AUCTORES
Globalize your Research

Journal of Psychology and Mental Health Care
Maria Jose Distefano

Open Access

Research Article

Presence, Cybersickness, Anxiety, and Heart Rate Variability in a Non-Clinical Population Using Virtual Reality Environments Designed For Specific Phobias' Treatment

Maria Jose Distefano[1*], Lucas P. Labandeira[2], Fernando M. Tarnogol[2], Belen Mesurado[3]

[1] PsicoTech, Céspedes 2438, 6°B, C1426DUH, Ciudad Autónoma de Buenos Aires, Argentina
[2] Psychological Technologies, Conesa 1051, C1426AQU, Ciudad Autónoma de Buenos Aires, Argentina
[3] Interdisciplinary Centre for Research in Mathematical and Experimental Psychology (CIIPME), National Scientific and Technical Research Council (CONICET) Tte. Gral. Juan D. Perón 2158, C1040AAH, Ciudad Autónoma de Buenos Aires – Argentina

***Corresponding author:** Maria Jose Distefano, Céspedes, C1426DUH, Ciudad Autónoma de Buenos Aires, Argentina. Email: distefanomj@gmail.com (or) mjdistefano@uca.edu.ar

Received Date: December 20, 2019; Accepted Date: January 27, 2020; Published Date: January 30, 2020.

Citation: Maria Jose Distefano, Lucas P. Labandeira, Fernando M. Tarnogo, Belen Mesurado . Response Predictors for Pembrolizumab in Advanced NSCLC beyond PD-L1 Expression, J. Psychology and Mental Health Care, 4(1). Doi: 10.31579/2637-8892/069.

Abstract

The current study was performed to assess the phenomenon known as Presence, to measure Anxiety responses, simulator sickness and autonomic activation in subjects of the general population.
The sample consisted in 37 Argentine participants (15 male, 22 female) between ages 20 and 40; who were exposed to 3 virtual environments designed to research and treat phobias. Instruments utilized for this study were the Symptom Checklist 90-R, Acrophobia Questionnaire, Fear of Spiders Questionnaire, The Claustrophobia Questionnaire, Igroup Presence Questionnaire, Simulator Sickness Questionnaire and the State-Trait Anxiety
Inventory.
All virtual environments generated sufficient feeling of presence. Cybersickness was only registered in the Elevator scenario. The Apartment and Spiders environments have shown not to be anxiety triggers within this population. As for Elevator, a significant increase in the level of state anxiety was generated. A possible hypothesis to account for this fact might be that reported anxiety responds to movement simulated in the virtual scenario while on the other two scenarios the subjects remained static.
The existence of a correlation between HRV and state anxiety has been analyzed and no significant relation has been found between the variables.
Even though there is a relation between anxiety and presence, no significant relation has been found between anxiety and presence.
Regarding sensory conflict, a follow up study in the Elevator environment should be done, eliminating movement and exposing subjects to the stimuli while static at different heights.
Future studies should consider broadening the size of the sample and studying clinical population to compare results.

Keywords: virtual reality; presence; cybersickness; anxiety; heart rate variability

Running title: Presence, Cybersickness and Anxiety in VR exposure

Introduction

Virtual reality is a computer generated simulation in which the individual moves from the place of a spectator to become an active participant who interacts and manipulates a synthetic and tridimensional universe [1]. It is a technology that provides the creation of computer simulated and interactive environments - cyberspaces similar to real spaces- which create the feeling of being physically present in them and allow interaction with it, with its diverse scenarios, objects and beings in real time [2,3,4]. In these tridimensional environments where an individual can find himself dynamically interacting, outstanding stimuli can be manipulated and presented in a context which is significant for the individual; and such stimuli can be systematically [5] controlled. For this reason, VR offers a powerful tool for the approach to diverse problems.

1.1. Virtual Reality and Anxiety Disorders

Virtual reality (VR) allows to bring the world inside the therapy and to carry out oneof the chief techniques of cognitive-behavioral therapy, the exposure, which offers the possibility to expose an individual to anxiety-triggering situations allowing an alteration in the structures which perpetuate avoidance and fear [6]. Since the situations for the individual to face are artificial, gradual exposure tasks can be repeated the times it may be deemed necessary in a context controlled by the professional while diverse patient reactions are live monitored [7].
As for the most relevant advantages, it is worth pointing out the opportunity to carry out the exposure to the virtual environment without having to wait until certain circumstances occur in the real world; the possibility to graduate the difficulties on an accuracy level which reality does not permit; keep each of the elements and occurrences under the therapist's control; and to manipulate certain variables such as the length of time and repetition [2,8].On the other hand, research in the field reveal that certain patients would rather be exposed to VR than to a real live situation [9,10] a fact which also preserves the intimacy and privacy of the

patient who does not need to go outdoors for the purpose of working to face his feared situations[2,11].
Meta-analytic studies have proved clinical efficacy of the VR for the anxiety disorder spectrum in adults, children and adolescents [12, 13, 14, 15]. The use of VR as an exposure technique in anxiety disorders covers claustrophobia[16], flying phobia[17,18,19], acrophobia[]20,21], fear of small animals[22,23,24], panic[8], agoraphobia[8], posttraumatic stress disorder[3]and stage fright[25], among many others.

1.2. Presence

Presence is not the same as immersion. Immersion is related to the quantity and quality of sensorial stimuli coming from the environment [15], and is considered as a product of the technological devices offering the user a sensorial and multimodal *input* [4,26].
Presence is considered a state of consciousness, a state of being in an environment[27]. It is the psychological perception of being there, inside the virtual environment (VE)[28]; the subjective perception of a synthetic environment "forgetting" technology's influence[4].
According to Riva and his team, the illusion of presence requires three elements: firstly, the possibility of putting the multisensory signals of the virtual environment into coherent perceptual categories, thus adding reality to the experience; secondly, the aforementioned task to be carried out in an egocentric frame of reference constituted by the individual and the environment in which he or she is immersed; lastly, the capacity of making the virtual experience meaningful and relevant [29].
For some specialists, presence is considered an internal and psychological phenomenon which is independent from the means employed to achieve it, and whose purpose is to control the activity of the subject in the context in which he or she is and feels immersed[30,31,32]. In this sense, a subject feels present in a place as long as he or she feels capable of interacting with it and, even more, doing it successfully. That is to say, action is more important than perception. Hence, presence means "the non-mediated (pre reflexive) perception of the use of the body to successfully transform intentions into actions" (Riva et al, 2014. p. 15) [29].

1.3. Cybersickness

An adverse aspect of virtual reality is sickness provoked by the simulator or *cybersickness*. It is the way of referring to a group of adverse symptoms such as visual fatigue, cephalic, nausea and dizziness, among others. Lawson, Graeber, Mead and Muth (2002) [33] deem this type of physiological response as typical due to the exposure to unusual stimuli. The most accepted theory to explain said cybersickness is the sensory conflict between the vestibular system and the visual system. The vestibular system is the non-auditory part of the inner ear and provides information about the position, orientation and acceleration of a subject; while the visual system refers to the subjective perception of movement from visual stimuli and the visual field generated by the virtual reality viewer. The sensory conflict arises when the information provided by the visual system does not coincide with what the vestibular system registers, that is to say, the simulated visual stimulus generates a sensation of movement while the vestibular system does not register any change [34,35]. Only 5% of the general population experiences adverse symptoms in high intensity while the remaining 95% presents few symptoms or none [36].

1.4. Anxiety

Anxiety is an emotional, natural and necessary response which has an adaptive function. However, once certain thresholds have been exceeded, it starts to interfere in the daily performance and activity to the point it might become pathological [37].
It is presented in a three-level response scheme: cognitive, physiological and motor. The cognitive aspect includes thoughts, preoccupations or images accompanying the emotional state. The physiological response, related to an activity in the nervous system, is manifested in variations in the breathing rate, cardiovascular activity, electro-dermal response and muscle tone, among others. These two reactions, the cognitive and physiological type, lead to different behavioral responses such as motor restlessness, unnecessary gesticulations, slowdown, inhibition, avoidance or flight, among others [38].
Spielberger (1972) [39] describes anxiety as a transitory emotional state associated with an increase in autonomic activity, feelings of tension, nervousness and apprehension. Such state fluctuates depending on the stressors the subject may be presented with. Unlike state anxiety, trait anxiety is defined in relation to individual differences which are relatively stable in frequency and appearance of anxiety states.

1.5 Heart rate variability

The autonomic nervous system is in charge of controlling bodily non-voluntary processes. The sympathetic branch of the autonomic nervous system prevails in alert and stressful situations, while the parasympathetic branch prevails in a restful situation such as sleep [40]. The Heart Rate Variability (HRV) analysis allows for the assessment of the autonomic activity. Sympathetic-parasympathetic interaction determines that the heart rate length fluctuates throughout time. These oscillations present different frequencies. High frequency (HF) is related to a respiratory sinus arrhythmia and is a reflection of the parasympathetic modulation. Low frequency (LF) is related to baroreflex and reflects sympathetic and parasympathetic stimuli. LF/HF relation is deemed a sympathetic modulation indicator. SampEn and Alpha 1, which respectively are increased and decreased in parasympathetic prevalence conditions, fall within the most used indicators [41,42].

1.6 Current study

The current study is a pilot study which consisted in the exploration of basic and necessary variables of three environments designed for specific phobias treatment: presence, cybersickness and anxiety in the general population. The questions to be answered are: Will the designed environments generate a necessary feeling of presence for the subjects to feel the environment as real? Will they be friendly experiences? Won't they provoke cybersickness? Will they provoke anxiety responses in the subjects? Will the anxiety responses taken from self-reports correlate effectively with physiological reports?

2.0 Methods and Materials

2.1. Participants

An open call has been made through social media and email. The final sample has been constituted by 37 participants of Argentine nationality (15 male and 22 female) between ages of 20 and 40 (M=28,59, SD=6,61). The inclusion criteria were: scores below T65 in all and each SCL-90R scale [43, 44, 45]; and non-clinical scores in questionnaires of acrophobia[46], fear of spiders[47] and claustrophobia[48,49]. And the exclusion criteria were: pregnancy (for female participants), epilepsy antecedents, severe visual difficulties, cardiovascular diseases, being under the effects of alcohol or drugs, sleep deprivation, vertigo, serious medical conditions.

2.2 Hardware.

The virtual environments were displayed on a PC and it´s visualization was made through an Oculus Rift DK2 headset, complemented with stereo headphones. For cardiologic monitoring, an Eccosur HT103 Holter was used.

2.3.Software.

The subjects were exposed to three of the PHOBOS' virtual reality environments.

Elevator. An urban environment with high rise buildings surrounding and overlooking a central square surrounded by streets with traffic and crowds. A cargo elevator was placed on the outside of one of these buildings with a maximum height of 70m. Subjects started the scene inside the elevator at ground level and were lifted up to the top, waited for 2.5 minutes then brought down to ground level. (Figure 1)

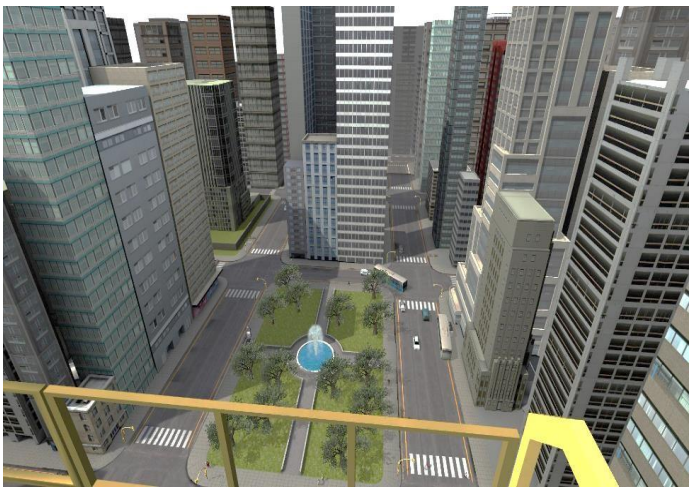

Figure 1. Elevator Environment

Small Apartment. The scenario includes a small, modular apartment which consisted of a 2x4m area. Within this area, there was a sink, a bathroom which view was occluded by a door and a closet embedded on the wall. (Figure 2)

Figure 2. Apartment Environment

Spiders Scene. This scenario includes a large apartment. The exposure took place in the kitchen where subjects were seated at the end of a table. On the opposite end of the table was a rectangular fish bowl with a rolled towel within it, functioning as a visual barrier between the subjects and the spider behind the towel. To increase sense of presence, a virtual beheaded avatar was placed on the chair with both hands positioned open over the table. The subjects´ point of view was situated above the neck of the virtual avatar.

When the virtual reality experience was initiated, the fish bowl´s front wall opened which triggered a scripted 3 minute animation where the spiders moved out of the fish bowl, approached the subject´s end of the table and stopped 5cm away from the subjects´ virtual hands. (Figure 3)

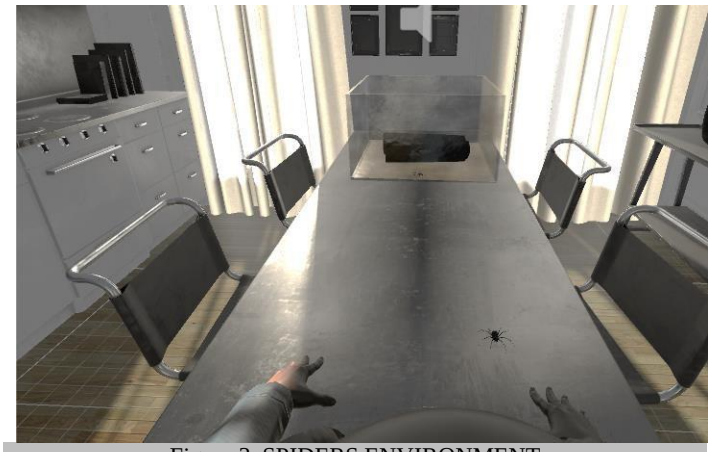

Figure 3. SPIDERS ENVIRONMENT

2.4 Instruments

Symptom Checklist 90-R (SCL-90R) [43,44,45]. This inventory was created to assess the presence of 90 symptoms on subjects between 13 and 65 years old, and it can be used to screen for psychiatric disorders. The instrument has fair psychometric properties of reliability and validity. The internal consistency of different dimensions fluctuates between alpha .77 coefficients for Psychoticism and .90 for Depression [45].

Acrophobia Questionnaire (AQ) [46]. This questionnaire consists of 40 items which present different situations purpose of which is to evaluate phobia of heights by means of two subscales: an anxiety subscale; and another avoidance subscale. This instrument shows reasonable internal consistency and test-retest reliability (r=.82 for the anxiety scale and r=.70 for the avoidance scale) [46].

Fear of Spiders Questionnaire [47]. Self-administered questionnaire for the assessment of the fear of spiders. It consists in 18 items. Scores may vary from 0 to 126. Having a Cronbach's alpha value of 0.92, the instrument shows a very good internal consistency [47].

The Claustrophobia Questionnaire [49]. This questionnaire consists of 26 items which describe claustrophobic situations and have to be scored in relation to the degree of anxiety which will be experienced in each of them. The instrument shows a very good internal consistency, having a Cronbach's alpha value of 0.95 in its original version [49]; and 0.88 in a study addressed to a Spanish population [48].

I group Presence Questionnaire (IPQ) [50]. This questionnaire was designed to assess the feeling of presence achieved in virtual environments. It consists of 14 items that can be grouped into three

subscales which assess three dimensions of the presence experience (involvement, spatial presence and realness) or can be taken as a compound global value.

The IPQ has shown fair psychometric properties50 with a mean of 38.16 (SD=17.53) [51].

Simulator Sickness Questionnaire (SSQ)[52]. This questionnaire consists of 16 items which show symptoms associated with the use of VR. For this study, the version carried out by Bouchard et al (2007)[53] has been taken as a reference since it dealt with general population, it was the most recent version and it used environments which were more similar than those of this study. Moreover, the instrument offers a global cybersickness score (M=3.86; SD=4.6)[53] which was taken into account in this study.

State-Trait Anxiety Inventory (STAI)[54]. Self-administered inventory designed to assess anxiety by means of two subscales, each of them consisting of 20 items: one for trait anxiety as a subject's stable inclination towards anxiety; and the other for state anxiety considered a transitory emotional state. The instrument has a proper internal consistency showing a Cronbach's alpha between 0.9 and 0.93 in state subscale; and between 0.84 and 0.87 in trait subscale [54].
A STAI-R normative study carried out in general Argentine population, in adults of both genres and of ages between 18 and 76, showed a median of 37.65 (SD= 8.81) for state anxiety subscale; and 39.56 (SD= 8.91) for trait subscale. Cronbach's alphas (0.93 for state subscale and 0.86 for trait subscale) also show good internal consistency [55].

Instruments which do not have a Spanish version were translated into Spanish, reviewed by bilingual psychologists and translators for the purpose of obtaining the most accurate translation. Later they were translated again into English, reviewed for the second time by other bilingual psychologists and translators in order to check the accuracy of the back translation.

2.5 Procedure

Once the informed consent has been signed, subjects who accepted being part of the research were submitted to an initial screening in which the Symptom Checklist 90-R has been used, and to questionnaires on acrophobia, fear of spiders and claustrophobia. Once they have been entirely administered, an immediate analysis was carried out, which allowed for the identification of the non-clinical population, excluding those who did not meet the exclusion criteria.
Later, subjects were invited to put on a holter according to the indications provided by a researcher and its proper installation and operation were tested.
The exposure phase started upon the placement of a virtual reality viewer in which a neutral environment was projected. At the same time, headphones were put on by means of which sounds inherent to the environment were transmitted for the subject to achieve a deeper immersion in the virtual environment.
Basal measures (HRV and STAI-S) were taken after six minutes of exposure to a neutral environment previously tested.
Then, the subject was exposed to each of the three experimental environments in a random order to avoid the occurrence of a bias due to the environments' sequence. Each exposure consisted of three minutes in the neutral environment and another three minutes in the experimental environment. Afterwards, the viewer and headphones were removed and post- test instruments (IPQ, SSQ y STAI-S) were administered. Once the three sequences were finished, the holter was removed and the experimental phase was considered finished. The average length of the entire procedure was of one hour and a half.

2.6 Measures

For each environment, means and standard deviations of variables pertaining to presence and cybersickness were calculated.
In order to assess changes in state anxiety before and after the exposure to every environment, a Wilcoxon test has been used since it had a non-homogeneous sample distribution.
For the HRV variable, significant differences between PRE, EXP and POST exposure to every environment were searched through an ANOVA with repeated measures, followed by a Bonferroni post-hoc analysis.
One-way ANOVAS of each variable were calculated with the purpose of analyzing differences between genres.

3.0 Results

3.1 Presence

The virtually designed scenarios generate a reasonable and necessary feeling of presence so as to achieve a good experience in immersive VRE. Average presence values found in this research are higher in all the environments than those calculated with the data provided by IPQ authors, M=38.16; SD=17.53[51]. No significant differences between male and female participants have been found (Table 1).
Elevator has been the environment which generated the most significant feeling of presence in the participants according to its global value as well as each of its factors: feeling of presence, involvement (attention component), spatial presence and judgment on realism (Table 1).

Global										Components													
	Total			male			Female			Involvment			Spatial Presence			Realism			Presence				
Frequency		37			15			22		37			37			37			37			37	
	M		*SD*	M		*SD*	M		*SD*	F (1,35)		M		*SD*	M		*SD*	M		*SD*	M		*SD*
Elevator	59.81		9.69	60.87		7.05	59.09		11.25	.29		3.95		4.65	9.92		3.58	1.84		4.01	5.11		1.02
Spiders	55.24		14.92	59.53		11.43	52.32		16.50	2.15		2.89		5.70	8.24		6.67	.46		4.38	4.65		1.65
Apartments	54.38		10.60	56.87		9.58	52.68		11.14	1.41		1.76		4.23	7.97		4.53	.92		4.02	4.73		1.17

Table 1. Presence Experience

3.2 Cybersickness

Spider and Apartment environments have not generated cybersickness since means below the indicated by Bouchard (2007) have been found, M=3.86; SD=4.6[53]. As for the Elevator environment, cybersickness symptoms were generated in subjects with a mean slightly higher than the indicated by the author. As regards cybersickness, no significant differences between genres have been found (Table 2).

	Total		Male		Female		
Frequency	37		15		22		
	M	SD	M	SD	M	SD	F (1,35)
Elevator	4.03	4.72	3.33	3.35	4.50	5.48	.539
Spiders	3.00	3.65	3.13	3.22	2.9	3.99	.014
Apartment	3.05	3.70	3.33	3.56	2.86	3.87	.033

Table 2. Simulator SicknessAnxiety

3.3. Anxiety

A comparison has been carried out between basal state anxiety and state anxiety measured after exposure to each virtual environment but making reference to what has been experienced during exposure. For that purpose, the Wilcoxon Test has been used since the subjects' distribution according to state anxiety in all the environments was not homogeneous.

Apartment and Spiders environments have shown not to be anxiety triggers in general population. As for Elevator, a significant increase in the level of state anxiety has been generated ($Z = -2.05$; $p = 0.04$) (Table 3).

No significant differences in state anxiety according to genre have been found in any scenario.

			Total			Male			Female
Frequency			37			15			22
	Med	Z	M	SD	M	SD	M	SD	F (1,35)
Elevator	30	-2.05*	32.97	11.23	29.67	9.19	35.23	12.12	2.26
Spiders	31	-1.60	32.89	11.88	29.27	7.44	35.36	13.76	2.44
Apartment	28	-.26	29.65	8.08	27.2	6.11	31.32	8.94	2.40

* $p<0.05$

Table 3. Anxiety State

3.4 Heart rate variability

A subgroup of 19 cases with clean and complete record has been taken for the analysis of HRV. Elevator and Apartment environments showed similar autonomic activation patterns in the experimental situation. Both presented a decrease in HRV in general, which was compatible with a parasympathetic withdrawal (RRM, SDNN, VLF, HF, HF_nu, Alpha1) (Table 4). As for the Spider environment, no signs of a significant autonomic activation have been found in the experimental situation (Table 4).

	ELEVATOR							APARTMENT							SPIDERS						
	PRE		EXP		POST		p (PRE vs EXP vs POST) (1)	PRE		EXP		POST		p (PRE vs EXP vs POST) (1)	PRE		EXP		POST		p (PRE vs EXP vs POST) (1)
	M	SD	M	SD	M	SD		M	SD	M	SD	M	SD		M	SD	M	SD	M	SD	
RRM	786.75	149.43	774.79	145.67	833.97	157.60	Post> Pre, Exp	786.75	149.43	769.43	132.88	841.38	140.16	Post> Pre, Exp	786.75	149.43	846.88	146.29	836.41	131.92	Pre < Exp, Post
SDNN	60.60	24.73	42.76	13.75	51.83	20.13	Pre>Exp, Post; Post > Exp	60.60	24.73	42.77	17.55	51.34	23.84	Pre>Exp, Post; Post > Exp	60.60	24.73	48.50	19.51	49.67	17.18	Pre> Exp, Post
RMSSD	39.65	22.86	27.51	12.77	41.55	21.62	Exp < Pre, Post	39.65	22.86	26.86	13.02	42.47	23.63	Exp < Pre, Post	39.65	22.86	41.08	22.21	39.29	19.45	ns
TA	7.94	.88	7.38	.78	7.60	.76	Pre >Exp	7.94	.88	7.35	.82	7.61	1.03	Pre>Exp	7.94	.88	7.48	1.06	7.61	.73	ns
VLF	6.99	.93	6.19	.95	6.43	.88	Pre>Exp, Post	6.99	.93	6.15	.98	6.39	1.28	Pre>Exp, Post	6.99	.93	6.15	1.15	6.34	1.01	Pre> Exp,Post
LF	6.96	.99	6.63	.83	6.64	1.06	ns	6.96	.99	6.58	.92	6.61	1.25	ns	6.96	.99	6.59	1.23	6.60	.97	ns
HF	5.90	1.04	5.32	1.08	5.88	1.27	Exp < Prel, Post	5.90	1.04	5.36	.92	6.03	.94	Exp < Pre, Post	5.90	1.04	6.01	1.10	6.15	.80	ns
VLF_pt	42.53	16.67	33.88	16.78	34.55	16.86	ns	42.53	16.67	34.03	14.57	34.47	16.77	ns	42.53	16.67	29.93	12.86	32.70	15.70	ns
LF_pt	42.10	18.45	51.28	18.10	41.83	16.69	ns	42.10	18.45	48.88	14.63	40.25	15.91	ns	42.10	18.45	43.77	16.49	41.01	19.29	ns
HF_pt	15.36	8.80	14.84	7.70	23.61	17.36	ns	15.36	8.80	17.09	11.71	25.27	16.96	ns	15.36	8.80	26.30	12.10	26.29	13.16	Pre < Exp,Post
LF_nu	.71	.18	.76	.15	.66	.21	Exp>Post	.71	.18	.74	.16	.63	.19	Exp>Post	.71	.18	.62	.17	.60	.21	ns
HF_nu	.29	.18	.24	.15	.34	.21	Post> Exp	.29	.18	.26	.16	.37	.19	Post> Exp	.29	.18	.38	.17	.40	.20	ns
L_H	4.06	3.34	5.19	4.58	3.47	4.22	ns	4.06	3.34	4.79	4.19	2.53	1.97	Exp>Post	4.06	3.34	2.65	3.09	2.21	1.65	ns
SampEn	1.42	.27	1.40	.31	1.46	.32	ns	1.42	.27	1.43	.38	1.63	.26	Post> Pre, Exp	1.42	.27	1.66	.33	1.62	.34	Pre <Exp,Post
Alpha1	1.30	.23	1.35	.24	1.23	.28	Exp>Post	1.30	.23	1.35	.27	1.09	.29	Post< Pre, Exp	1.30	.23	1.07	.27	1.21	.22	Pre>Exp
Alpha2	19	.84	.25	.80	.25	.76	.24	.84	.25	.78	.19	.81	.27	ns	.84	.25	.74	.23	.80	.24	ns

Table 4. Heart Rate Variability

(1) Repeated measures ANOVA. $p<0.05$

The existence of a correlation between HRV and state anxiety has been analyzed in the experimental situation. No significant relation has been found between the variables.

4. Discussion and Conclusions

This has been a preliminary study to give ecological validity to the aforementioned environments. A study in basic variables has been carried out, and its behavior has been analyzed so as to determine it appropriateness in order to move on to another experimental study on clinical population so as to finally carry out a study on the effectiveness of the use of these environments for specific phobias treatment.

Firstly, the variable presence in each environment has been explored. It has been found that said variable reflects values which are expectable and necessary for an adequate experience in VE. Moreover, no significant differences between female and male subjects have been found. Among the explored environments, Elevator has been the environment which generated the strongest feeling of presence on the participants as for its global value as well as each of its factors: feeling of presence, involvement, spatial presence and judgment on realism. However,

this fact has not showed any significant relation with the degree of anxiety perceived by the subjects nor the cybersickness provoked.

No signs of cybersickness in virtual environments were expected, although it is known that only between 5% and 20% of the subjects who experience VR do not present them36. The three environments studied herein have revealed means which were similar to those indicated by Bouchard (2007)53, although Elevator has been the environment which reflected the highest value. The latter might be due to what is known as sensory conflict. There are several theories regarding sensory conflict, one which explains that cybersickness is produced by a conflict between visual, vestibular and proprioceptive stimuli. The fact is that there is no correspondence between visual, vestibular and proprioceptive stimuli, that is to say, between the input the visual system perceives and the input the vestibular system processes [56,57,58,59] . In the case of the Elevator environment, the subject receives a visual stimulus of ascending but without any feedback provided by the vestibular system since the subject stays physically in the same place.

In order to verify the hypothesis that the however mild but existent cybersickness is provoked by a sensory conflict, it will be necessary to carry out a new study in which two static situations are compared without any transition in between. That is to say, to compare cybersickness standing on the cargo elevator on the ground floor and repeating the situation standing at the top of the terrace. This way, the movement variable and its sensory conflict consequence is removed.

Another hypothesis is that, since some of the SSQ items are influenced by anxiety symptoms26, it is possible that the cybersickness perceived (however mild and within the expected range) has been concealed under state anxiety symptoms informed in the Elevator.In accordance with previous studies which showed that female participants tend to present more cybersickness symptoms than male participants[36], women's mean on cybersickness has been higher than men although the difference

has not been substantial.

Regarding subjective anxiety informed by the subjects, the Apartment and Spider environments have shown not to be anxiety triggers in general population. As for Elevator, a significant increase on the level of anxiety has been reported. A possible hypothesis to account for this fact might be similar to the former in which the reported anxiety responds to a movement simulated in the virtual scenario while on the other two scenarios the subjects remain static even in the VE.

On the other hand, the relation between state anxiety and reported cybersickness has been explored and a correlation between both variables ($r=.564$; $p<0.01$) has been found. It would be necessary to explore its relation deeply and ratify their reciprocate independency or one's influence of upon the other. In other words, it would be necessary to verify if the reported state anxiety is the product of an anxiety response induced by fear of heights or by the cybersickness produced; or, in reverse, that the reported cybersickness is an effect of the triggered anxiety, as it has been previously pointed out.

Even though there is a relation between anxiety and presence by means of which higher levels of presence lead to higher levels of anxiety [60], no significant relation has been found between both variables in this study.

Lastly, an autonomic activation has been observed in the Elevator and Apartment environments during the experimental situation. Because of state anxiety and higher levels of presence and cybersickness reported in Elevator, the reflected autonomic activation is not an extraordinary occurrence while it does draw attention in the Apartment environment. Ahypothesis might be that the virtual reality experience itself might be stimulating. However, this is compared to what happened in the Spider environment, in which something counterintuitive happens since lesser activation in the experimental situation is observed.

Another hypothesis for this discrepancy might be attributed to the experimental experiences since in the Elevator environment as well as in Apartment, the subjects were standing, while in Spider they were seated. A path to clear this situation might be to replicate the study, maintaining the subjects standing during the three experimental situations and compare the HRV. Furthermore, Spider has been the only environment in which a bodily representation has been added to the virtual environment, a fact which might be acting as a strange variable, although it did not affect the reported feeling of presence. At the same time, subjects might visually avoid spiders by observing other parts of the environment, which might also have affected the experience. On the other hand, however, this was the only environment in which two subjects asked for an interruption of the exposure.

5. Limitations and Further Research

Future studies should consider broadening the size of the sample; advancing on clinical population and comparing the results.

Regarding the sensory conflict, a study in the Elevator environment should be done, in which the same variables of this study are explored but in two situations where no movement or displacement is generated: on the building's ground floor and terrace.

Replicating the research is also suggested, maintaining the experiences in each environment as similar as possible in order to disregard possible strange variables (e.g.: subjects' position).

Lastly, it would be interesting to monitor in real time the subjects' anxiety experience (and not afterwards as it has been done in this study) so as to compare them to HRV objective

variable measured in real time. In order to do so, a SUDS scale could be used. However, it would be necessary not to interrupt the virtual experience immersion.

6. Ethics and Human Rights

For this study, subject participation was voluntary without any kind of monetary or material incentive whatsoever. Everyone participating as a test subject, signed an informed consent form that included information pertaining to their involvement in the study and the test phase process. In all cases it was made clear that they could opt to decline participation at any time during the examination.

The present work, followed the ethical principles included in the Helsinki declaration of the world health organization, celebrated in Seoul in 2008 and the 64th general assembly in Fortaleza, Brazil.

An ethical committee called IRB (Iniciativa y Reflexión Bioética) assessed and approved the study issuing the resolution N° DI 77-DGDOIN/15 dated May 4th 2015. The aforementioned committee is registered in the ethical Committees registry of the city government of Ciudad Autónoma de Buenos Aires, Argentina. Simultaneously, the study had a professional and civil responsibility insurance issued by an insurance company called Noble Seguros, the corresponding insurance policy number was 8092412.

7. Acknowledgment

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

We would like to thank María Cecilia Raventos Haggi, Florencia de Sanctis, Guido Cataldo, Melanie Quaglia and Victoria Rojas, teacher and students in Pontifical Catholic University of Argentina, for their assistance with data collection.

8. Author Disclosure Statement

No competing financial interests exist.

9. Funding's

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Briggs, JC. (1996). The Promise of virtual reality. The Futurist; 30:13-18.
2. Botella C, Baños R, García-Palacios A, Quero S, Guillén V, et al. (2007). La utilización de las nuevas tecnologías de la información y la comunicación en la psicología clínica. UOC Papers. Revista sobre la sociedad del conocimiento; 4: 32-41.
3. Wiederhold, B, Wiederhold, MD. (2014). Virtual reality for posttraumatic stress disorder.
4. In Wiederhold BK, Bouchard S, eds. *Advances in Virtual Reality and Anxiety Disorders*. New York: Springer, pp.211-234.
5. Krijn M, Emmelkamp PMG, Biemond R, de Wilde de Lingy C, Schuemie MJ, et al. (2004). Treatment of acrophobia in virtual reality: the role of immersion and presence. Behaviour Research and Therapy; 42: 229-239.
6. Climent-Martínez G, Luna-Lario P, Bombín-González I, Cifuentes-Rodríguez A,Tirapu- Ustárroz J, et al. (2014). Evaluación neuropsicológica de las funciones ejecutivas mediante realidad virtual. Revista de Neurología; 58: 465-75.
7. Maples-Keller JL, Bunnell BE, Kim S, Rothbaum, BO. (2017). The use of virtual reality technology in the treatment of anxiety and other psychiatric disorders. Harvard Review of Psychiatry; 25:103-113.

8. Anderson PL, Jacobs C, Rothbaum BO. (2004). Computer-supported cognitive behavioral treatment of anxiety disorders. Journal of Clinical Psychology; 60(3): 253–267.
9. Botella C, García-Palacios A, Baños M, Quero Castellano S. (2007). Realidad virtual y tratamientos psicológicos. Cuadernos de Medicina Psicosomática y Psiquiatría de Enlace; 82:17- 30.
10. García-Palacios A,Botella C, Hoffman H, Fabregat S. (2007). Comparing acceptance and refusal rates of virtual exposure versus in vivo exposure by patients with specific phobia. CyberPsyhology and Behaviour; 10:722-724.
11. Rothbaum B, Hodges L, Smith S, Lee J, Price L. (2000). A controlled study of virtual reality exposure therapy for the fear of flying. Journal of Consulting and Clinical Psychology; 68: 1020-1026.
12. Wiederhold B, Wiederhold, MD. (2014). Introduction. In Wiederhold BK, Bouchard S, eds.
13. *Advances in Virtual Reality and Anxiety Disorders*. New York: Springer, pp 3-8.
14. Bouchard S. (2011). Could virtual reality be effective in treating children with phobias? Expert Review of Neurotherapeutics; 11:207-213.
15. Meyerbröeker K, Emmelkamp PM. (2010). Virtual reality exposure therapy in anxiety disorders: a systematic review of process-and-outcome studies. Depression and Anxiety; 27:933-944.
16. Opris D, Pintea S, García-Palacios A, Botella C, Szamosközi S, et al. (2012). Virtual reality exposure therapy in anxiety disorders: a quantitative meta-analysis. Depression and Anxiety; 29: 85-93.
17. Parsons T D, Rizzo A. (2008). Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: a meta-analysis. Journal of Behavior Therapy and Experimental Psychiatry; 39: 250-261.Bouchard S, Wiederhold B, Loranger C. (2014). Claustrophobia: Efficacy and Treatment Protocols. In Wiederhold BK, Bouchard S, eds. *Advances in Virtual Reality and Anxiety Disorders.* New York: Springer, pp. 145-162.
18. Price M, Anderson P, Rothbaum BO. (2008). Virtual Reality as Treatment for Fear of Flying: A Review of Recent Research. International Journal of Behavioral Consultation and Therapy; 4:340-347.
19. Tortella-Feiu M, Bornas X,Llabrés J. (2007). Tratamiento del miedo a volar con exposición asistida por ordenador. Computer-Assisted fear of flying treatment. Cuadernos de Medicina Psicosomática; 81:21-34.
20. Wiederhold BK, JangDP, Gevirtz, RG, Kim, SI. (2002). The treatment of fear of flying: a controlledstudy of imaginal and virtual reality graded exposuretherapy. Transactions on Information Technology in Biomedicine; 6:218-223.
21. Bouchard S, Wiederhold B,Bossé J.(2014). Fear of heights (acrophobia): efficacy and lessons learned from psychiphysiological data.In Wiederhold BK, Bouchard S, eds. *Advances in Virtual Reality and Anxiety Disorders*. New York: Springer, pp. 119-144.
22. Emmelkamp PM, Bruynzeel M,Drost L, Van der Mast ChA. (2001). Virtual reality treatment in acrophobia: a comparisonwithexposure in vivo. CyberPsychology & Behavior; 4: 335-339.
23. Botella C, Bretón-López J, Quero S, Baños R, García-Palacios A. (2010). Treating cockroach phobia with augmented reality. Behavior Therapy ;41:401-413.
24. Bouchard S, Côté S, St-Jacques J, Robillard G, Renaud P. (2006). Effectiveness of virtual reality exposure in the treatment of arachnophobia using 3D games. Technology and HealthCare; 14:19–27.Michaliszyn D, Marchand A, Bouchard S, Martel MO, Poirier-Bisson J. (2010). A randomized, controlled clinical trial of in virtuo and in vivo exposure for spider phobia. CyberPsychology, Behavior and Social Networking; 13:689-695.
25. Bouchard S, Bossé J, Loranger C, Klinger E. (2014). Social anxiety disorder: efficacy and virtual humans. In Wiederhold BK, Bouchard S, eds. *Advances in Virtual Reality and Anxiety Disorders*. New York: Springer, pp. 187-211.
26. Burdea G, Richard P, Coiffet P. (1996). Multimodal virtual reality: input-output devices, system integration, and human factors. International Journal of human Computer Interaction; 8: 5-24.
27. Slater M, Usoh M, (1994). Steed A. Depth of presence in virtual environments. Presence: Teleoperators and VirtaulEnvironments; 1: 130-144.
28. Heeter C. (1992). Being there: The subjective experience of presence. Presence: Teleoperatorsand Virtual Environments; 1: 262-271.
29. Riva G, Mantovani F, Buchard S. (2014). Presence. In Wiederhold BK, Bouchard S, eds.
30. *Advances in Virtual Reality and Anxiety Disorders*. New York: Springer, pp. 9-34.
31. Baños RM, Botella C, Perpiña C. (1999). Virtual reality and psychopathology. Cyberpsychology & Behavior; 2:283-292.
32. Riva, G. (2009). Is presence a technology issue? Some insights from cognitive sciences. Virtual Reality; 13: 59-69.
33. Riva G, Waterworth JA, Waterworth EL, Mantovani F. (2011). From intention to action: the role of presence. New Ideas in Psychology; 29, 24-37.
34. Lawson BD, Graeber DA, Mead AM, Muth ER. (2002). Signs and symptoms of human syndromes associated with synthetic experience. In Stanney KM, ed. Handbook of Virtual Enviroments: Design Implementation and Applications. Mahwah: NJ: LawrenceErlbaum Associates, pp. 589-618.
35. Bos JE, Bles W, Groen EL. (2008). A theory on visually induced motion sickness. 29:47-57.
36. La Viola Jr J J.(2000). A Discussion of cybersickness in virtual environments. SIGCHI Bulletin; 32:47-56.
37. Quintana P, Bouchard S, Serrano B, Cárdenas-López G. (2014). Efectos secundarios negativos de la inmersión con realidad virtual en poblaciones clínicas que padecen ansiedad. Revista de Psicopatología y Psicología Clínica; 19:197-207.
38. Cano Vindel A, Miguel Tobal JJ. (2001). Emociones y salud. Ansiedad y Estrés; 7:111-121.
39. Lang P. (1968). Fear reduction and fear behaviour: Problems in treating a construct. In Shilen JM, ed. Research in Pschotherapy Vol.III. Washington: American Psychological Association.
40. Spielberger CD. (1972). Anxiety as an emotional state. In Spielberger CD, ed. Anxiety Behavior. New York: Academic Press, pp. 23-49.
41. Thayer JF, Brosschot JF. (2005). Psychosomatics and psychopathology: looking up and down from the brain. Psychoneuroendocrinology ;30:1050-8.
42. Stauss HM. (2003). Heart rate variability. Am J Physiol Regul Integr Comp Physiol; 285: R927-31.
43. (1996). Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Heart rate variability: standards of measurement, physiological interpretation and clinical use. Circulation; 93:1043-65.
44. Casullo MM, Perez M. (2008). El inventario de síntomas SCL-90-R de L. Derogatis.
45. Derogatis L. (1994). SCL 90-R administration, scoring and

procedures manual. 3° Ed.
46. Minneapolis: National Computer Systems.Derogatis LR. (1975). The SCL-90-R. Baltimore: Clinical Psychometric Research.
47. Cohen DCh. (1997). Comparison of Self-Report and Overt-Behavioral Procedures for Assessing Acrophobia. Behavior Therapy; 8:17-23.
48. Szymanski J, O´Donohue W. (1995), Fear of Spiders Questionnaire. Journal of Behavior Therapy and Experimental Psychiatry; 26: 31-34.
49. Martínez Valls MA, García Palacios A, Botella C. (2003). Propiedades psicométricas del cuestionario de claustrofobia en población Española. Psicothema; 15: 673-678.
50. Radomsky AS, Rachman S, Thordarson DS, Mc Isaac HK, Teachman BA. (2001). The Claustrophobia Questionnaire. Journal of Anxiety Disorders; 15:287-297.
51. Schubert T, Friedmann F, Regenbrecht H. (2001). The experience of presence: Factor analytic insights. Presence: Teleoperators and Virtual Environments; 10: 266-281.
52. Morina N, Brinkman WP, Hartanto D, Emmelkamp, PMG. (2014). Sense of presence and anxiety during virtual social interactions between a human and virtual humans. Peer J; 2:e337.
53. Kennedy RS, Lane NE, Berbaum KS, Lilienthal MG. (1993). Simulator Sickness Questionnaire: An enhanced method for quantifying simulator sickness. International Journal of Aviation Psychology 3: 203-220.
54. Bouchard S, Robillard G, Renaud P. (2007). Revising the structure factor of the Simulator Sickness Questionnaire. Annual Review of Cybertherapy and Telemedicine. 5:117-122.
55. Spielberger CD, Gorsuch RL, Lushene RE. (1970). Manual for the state-trait anxiety inventory. Palo Alto: Consulting Psychologists Press.
56. Acuña DF. (2010). Evaluación de Ansiedad. Datos normativos del Inventario de Ansiedad Estado-Rasgo en Buenos Aires. (Tesis de Grado). Universidad de Belgrano. \
57. Bos JE, Bles W, Groen EL. (2008). A theory on visually induced motion sickness. 29:47-57.La Viola Jr J J. (2000). A Discussion of cybersickness in virtual environments. SIGCHI Bulletin 32:47-56.
58. Gronwall, DM. (1997). Paced auditory serial-addition task: A measure of recovery from concussion. Perceptual and Motor Skills, 44:367–373.
59. Akiduki H, Nishiike S, Watanabe H, Matsuoka K, Kubo T, Takeda N. (2003). Visual–vestibular conflict induced by virtual reality in humans. Neurosci Lett 340:197–200.
60. Robillard G, Bouchard S, Fournier T, Renaud P. (2003). Anxiety and presence during VR immersion: A comparative study of the reactions of phobic and non- phobic participants in therapeutic virtual environments derived from computer games. Cyberpsychology & Behavior 6:467–476.

DOI: 10.31579/2637-8892/069