, there is a need to investigate to what extent our findings are relevant to or important for this rapidly growing segment of the population.

Second, the COVID-19 pandemic was demonstrated to restrict the time spent outdoors (TSO) in Turkish community-dwelling elderly adults (40). Therefore, the study period might have reduced participants' nature visit frequency and inflated the potency of VNC. Although the TSO may not exceed an hour in the home-dwelling (41) and institutionalized (42) elderly and that no statistically significant associations were identified between participants' reported visit frequencies and changes in affect, this inherent limitation of our study warrants consideration and should be addressed in future studies.

Conclusion

Evidently, more studies are required to fully understand the restorative effects of natural IVEs on the elderly and to recommend this technology as a substitute or supplement to natural contact. Nonetheless, two conclusions can be drawn from our results and those obtained in earlier studies. First, it is possible to conclude that brief indirect contact with nature in VR may reduce the emotional burden of urbanization and lack of direct nature contact on older adults, especially those with impaired mobility. Second, the IVE technology is generally tolerated well. Therefore, it can be considered as a non-pharmacological treatment adjunct for psychological disturbances in old age, without ignoring the fact that it may cause minor discomfort in some of the elderly.

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Ethics

Ethics Committee Approval: As per the ethical clearance issued by Yaşar University (decision number: 13878, date: 27.10.2021), all volunteers consented to participate after being thoroughly informed about the study protocol and the potential side effects of viewing IVEs.

Informed Consent: All volunteers consented to participate after being thoroughly informed about the study protocol and the potential side effects of viewing IVEs.

Authorship Contributions

Concept: K.E.Ş., S.A., F.Ö., Design: K.E.Ş., Data Collection or Processing: K.E.Ş., A.C.Ş., S.A., F.Ö., A.P., Analysis or Interpretation: K.E.Ş., A.C.Ş., A.P., Literature Search: K.E.Ş., S.A., F.Ö., Writing: K.E.Ş., A.C.Ş.

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