Rapid Communication

Virtual Reality and Claustrophobia: Multiple Components Therapy Involving Game Editor Virtual Environments Exposure

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Abstract

The effectiveness of a multiple components therapy regarding claustrophobia and involving virtual reality (VR) will be demonstrated through a trial which immersed six claustrophobic patients in multiple context-graded enclosed virtual environments (VE) using affordable VR apparatus and software. The results of the questionnaires and behavior tests exhibited a significant reduction in fear towards the enclosed space and quality of life improvement. Such gains were maintained at 6-month follow-up. Presence score indicated the patients felt immersed and present inside the game editor VE.

Introduction

DERIVED FROM THE LATIN ROOT claustro- (locked, enclosed) and the Greek root phobia (the dreadful squire of Ares and by extension the fear), claustrophobia is therefore the fear of enclosed spaces.[1] The prevalence of claustrophobia ranges from 2% to 5% in the general population.[2] Because of adaptive related behaviors such as avoidance of enclosed spaces (elevators, means of transportation . . .), claustrophobia can be considered as an impairing mental disorder. The dramatic advances in computer science, hardware performances, the emergence of virtual reality, and the reduction in material cost allow the use of virtual environments (VE) and computer devices to substitute phobogenic/anxiogenic objects or situations during systematic desensitization, *in vivo* desensitization, flooding, or exposure for their virtual avatars. However, professional VEs creating or editing software (e.g., Virtools or sense8 World Up) are often expensive. In contrast, level design game editors coming from mainstream games, while rather cheap (from 10 to 50 USD) possess powerful 3D engines, compatible with a large array of PCs. On the other hand, unlike professional software, a game editor does not rely on highly interactive environments or customized interface. Yet, it offers enough realistic features to induce presence and anxiety as demonstrated by previous studies relative to presence measures,[3] post-traumatic stress disorder,[4] and arachnophobia.[5] Therefore, the aim of the present experiment was to demonstrate the efficiency of a multi-component treatment (educational, relaxation, cognitive procedures, and behavioral sessions), including VR exposure for claustrophobic patients.

Methods

Subjects

Six patients (4 women, 2 men) suffering from claustrophobia (DSM IV criteria)[1] volunteered to undergo the experiment. The mean duration of claustrophobia was 15.33 years, and three subjects exhibited comorbid phobias: acrophobia, driving phobia, and agoraphobia.

Procedure

The 1st, 2nd, and 3rd sessions consist of different components: psycho-educational, relaxation initiation, cognitive restructuring, and homework assignments. From the 4th to the 8th session, the procedures comprise a VR exposure to nine different VEs. This VR exposure is gradually phobogenic, as the fear provoking stimuli vary in difficulty from one VE to the next. Each patient explores each VE during 50 to 55 minutes. They are invited, but never ordered, to enter the enclosed spaces and to remain in a narrow place as long as they can bear.

Assessment instruments

Beck Depression Inventory (BDI)[6] is a 21-item subjective questionnaire that uses a 4-points scale to measure mood and depressive symptoms.

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State Trait Anxiety Inventory (STAI)[7] Y-A (state), T Type (general) form. 20-items subjective questionnaire on a 4-points scale that assesses the individual tendency to regard situations as threatening or likely to elicit anxiety.

Questionnaire sur la Propension à l'Immersion (ITQ-F)[8] is a validated French Canadian adaptation of the *Immersive Tendencies Questionnaire.*[9] This 7-points scale subjective questionnaire uses 19 items to measure the individual tendencies to feel immerse in a nonexistent world.

Questionnaire sur l'état de Présence (PQ-F)[8] is a validated French Canadian adaptation of the *Presence Questionnaire.*[9] It consists of 22 items rated on a 7-points scale, assessing the degree of presence.

Claustrophobia Questionnaire (CLQ).[10] As part of this 26 items questionnaire (4-points scale), the two components of claustrophobia are measured on two distinct subscales: suffocation (closed spaces) and restriction (confined places).

Echelle sur la Qualité de Vie: Life Quality Scale.[11] French assessment instrument featuring a 10-points scale questionnaire of six items. It evaluates anxiety/phobia related feeling of impairment regarding the several areas of daily life.

Behavioural Avoidance Test (BAT). Classic objective behavioral measures of phobia intensity and clinical progress. The patient is instructed to stand at different distances from a real elevator, to enter it, to let the door close, and to proceed to upper floors. Each achieved step grants a point on the scale, ranging from 0 to 10.

Subjective Unit of Discomfort (SUD).[12] 10 or 100 points scale tests which measures the perceived level of anxiety at an exact time.

Apparatus and VE

The VR system conforms to the "affordable materials" constraint of the test. It includes a ruggedized Sony Glasstron LDI-100B Head-Mounted Display (800x600 non stereoscopic LCD screen) coupled with a 3 degrees of freedom head tracker (Intersense Intertrax, Bedford, MA, USA).

The VEs are generated by an affordable software (10 to 50USD): UnrealED 3.0, the level editor software of the Unreal Tournament 2003/2004 game (Epic Games Inc., Cary,

NC, USA) and run on an ordinary notebook Pentium IV 3 GHz. The VEs consists of nine different and gradual VEs suitable for claustrophobia. It comprises houses, corridors, hallways, caverns, concrete channels, underground access, and elevators. All VEs feature gradual anxiogenic characteristics (limited space from 12 to 1 m^2, low ceiling, number of windows, light intensity, automatic door closing, temporary no reopen instructions, and sliding walls).

Results

Means, standard deviations, and ANOVA *F* values are presented in Table 1 for pre-test/post-test, post-test/follow-up comparisons. The data analyzed with ANOVA showed a significant time (pre-post) effect for the CLQ. This concerned the Suffocation as well as the Restriction Scale. There is also a significant time effect on BDI and EQV tests. The BAT exhibits higher significant scores, as patients were able to achieve more steps toward the fearful situation. The STAI and the ITQ score are considered stable as they reflected a trait or a tendency. The PQ scores indicated that the patients felt immersed and present inside the VEs. The patients' mean peak SUD rating also revealed they perceived the VEs as fearful or anxiety eliciting.

Regarding follow-up, there were no significant differences between the post-test and follow-up rating. Furthermore, the most striking evidence for therapy protocol involving VR exposure efficacy is outdoor real life behavior. After the therapy, all patients were able to use the elevator alone, stay in a building cellar, use public toilets, and three of them experienced real flight without incident, while they did not dare take the plane before the experiment.

Discussion

The multi-component therapeutic protocol involving virtual reality exposure was effective, since the fear towards enclosed spaces was lessened, humor and life quality improved, and avoidance behavior started being forsaken. Such results also corroborate the first trial involving VR and claustrophobia.[13] The patients exhibit generalization effects of the

TABLE 1. MEANS, STANDARD DEVIATIONS OF THE DEPENDENT VARIABLES AND RESULTS OF RELATED ONE WAY ANOVA. ANALYSIS OF DIFFERENCES BETWEEN PRE- AND POST-TEST PERIOD, POST-TEST PERIOD, AND 6-MONTH FOLLOW-UP

Tests	Pre-test (n = 6) mean (SD)	Post-test (n = 6) mean (SD)	ANOVA F (1.5)	Eta^2	6-Months Follow-up (n = 6) mean (SD)	ANOVA F (1.5)
CLQ	50.5 (10.05)	23.66 (13.04)	53.88***	0.61	18.83 (13.30)	0.93
SS	27.66 (9.16)	12 (6.96)	62.75***	0.52	9.66 (6.89)	0.97
RS	22.83 (4.96)	11.67 (7.03)	15.92**	0.50	9.16 (6.70)	0.82
BDI	13.33 (5.75)	5.33 (3.83)	9.41*	0.44	4.5 (4.54)	0.59
EQV	8.33 (4.93)	4.17 (4.21)	10.01**	0.19	3 (3.52)	0.59
BAT	6.66 (2.80)	9.5 (1.22)	7.81*	0.33	9.83 (0.41)	1.00
STAI	47 (2.31)	48.16 (3.02)	1.17	0.04		
ITQ	57.67 (11.02)	63.16 (9.41)	4.64	0.08		
PQ		113.03 (11.7)				

ANOVA, analysis of variance; CLQ, claustrophobia questionnaire; RS, restriction scale; SS, suffocation scale; BDI, beck depressive inventory; EQV, echelle de qualité de vie (life quality scale); BAT, behavioral avoidance test; STAI, state trait anxiety inventory; ITQ, immersive tendencies questionnaire, PQ, presence questionnaire.

*$p < 0.05$; **$p < 0.025$; ***$p < 0.001$.

VR therapy as they could reproduce their VR experience results in daily life and towards real fearful situations (narrow elevator, cellar, plane . . .). The follow-up survey demonstrated the stability of the positive effect of the therapeutic sessions on claustrophobia.

Furthermore, the three patients who suffered from comorbid phobias also expressed improvement toward situations other than closed spaces, such as height or overcrowded places, even if the protocol was not designed to achieve such goals. These allegations may support a hypothesis of overgeneralization effect of the multi-component protocol involving VR.

The results also confirm the general guideline that virtual reality exposure using a video game level editor can be an efficient tool for therapy protocols using VR. The mean SUD peak and the overall presence scores through the exposure indicated that the patients felt immersed and present, but also experienced fear toward phobogenic virtual enclosed spaces.

On top of usual advantages offered by VRET (efficiency, interactivity, controlled environment, and harmlessness, flexibility, confidentiality, motivation) and compared to *in vivo* exposure, such therapy is an economical mean to modify patients attitude towards phobogenic situations and can be achieved, as proven in the present study, with an affordable stand alone immersive solution using video games level editor.

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Disclosure Statement

The authors have no conflict of interest.

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