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## Research Article

### SIMULATION OF PSYCHOTIC SYMPTOMS IN VIRTUAL REALITY: EMOTIONAL STATE ASSESSMENT AND CYBERSICKENESS IN MENTAL HEALTH PROFESSIONALS

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#### ABSTRACT

**Introduction:** The prospective of Virtual Reality (VR) in psychiatry concerns the possibility of creating social environments that cause the same answers in the real world.

**Aims:** Evaluation emotional responses, rate the sense of presence and simulator sickness in a VR scenario with hallucinations simulations.

**Methods:** Fourty eight healthy volunteers have tried out an immersive experience in a virtual scenario for about 10 minutes. Through individualized simulations they lived visual and auditory hallucinations.

##### Results:

- PANAS (evaluation of the emotional state): from the comparison of the average values reached in the two scales we highlight: scale of positive affect (PA) M 28.13; SD 5.59; negative affect scale (NA) M 17.44; SD 6.27.
- SSQ (cybersickness): 47.9% of the volunteers reported the complete absence of symptoms and 52.1% reported negligible symptoms reaching a Total Score (TS) between 0 and <5. There is an absence of symptoms for the 16 disorders with M 36.25; SD 9.07.
- Questionnaire (identification in the psychotic symptomatology and sense of presence): high levels of identification and sense of presence have been highlighted.

**Conclusions:** VR has no side effects; the simulation is able to simulate an emotional state found in psychosis; high sense of presence in the virtual scenario.

In the future:

- Training courses for mental health workers.
- Support to cognitive behavioral therapy in the treatment of psychotic symptoms by giving patients the opportunity to confront their symptoms and learn a new coping strategy.

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#### INTRODUCTION

Virtual Reality (VR) is characterized by a three-dimensional simulation of a computer-generated environment in which users can interact in a seemingly real or physical way through input and output accessories and peripheral devices.

Although it existed for over half century, VR has only been used for the last thirty years due to the high cost of the

equipment, the software limitations and cyber-sickness, a collateral effect due to undeveloped headsets.

With technological progress and the reduction of costs, there has been a renewed interest and an increase in popularity of VR. Today, this technology is used in many areas because the "sense of presence", is able to stimulate perceptive, cognitive and emotional responses equal to those experienced in real world: this aspect represents the great potential of VR in psychiatry.

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VR allows the treatment and evaluation of many psychopathologies: anxiety disorders,<sup>1,2</sup> with a special attention to the specific phobias' world<sup>3,4</sup> of the D.O.C.<sup>5, 6</sup>, of agoraphobia<sup>7</sup>, of the social phobia<sup>8, 9,10,11</sup>, at the drugs abuse<sup>12</sup>, and eating disorders<sup>13,14, 15</sup>.

In addition to the above studies, further studies have been conducted on the evaluation and the treatment of persons affected by schizophrenia<sup>16,17,18,19</sup> <sup>20</sup> and others on healthy subjects. In both scenarios it was possible hear simulations of auditory hallucinations made in VR with the sole use of headphones.

In 1996 Patricia Deegan<sup>21</sup> developed the Toolkit "Hearing Distressed Voices Simulation" which provides a group of subjects with listening of hallucinations simulation. The Toolkit provides distressing and disparaging voices recorded with different tones and volumes, while subjects perform certain tasks (cognitive exercises, social interactions, activities related to the profession).

The studies were conducted through the use of the Toolkit for students of different health professions. The aim was to assess improvements students' in their understanding of psychotic symptoms, in reducing stigma and in increasing empathy. The study also highlighted how the auditory hallucinations disturbed the completion of assigned tasks<sup>22, 23, 24, 25, 26</sup>.

Yellowlees and Cook<sup>27</sup> in 2006 assessed an Internet VR technology as an educational tool for visual and auditory hallucinations. With an online platform, the users visited a virtual psychiatric department in which hallucinations simulations were present. A resulting survey showed a greater understanding of psychotic symptoms due to the VR experience.

The current studies that prove the effectiveness of the simulation of hallucinations in immersive VR are limited and there are no studies focused on the simulation of psychotic symptoms in VR aimed at mental health professionals. Kalyanaraman<sup>28</sup> in 2010 and Formosa<sup>29</sup> in 2018 conducted their studies using the immersion in virtual scenery that simulate the psychotic symptomatology in a group of general publics to reduce the stigma and increase the level of empathy.

Conversely, we evaluated the experience of hallucinatory simulation and emotional states in the mental health professionals with VR. Consequently, it will be possible to use the scenario for psycho educational purposes. For this reason, an immersive VR environment was devised and administered to mental health professionals who already have clinical experience with psychosis patients.

### ***Sense of presence***

In order to define VR in terms of human experiences a sense of presence concept is required.

The sense of presence can be defined as the impression of the subject that takes part in a virtual environment due to the stimulation of emotional, cognitive and perceptive processes. A commonly accepted definition is "perceptual illusion of non-mediation" through sense of presence<sup>30, 31, 32</sup>, that is simply described as the sense of "being there" inside the virtual space<sup>33</sup>, or to being in a world that exists outside of us<sup>34</sup>.

### ***Cybersickness***

The cybersickness or digital motion sickness is caused by conflicting information that the brain receives from the eyes and the vestibular system. In fact, the sight gives an illusory perception of movement while the proprioceptive and vestibular systems does not detect any change in position.

Technological improvements over the very early versions of VR headsets should help to solve this problem as the artificial stimulation of movement to the vestibular system is consistent with those tested in VR.

### ***Aims***

The aims of this study were the evaluation of the emotional state, cybersickness and the sense of presence in a population of mental health professionals following the immersion in a virtual scenario that simulate the psychotic experience.

## **MATERIALS AND METHODS**

Forty-eight healthy volunteers lived an immersive experience in a virtual scenario for the duration of 10/15 minutes at the VR laboratory "Sergio Piro" of the local healthcare company, ASL Napoli2 Nord.

The sample consists of professionals working in the mental health department of the ASL Napoli 2 Nord and in the psychiatry department of the University of Studies of Campania "Luigi Vanvitelli" located in Napoli.

The average age is 35.22 years (DS11,4) with a minimum age of 23 years and a maximum age of 64 years of which 68.75% female (n=33) and 31.25% male (n=15).

Before the simulation, the general characteristics of the virtual scenario and the modalities of movement both in physical and virtual space were illustrated with the help of motion trackers and controllers.

Afterwards, the subjects wore the headsets, familiarized with the equipment and started the simulation in the virtual scenario. In order to avoid conditioning, they were asked not to discuss the simulations.

At the end of experience, the volunteers completed a self-report scale for the evaluation of the emotional state experienced (PANAS), a questionnaire about the cybersickness (SSQ), and a questionnaire that investigated the level of distress in being called, of identification with psychotic symptoms, of oppression and the sense of presence.

### ***Positive and Negative Affect Scales (PANAS)***

The PANAS<sup>35</sup> is one of the most common methods to evaluate the positive and negative affective states. The self-report scale is composed by 20 adjectives, 10 for the positive affect (PA), 10 for negative affect (NA). Both subscales reflect disposition dimensions; the first represents the degree of enthusiasm, interest, activity, attentiveness and strongness; the second represents general feelings of subjective distress which includes a variety of negative mood states, such as irritable, distressed, scared and jittery. The subject must assess how he feels described by the adjective, by responding on a 5-point Likert scale (1= Very slightly or not at all; 2= A little; 3= Moderately; 4= Quite a bit; 5= Extremely). The coefficient of consistency of the PA scale varies from 84 to 87. Furthermore,

the test presents a good convergent and divergent validity. The two subscales have a low correlation, which is a characteristic in line with the two- factors theory, that is, PA and NA are independent of each other.

### Simulator Sickness Questionnaire (SSQ)

The SSQ<sup>36</sup> is the gold standard of clinical and epidemiological studies on the motion sickness generated by flight simulators, and currently is the most used tool for the evaluation of cyber sickness in absence of more specific psychometric evaluations. It is a self-report questionnaire consisting of a list of 16 most known symptoms among VR users attributable to 3 clusters that analyse the state of the vestibular and proprioceptive system: Nausea (N), Oculomotor (O), Disorientation (D). The subject must indicate for each symptom which answer best describes what he felt during the simulation.

The four levels, in ascending order are:

1. No symptom
2. Slight presence of the symptom
3. Moderate presence of the symptom
4. Strong presence of the symptom

From the SSQ, three partial cluster scores and a total score (TS) are obtained which represents the measure of the ability of the simulator to generate discomfort.

### Questionnaire

A questionnaire was administered at the end of the VR simulation composed by 8 items to investigate on the level of anxiety in being called, on the identification with psychotic symptoms, on oppression and on the sense of presence. A 4-point Likert scale was used for the answers (1=nothing, 2=a little, 3=quite, 4=very). In addition, a session was added with comments relating to the experience lived.

### HTC VIVE

The HTC Vive is a VR headset developed by HTC and Valve Corporation. The headset uses “room scale” tracking technology allowing the user to move in 3D space and use motion-tracked handheld controllers to interact with the environment.

This technology is associated with tracking and game commands that simulate the movement of the hands, transforming the HTC’s VR in an immersive experience allowing the user to interact almost completely with the virtual world.

### Graphic project

The graphic project was realised with the help of different software for: 3D modeling, rendering creation, photorealistic effect, animation and programming.

In order to construct the virtual scenario, the indications of Ellis<sup>37</sup> were taken into account, so that a virtual environment consists of three essential components that are integrated one to each other:

- **Content:** refers to the quality of reproduction of virtual objects, which must be as close as possible to the reality ones, having characteristics of immobility and movement independently of the will of the user. In this way he has the

possibility of integrating himself with the content, not only as a simple explorer, but also as an acting subject.

- **Geometry:** refers to the physical extension that the programmer gives to the environment. For example, a closed environment like a building or an open environment like a park.
- **Dynamics:** refers to the interaction rules between all contents that a designer must take in account when creating a simulation. Indeed, all the objects contained within must conform their behavior to the physical laws of the reality.

### Characteristics of the scenario

The virtual scenario is composed of a home environment of approximately 120 m<sup>2</sup> with 4 rooms: one bedroom, one bathroom, one study, and an open space kitchen (Fig1 -Fig 2). In this environment there are simulations of visual and auditory hallucinations in addition to the typical messy of the psychotic patients’ home. The choice of the simulation theme refers to the persecutory ideation: the simulation of auditory hallucinations is realised by realistic imperative and devaluing voices, while the visual hallucination is represented by a shadow with human features.

At the end, in order to emphasise the persecutory aspect, the subjects, during the test, listen to a voice repeating their name.

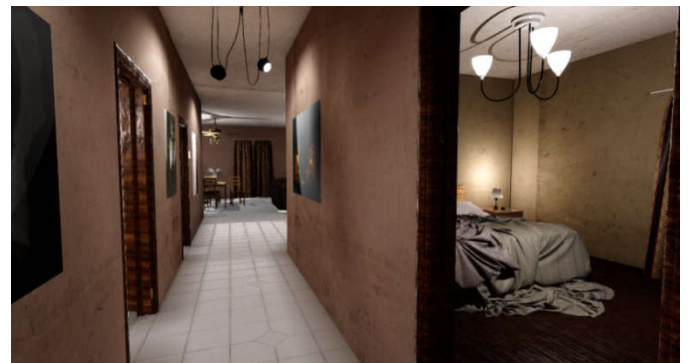


Figure 1 Virtual environment - hallway



Figure 2 Virtual environment- open space kitchen

## RESULTS

### PANAS

At PA subscale you get an average of 28.13 is obtained (DS 6.25) which appears to be slightly lower than the reference scale (M 17.4; DS 6.2). Moreover, the most important scores are related to the “interested” and “attentive” items to which the participant answered respectively 93.75% “quite a bit” and the 75% “extremely”. At NA subscale there is an average of

17.44 (DS 6.25) which is considerable compared to the average reference value of the scale itself (M17.4; DS6.2). To the "distressed" item 35.4% of the participants responded "quite a bit"; to the "upset" item 25% answered "moderately"; while 14.58% answered "quite a bit" or "extremely"; at "nervous" item 29.1% answered "moderately", while 12.5 % "quite a bit" or "extremely". At "guilty" item 91.6% of the participants answered "very slightly or not at all".

**SSQ**

The result of the SSQ show that 47.9% of subjects reported no symptoms, while 52.1 % reported negligible symptoms (Tab 1).

**Table 1** The result of the SSQ

Total Score	Category	% Subjects
0	Absence of symptoms	47.9
<5	Negligible symptoms	52.1
5-10	Minimal symptoms	0
10-15	Significant symptoms	0
15-20	Problematic symptoms	0
>20	Inappropriate system	0

**Questionnaire**

The questionnaire shows that 66.55% of participants answered "very/enough" to the "anguish in being called" item; 62.16% and 64.16% replied respectively "very /enough" to the item "identification in the psychotic symptomatology" and "sense of oppression". Finally, a high sense of presence was found (93.8% responded "very/enough" to the item "really feeling in the virtual environment") which allowed the subjects to feel part of the virtual environment (Tab 2).

**Table 2** The result of the questionnaire

Questions	Very/enough	Scant/none
Anxiety in being called	66.55%	33.45%
Identification with psychotic symptoms	62.16%	37.84%
Sense of oppression	64.16%	35.84%
Really feel in the VR	93.8%	6.2%
Feeling of interacting with the virtual environment	85.5%	14.5%
Awareness of the real world	27%	73%
Attention to the surrounding environment	20.7%	79.3%
Feeling that the virtual world was real	85.5%	14.5%

The comments section reports: a hostile perception of the environment with a sense of unease; the feeling of fear and anxiety related to their name being called, as well as the presence of continuous and disturbing voices; a state of alert and fear for the possible appearance of threatening figures; interest and curiosity about the scenario as it is representative of the patient's experience and his life environment. Finally, almost all of the subjects highlighted the usefulness of simulation in facilitating a more rapid understanding of psychopathological dynamics compared to theoretical references.

**DISCUSSION**

Although the participants were aware of the artificiality of the environment and already had clinical experience with subjects suffering from delusions and hallucinations, it was found that immersion in the virtual scenario influenced their emotional state, as shown by the data deriving from the PANAS (to the "distressed" item 35.4% responded "quite a bit", at the "upset"

item 25% answered "moderately", while 14.58% "quite a bit" or "extremely", at the item "nervous" 29.1% answered "moderately", while 12.5% "quite a bit" or "extremely"). Moreover, the totality of the participants considered the experience extremely interesting and suggestive (to the "interested" item 93.75% responded "quite a bit" or "extremely").

From the results of the SSQ, it is clear that the experience in VR did not involve any side effects (47.9% of subjects reported no symptoms, while 52.1% reported negligible symptoms) and therefore could be used in total safety.

The questionnaire shows that 66.55% of participants answered "very/enough" to the "anguish in being called" item; 62.16% and 64.16% replied respectively "very /enough" to the item "identification in the psychotic symptomatology" and "sense of oppression". This data is useful for a better understanding of distressing experiences of patients as already highlighted by Skoy<sup>24</sup> and Ozelie<sup>26</sup> studies. Finally, a high sense of presence was found (93.8% responded "very/enough" to the item "really feeling in the virtual environment") which allowed the subjects to feel part of the virtual environment.

**CONCLUSIONS**

The study highlighted how VR simulation is able to report changes in the emotional state of the participants such as restlessness, anxiety and agitation; no psychophysical symptoms were detected, attributable to cybersickness and, with reference to the sense of presence, most of the sample claimed to feel the scenario as real and to perceive themselves as part of it.

Therefore, the results obtained may be useful to formulate:

- A next study that includes an increase of the sample size;
- Training courses for mental health workers in order to facilitate the understanding of hallucinatory and delusional experiences and, consequently, to promote greater empathy towards mental illness. Kalyanamaran<sup>28</sup> affirm that the empathic understanding of people with mental disorders is a fundamental component to support the therapeutic alliance that is the basis of a good treatment process. In addition, the study by Formosa<sup>29</sup> evaluated the efficacy of VR in order to reduce the stigma towards mental distress;
- A future application in support of cognitive behavioural therapy in the treatment of psychotic symptoms. In fact, it may be interesting to focus on scenarios with auditory and visual hallucination simulations with specific themes for the patient. This should allow for greater insight and better symptom management through the acquisition of new coping strategies.

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