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New VR platform for the personalization of care in psychiatry: the example of ReViSTIM project

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Abstract

This paper presents a new VR platform in hospital environment for the study of mental diseases. The Revistim platform consists in several hardware devices and software tools for the immersion of subjects, the collection of various subjective, physiological and behavioral data as well as the use of new psychotherapeutic systems. The platform is used both for research in neuro-psychiatry (diagnosis, rehabilitation and treatment) and user experience modeling. Considering care, the main objective is to propose personalized care in psychiatry through the assessment of the patient state, the prioritisation of targeted interventions, and an efficient evaluation of the VR therapy on the different dimensions of the disease.

Author Keywords

VR; psychiatry; care; tDCS; acrophobia.

ACM Classification Keywords

H.5.2. [Information Interfaces and Presentation (e.g. HCI)]: User Interfaces; J.3. [Computer Applications]: Life and medical sciences; J.4. [Computer Applications]: Social and behavioral sciences

Introduction

Reaching personalization of treatment should be achieved throughout the study of patient-centered experience in

multiple settings. Neuropsychiatric diseases are the first cause of years lived with disability worldwide (Whiteford et al., 2013), with variability in clinical subtypes and co-morbidities. That is why research based on categorical classifications (CIM-10, DSM) may not be sufficient to ensure personalized therapy targeting precise individual impairments in cognitive and emotional regulation as well as social skills. It is indeed mandatory to:

1. ensure a personalized assessment of the patient state at the physiological, behavioral and subjective level;
2. ideally prioritize a targeted intervention based on this evaluation (instead of trial and error pharmacological approach);
3. evaluate the efficiency on the different dimensions of the disease.

To explore the interest of this new way of thinking clinical studies, we develop the concept of a new experience-oriented platform based on virtual reality technologies, to improve both personalized evaluation and treatments. This platform is supported by an interdisciplinary research team covering fields interested in the experience analysis: medicine/psychiatry, psychology, engineering and computer sciences, methodology in data analysis and statistics.

In the first part of this paper, we present a review of previous works about the use of VR in psychology and psychiatry. Then we detail the concept of our new in-hospital experience-oriented platform in terms of scientific, technological and medical points of view, and illustrate it through the on-going ReViSTIM project for coupling Virtual Reality and Transcranial Stimulation. This platform is focused on the modeling of experience to tackle personalization of treatment in psychiatry.

VR in psychology and psychiatry

Recently, Freeman et al. [8] published a systematic review of literature on VR in mental studies based on 285 previous publications.

As expected, the main use of VR in mental health concerns the treatment of anxiety disorders, mostly for specific phobias and post-traumatic stress disorders, thanks to Virtual Reality Exposure Therapy (VRET). These disorders are very often treated with Cognitive Behavioral Therapies (CBT). VRET consists in a progressive exposition to various virtual stimuli with a good controllability (intensity, duration of immersion), safety, and accessibility [14]. The use of VR in CBT reduces some drawbacks and risks comparing to real exposure. First, it is easier to setup and less expensive [16], as well as more accessible through the increasing availability of specific softwares and hardware devices. Moreover, VR can prevent an endangerment of patients. They can progress in a safe environment which provides them a sense of security [12]. This feeling enables users to freely explore and experience the environment [16]. VR also provides a better control and adaptability than real exposure by isolating anxiety-provoking objects [16], and varying the nature and intensity of anxious stimuli [3].

The second use of VR for mental health is the study of schizophrenia [8]. In this case, VR studies were most of the time focused on the assessment and evaluation of the psychosis, rather than therapy. For instance, VR can be used to understand the causes [6] and study the individual [7] and environmental factors of paranoia [20, 21].

VR is also quite often applied for the study of substance and eating disorders. For substance disorders, VR was proved to be efficient to trigger cravings for alcohol [10], cocaine [17], tobacco [2, 15] dependence as well as for food cravings (Ferrer). However, the use of craving elicitation

in VR for treatment has not been rigorously demonstrated yet [8]. In the study of eating disorders, VR is also used in CBT to improve body image and enhance emotional regulation skills through the modification of the image of the patient's body [4, 13].

Finally, Freeman et al. [8] identified only two studies that used VR for the treatment of depression through small case series without control conditions [18, 5].

A new in-hospital VR experience-oriented platform for psychiatry

Previous works showed the high potential of VR for mental health but they raised also some actual limitations. Indeed, there is a lack of rigorous demonstrations and methodologies for the use of VR in psychiatric diagnosis and treatment for substance, psychotic and depression disorders. We think that these specific disorders are more complex and idiosyncratic than anxiety ones. Therefore, the development of a dedicated platform with an interdisciplinary research and medical team seems mandatory to approach these complex diseases.

Platform presentation

Our concept is to develop a platform, as well as tools and methods, and assess their suitability to improve personalized evaluation and treatment for complex psychiatric disorders.

The platform is composed of VR hardware devices (head mounted display, trackers, etc.), VR softwares and environments to control content and stimuli, sensors for physiological (e.g. galvanic skin response, heart rate, cerebral activity) and behavioral (e.g. gaze data, gestures, postures) data, as well as therapeutic intervention devices (e.g. transcranial direct current stimulation, tDCS). All these devices

have their own constraints and environment and are not specifically built to work altogether. Thus, a specific task is currently dedicated to focus on building a stable experimental environment, taking into account all the constraints of the devices and of the in-hospital environment (e.g. ethics, security, information system).

This platform and the associated *ad-hoc* tools are designed, set up and supported by an interdisciplinary team: psychiatry, psychology (with an experiential/phenomenological background), engineering and computer sciences, methodology in data analysis/statistics. The objective of this platform is both for research and clinical use.

Research ambitions

The research ambitions of the platform are both in neuropsychiatry and experience modeling.

Neuroscience and Psychiatry. The platform is used to explore new kinds of therapy that constitute potential alternatives to conventional psychotropic drugs as VR therapies (see Section) and non-invasive brain stimulation (NIBS). NIBS allows cognitive and emotional regulation with reported effect on several psychiatric diseases [19, 11]. In this way, VR could be both a medium for experience assessment, and a tool for oriented rehabilitation via repeated expositions (enhanced or not by tDCS).

Experience modeling. The platform is also used to model experience integrating measures at the "first person" subjective psychological level (thanks to psychology) and at the "third-person" biological/physiological/behavioral level (thanks to technology) using virtual reality immersion (by nature experience-oriented, and allowing experimental control in a given environment). This scientific topic is useful both in Human-Computer Interaction to improve user expe-

rience and in psychology to articulate, at the methodological level, the links between physiological, behavioral and subjective scales.

Personalized care for complex psychiatric disorders

From the obtained results in research and clinical studies, the platform is intended to be used by practitioners for mental diseases diagnosis, rehabilitation and treatment. In particular, the developed methodologies and tools for experience modeling should help doctors to adapt treatments to patient's reactions and behavior. This can lead to a better performance and a reduction of the duration of the treatment. Moreover, the personalization of VR simulations for each patient can improve his/her in-hospital experience and social life by focusing on specific adequate situations and reducing some risks in comparison with real exposure.

The ReViSTIM project

The platform is currently tested through a first pilot study in the ReViSTIM project.

Objective and hypothesis

The main objective of ReViSTIM project is to test the effect of the combination of VR immersion and tDCS for acrophobia-related problems. It is assumed that eliciting anxiety in VR during the transcranial stimulation will lead to a stronger effect on tDCS.

Experiment

An double blind experiment has been designed in order to test this hypothesis. This experiment is currently running.

VR system. The virtual environment consists in a very high building under construction in which people can navigate through an elevator. In order to induce acrophobia, the user can move from different parts of the building on small temporary wooden walkways. A city is presented all

around the building. In order to augment the realism of the experience and the feeling of anxiety, a real wooden board is placed in the experimental room. The task during the simulation forces the user to walk on this board. Some illustrations of the virtual environment are presented Figure 1.

The VR environment is implemented in Unity software and displayed in a wireless HTC Vive HMD which provides good freedom of movement for the patient.

Subjects. 28 participants are included in this experiment. They are selected according to their level of anxiety and visual intolerance to height, evaluated through ATHQ [1] and vHISS [9] questionnaires. The subjects are divided in two groups: test group and placebo group. People in the placebo group wears a tDCS cap (Figure 2) but the electrodes do not deliver any electrical power during the stimulation.

Protocol. The experiment is split in 4 sessions. Sessions 1 and 4 are used to measure the acrophobia and the intolerance to height before and after the transcranial stimulation. In these sessions, subjects only navigate vertically with the elevator and assess their level of discomfort at each floor. During sessions 2 and 3, subjects wear the transcranial stimulation cap and test group receives tDCS. The task is slightly different than from sessions 1 and 4. Users must still use elevators to navigate up inside the buildings. However, at each floor, they have to walk on the wooden board which is above the emptiness. Participants also assess their level of discomfort before and after the task at each floor.

Recorded data and analysis. During the experiment, various subjective, physiological and behavioral data are acquired, as illustrated Figure 3. First, as explained above,



Figure 1: Screenshots of the virtual environment of ReViSTIM project.



Figure 2: Example of a tDCS cap.

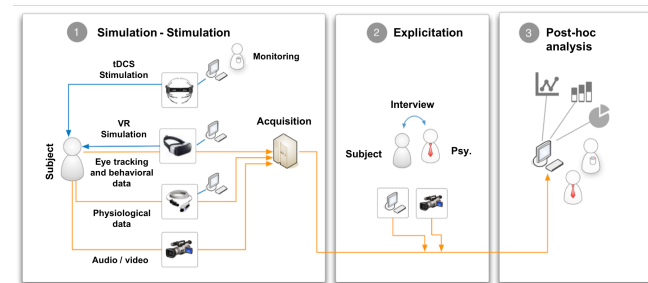


Figure 3: Recorded data in ReViSTIM project with the VR platform.

subjective data about the level of discomfort at each floor is stored for all the sessions. The user's positions as well as logs of the user's actions in the virtual environment are recorded all along the experience thanks to a Unity script. The HTC Vive HMD is equipped with a SMI eye tracker which enables to record head and gaze data during the VR experience. Finally, in sessions 2 and 3, tDCS system enables also to record cerebral activity with electroencephalography (EEG), and the level of salivary cortisol is taken before and after the exposure. Explicitation interviews (REF) are also conducted after the VR simulation to focus on the subjective experience of the participant while he was walking on the wooden board.

All this information will be used to compare subjective and objective reactions of the subjects of test and placebo groups, in order to confirm or infirm our hypothesis.

Conclusion

In this paper, we have presented a new VR platform in hospital environment for the study of mental diseases. This platform consists in several hardware and software devices for the immersion of subjects, the collection of various subjective, physiological and behavioral data as well as the use of new psychotherapeutic systems as tDCS. The platform is used both for research in neuro-psychiatry (diagnosis, rehabilitation and treatment) and user experience modeling. Considering care, the main objective is to propose personalized care in psychiatry through the assessment of the patient state, the prioritisation of targeted interventions and an efficient evaluation of the VR therapy on the different dimensions of the disease.

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