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Validación técnico-metodológica de un dispositivo de realidad virtual para la exposición de ambientes restauradores

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Abstract

The study presented below had the purpose to analyze the technical and methodological feasibility of the exposure of restorative environments, mediated through a virtual reality device, considering as options the projection of 2D images and images with angles of 180 ° and 360 °, for which a longitudinal study with a cross-over design and three measurements in random order was carried out, with 30 healthy male adults, aged 25 to 45 years (*M*= 33.27; *SD* =5.83). The findings showed that the 180º format obtained higher scores than the 2D and 360º formats (*f* = 20.29; *p* = .000), which can be a preliminary step for the in-depth study of the exposure of environments mediated through virtual reality in future research.

Keywords: Cognitive Fatigue, Environmental Psychological Restoration, Virtual Reality.

Resumen

El estudio que a continuación se presenta tuvo como propósito analizar la factibilidad técnica y metodológica de la exposición de ambientes restauradores, mediada a través de un dispositivo de realidad virtual, considerando como opciones la proyección de imágenes en 2D e imágenes con ángulos de 180° y 360°, para lo cual se realizó un estudio longitudinal con diseño cross over y tres medidas en orden aleatorio, con 30 adultos masculinos sanos, de 25 a 45 años (*M*=33.27; *DE*=5.83). Los hallazgos mostraron que el formato de 180º obtuvo puntuaciones más altas que los formatos planos en 2D y 360º (*f*=20.29; *p*=.000), que pueden ser un paso preliminar para el estudio a profundidad de la exposición de ambientes mediados a través de realidad virtualen investigaciones futuras.

Palabras clave: Fatiga Cognitiva, Restauración Psicológica Ambiental, Realidad Virtual.

Introduction

Problematic situation

Research around the environmental psychological restoration of cognitive fatigue andstress has evolved over the years, with the subject of environmental exposure to mediated restorative environments being a methodological and practical topic of interest in this field ofstudy (Martínez -Soto & González, 2020). A restorative environment is a perceived physical space that allows and promotes the restoration of a cognitive or affective deficit (Kaplan & Kaplan, 1989). On the other hand, a technologically mediated restorative environment is one whose visual exposure, manipulated through specific digital tools, promotes restorative psychological effects analogous to in situ environmental evaluations (Ulrich, 1983; Martínez-Soto & Montero, 2010; Martínez-Soto & González -Santos, 2020).

To evaluate and document an experience of environmental psychological restoration, it is necessary to observe and record psychological dimensions such as attention, emotions, and working memory (Hartig & Evans, 1991), however, it is necessary to have sufficient evidence ofthe adequate use of the precise tools to display the correct stimuli in such a restoration protocol. Although there is research evidence about the use of virtual reality devices (El-Beheiry *et al*., 2019; Egliston & Carter, 2020;), the mediated exposure of restorative images through these devices has not been studied in depth (Huygelier *et al*., 2019).

Background

Psychoevolutionary theories study the interaction between nature and the human being (Kaplan & Kaplan, 1989; Ulrich *et al*., 1991), from which it can be deduced that there are potential psychological benefits for experiences of this type, which have a beneficial impact on physical and mental health of people, significantly improving their quality of life (Martínez-Soto, 2010), although these interactions do not necessarily take place in a natural space directly, which could happen when observing images of nature (Hartig & Evans, 1991).

The theory of recovery from stress (Ulrich *et al*., 1991) studies the recovery processes of the emotional and physiological stress deficit, focusing on the visual properties of nature: structure, depth, and complexity (Ulrich, 1983), while the Attention restoration theory (Kaplan &

Kaplan, 1989), focuses on cognitive aspects related to focused attention, dealing with the environment and the environmental qualities that enhance said restoration, such as compatibility and fascination (Kaplan, 1995). According to Kaplan (1995), attention can be voluntary and involuntary. The first is an effort made with intention and that, therefore, can cause exhaustion due to the effort invested in maintaining the attentional focus on specific stimuli, which also implies an effort to avoid other surrounding stimuli. Involuntary attention is derived from the fascination that arises when perceiving stimuli that cause the emotion to be attracted without effort, for example, when observing beautiful images, this type of attention is what allows recovery from cognitive fatigue caused by voluntary attention (Delgado, 2018).

The environmental psychological restoration of attention has been analyzed through the systematic recording of changes in the execution of cognitive tasks after exposure to nature (Argüero-Fonseca, 2020; Martinez-Soto *et al*., 2010; Järvelin-Pasanen *et al*., 2018), which should be carefully controlled through the care of the basal state of the subjects in areas that could affect their performance. The restorative qualities of natural stimuli that can be measured are fascination (effortless attention); being away (avoidance of routine), scope (spaces as part ofa whole), compatibility (personal taste for that type of space) and coherence (between the elements of the scene) (Martinez-Soto *et al*., 2010).

Aim

Analyze the technical and methodological feasibility of restorative environments exposure, mediated through a virtual reality device, considering as options, the projection of 2D images and images with 180 ° and 360 ° angles.

Materials and method

The present study was carried out with a quantitative approach and longitudinal design of a pre-experimental type with three measures in random order (Balluerka, 2002; Hernández *et al*., 2017), as one of the phases of an experimental design of a doctoral thesis (Argüero-Fonseca, 2020).

Variables

Mediated restorative environment

Conceptual definition. A restorative environment refers to that physical setting where a person recovers from a cognitive or affective deficit (Kaplan & Kaplan, 1989). A mediated restorative environment allows the implicit evaluation of the perception of restorative qualities tobe given through a specific tool (Ulrich, 1983; Martínez-Soto & Montero, 2010; Martínez-Soto & González-Santos, 2020).

Operational definition. The restorative environment images mediated through a virtual reality headset will be presented in 2D format, which is a flat projected image, and in 180 and 360-degree-format.

Perception of Environmental Restoration

Conceptual definition. Perceptual assessment of the restorative qualities of natural or built environments with different restorative potential in simulated natural environments such asvirtual ones or mediated through videos, photographs, or slides (Martínez-Soto & Montero, 2010).

Operational definition. The evaluation of the perception of environmental restoration refers to the integration of five items taken from the Spanish version of the revised Environmental Restoration Perception Scale (Martínez-Soto & Montero, 2010), which each represent the factors of said scale: Being Away (BA; ―being here is like a break from my daily routine‖), Coherence (COH; ―it's easy to see how things are organized in this place‖), Fascination (FA; ―this place is fascinating‖), Scope (SC; ―this place seems quite spacious to me‖) and Compatibility (COM; ―it's easy to do what I want in this place‖) (Martínez-Soto & Montero, 2008).

Immersive Virtual Reality (IVR)

Conceptual definition. It is a system that seeks to make the user lose contact with the real world, blocking attention to stimuli outside the proposed reality, using the visual perceptionof the real world within completely artificial computer-generated environments (El-Beheiry, *et al*., 2019).

Operational definition. Immersive virtual reality, using an HMD (Head-Mounted Display), can be experienced through Virtual desktop that allows projecting a computer screenand adjusting the image to the desired size or angle, so three angles are tested in this dimensiondifferent angles, flat screen, 180 ° and 360 ° angle (Valve corporation, 2020).

Participants

The study sample consisted of 30 healthy male adults, between 25 and 45 years old (M= 33.27; SD = 5.83), summoned through a social network and chosen at their convenience.

Exclusion criteria

People who reported suffering from physical or mental illnesses diagnosed at the time ofthe study. Were excluded those with a vital crisis that could modify their normal state, and people who sleep less than 6 hours or more than 9. People who have changed their eating habitsin recent days, or those who use controlled medications or psychoactive substances.

Elimination / permanence criteria

People who decide not to continue, people who feel uncomfortable with the HMD.

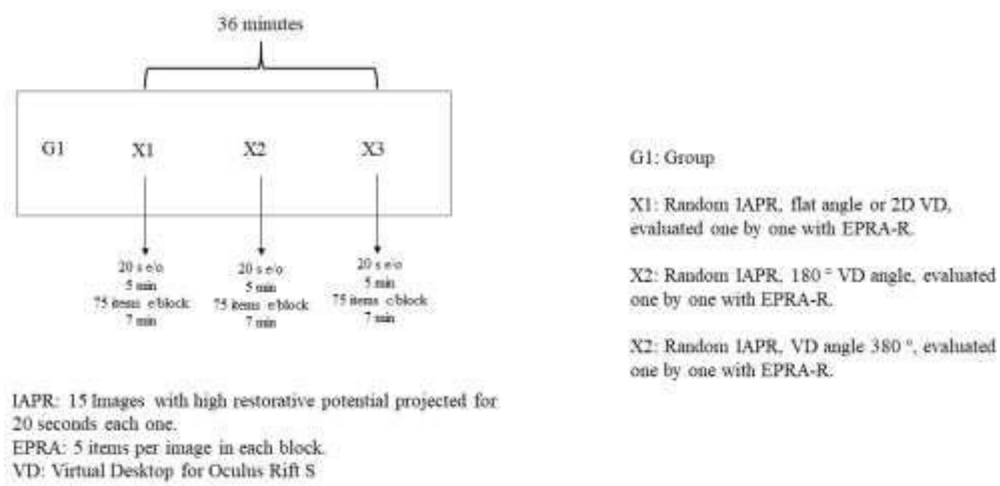
Technique and instruments

Design

As can be seen in Figure 1, this is a longitudinal study with a cross-over design and three measurements in random order.

Figure 1

Evaluation of differences in Perception of environmental psychological Restoration in images projected in Immersive Virtual Reality



Source: Argüero-Fonseca (2020)

Instruments

Google form with personal data and informed consent. A survey was conducted with biopsychosocial data to confirm that the participants met the requested criteria and were aware of the scope of their voluntary participation.

Environmental Restoration Perception Scale-Revised (EPRA-R). In this study, a short version is presented based on the original scale of Martínez-Soto and Montero (2008). This version has been used in related research (Berto, 2005; Pasini, *et al*., 2014; Ruíz, *et al*., 2014) and it has been used in experimental contexts where it is required to sample a number of environmental stimuli and where the evaluation time is limited (Pasini, *et al*., 2014). It has

response options from 0 (Nothing, the described experience does not apply) to 10 (completely, it does faithfully apply to the experience). The reliability presented for the present version of the EPRA-R is α = .96, which is substantially better than that obtained in previous research using thesame version (Berto, 2005; Pasini, *et al*., 2014; Ruíz, *et al*., 2014).

Tools

Virtual Desktop for Óculus Rift S. The IVR Óculus Rift S device is a Head-mounted

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display (HMD), which serves to project immersive virtual reality images in front of the users and allow them to focus on the screen without distractions (Facebook, 2014). A magnetic sensor inside the HMD detects the movement of the user's head and sends that information to the attached processor. Consequently, the user turns his head. The graphics shown can reflect the changing point of view, which allows an immersive experience in virtual reality designed for video games (Facebook, 2014), although it also allows the projection of images, various applications, and 2d videos, this hardware has been used in various investigations (Chessa, *et al.*, 2019; Egliston & Carter, 2020).

Virtual Desktop is an application that allows you to use your computer in virtual reality. Allows you to browse the web, watch movies, play games and interact with the desktop to view images and open files, the image can be adjusted in inclination, size, distance, and angle. The standard size, distance, and tilt were chosen but tested with flat, 180 °, and 360 ° 2D projection.

Images with high restorative potential (IAPR). For the evaluation of the environmental psychological restoration, 15 photographs from a restorer image bank with high restorative potential will be used (natural settings n = 13, urban green areas n = 2; average perceived restoration 8.31 ± 1.24, scale 0-9; Martínez-Soto & González, 2020; Martínez-Soto *et al*., 2014). The natural IAPR sample contains mountainous landscapes with bodies of water and beaches.

Urban green areas include the image of a fountain inside a botanical garden and a garden with different layers of vegetation. These photographs were digitized and organized to be presented inthis study.

Procedure

The volunteers were summoned through Facebook, who were asked to fill out a Google form to ensure the reading of the instructions and acceptance of the informed consent, later they were sent a message to schedule the time and date for the application. They were asked to meetthe requested criteria regarding food, sleep, no consumption of stimulants, and alcoholic beverages.

The experiment was carried out individually and in a single session, in a private psychological clinic located in the city of Tepic, Nayarit. Once in the office, each participant was installed in a comfortable chair to be able to connect in pleasant environmental conditions of temperature, humidity, ventilation, acoustic insulation, etc., to direct their attention towards the investigation.

They were asked if they still had doubts, and those that did arise were resolved. The general instructions were about the proper use of the oculus rift, and the specific ones about howto stop the experiment in case of discomfort. They were allowed to familiarize themselves with the IVR device for 10 minutes to adapt to the functions of the controls and the viewer. Then, theimages were projected randomly manually through the virtual desktop, first for the flat format orin 2D; then for the 180° format and finally for the 360° format. They were instructed to answer the questions, the responses of which were recorded manually. Finally, they were asked about their general experience and ended by thanking them for their cooperation.

Data analysis technique

A descriptive analysis was carried out to know the characteristics of the sample and repeated-measures ANOVA were used to know the differences in preference, through the statistical software SPSS 23.0 (IBM Corp., 2017).

Ethical considerations

The participants received an informed consent form, considering the regulations of the General Health Law on Research for Health, regarding the second title, ethical aspects of Research in Human Beings, chapter I, Articles 13 to 22. This protocol has been approved by the State Bioethics Commission of the state of Nayarit, with registration number CEBN/05/2020.

Results

From the analysis of the measures of central tendency and dispersion, it can be seen thatthe version with 180 ° is the one with the highest perceptions of restorative qualities, according to the dimensions of the restoration. However, as the standard deviation shows, the variability ofthe responses is low, as it can be seen in Tables 1 and 2.

Table 1.

Descriptive statistics of the measures of central tendency and dispersion

	2D	180°	360°
N	30	30	30
alid			
	0	0	0
ost			
Mean	3.47	3.58	3.50
Median	3.60	3.75	3.60
Mod	3.57	3.80	3.57
Standard	.67	.62	.65
deviation			

Note: The scores were grouped into 4 levels, recoding the response into 1 low, 2 fair, 3 high, and4 very high. *Source:* Argüero-Fonseca (2020)

Table 2.

Perception of restorative qualities of the environment

	2		18		36	
	D	0°		0°		
Indicator	*M*		*M*		*M*	
	D		*D*		*D*	
Being away	3.		3.		3.	
	47	.9058	.84	50	.87	
Coherence	3.		3.		3.	
	09	.0127	.90	12	.00	
Fascination	3.		3.		3.	
	89	.6793	.65	90	.67	
Scope	3.68	0	3	0	3	
	.69	.77	.64	.70	.67	
Compatibility	3.23	0	3	0	3	
	.91	.37	.79	.26	.89	

Note: The scores were grouped into 4 levels, recoding the response into 1 low, 2 fair, 3 high, and4 very high. *Source:* Argüero-Fonseca (2020)

To identify the format that had the best Environmental Restoration scores, a set of repeated measures ANOVA tests was carried out, where it was observed that there are significant differences between the types of format in the indicators of: "Being away" (f = 13,987 ; p = .000) –Coherence‖ (f = 16,694; p = .000), –Fascination‖ (f = 5,455; p = .007), –Scope‖ (f=9,980; p =.000) and –Compatibility ‖(F = 12.137; p = .000), as well as the general average (f=20.289; p =.000), as it can be seen in table 3.

Table 2.

Summary of repeated measures ANOVA

Factor	*F*	*Sig.*	*η2p*
BA	14.00	0.00	0.33
COH	10.70	0.00	0.27
FA	5.46	0.01	0.16
SC	9.98	0.00	0.26
COM	12.10	0.00	0.30
AVERAGE	20.30	0.00	0.41

Note: The scores were grouped into 4 levels, recoding the response into 1 low, 2 fair, 3 high, and 4 veryhigh
Source: Argüero-Fonseca (2020)

When performing a subsequent test (post hoc) in each of the dimensions using the Bonferroni statistic, it was found that, in all cases, except for the Fascination factor, the 180º image format was significantly better than the rest, as shown you can see in the descriptive statistics of each score

Discussion

The present study was carried out with the objective of analyzing the technical and methodological feasibility of mediated exposure to restorative environments using the digital projection of 2D images at 180 ° and 360 ° angles. The experiences of perceived environmental restoration obtained in an IVR device with three different projection modalities indicate that

there are statistically significant differences in terms of restorative experiences depending on the type of format, being the version with 180 ° IVR the one that allows to have a best experience in assessing the restorative qualities of environments. These findings are consistent with previous research which highlights the role of the image presentation format (eg image projection size) to produce immersion and presence, important aspects to promote restorative experiences (De Kort, Meijnders, Sponselee, & IJsselsteijn, 2006; IJsselsteijn, de Ridder, & Freeman, 2001). Likewise, the findings could be explained considering that attentional capacity is better focused in this modality (Pasanen *et al*., 2018). In fact, the participants commented that they felt more comfortable, immersed and focused looking at the images at 180º, whereas when they were projected flat, they did not feel the same effect. On the contrary, some participants indicated a negative or adverse effect in the 360º format, alluding to feeling overexposed. The fact that the variable of fascination did not differ from the three presentation formats, suggests a high restorative quality of the environments presented, as evidenced in the high scores for the three formats, and in previous research that accounts for the fascination factor. as an important

variable for the prediction of restorative potential (Kaplan & Kaplan, 1989). Although the findings showed that the 180º format obtained higher scores than the flat 2D and 360º formats, future research could consider the influence of other perceptual variables on these types of presentation such as levels of complexity, illumination and level of familiarity of the participantswith the images.

Conclusion

Based on what was found in the statistical analyzes and the comments of the participants,it can be concluded that the most appropriate format and the one with the best scores for the perception of environmental restoration was 180º.

A 180° mediated presentation format of restorative environments is effective in promoting restorative experiences and potentiating the beneficial psychological effects derivedfrom contact with these types of environments.

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