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Computer tool to evaluate the cue reactivity of chemically dependent individuals

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ABSTRACT

Background and objective: Anxiety is one of the major influences on the dropout of relapse and treatment of substance abuse treatment. Chemically dependent individuals need (CDI) to be aware of their emotional state in situations of risk during their treatment. Many patients do not agree with the diagnosis of the therapist when considering them vulnerable to environmental stimuli related to drugs. This research presents a cue reactivity detection tool based on a device acquiring physiological signals connected to personal computer. Depending on the variations of the emotional state of the drug addict, alteration of the physiological signals will be detected by the computer tool (CT) which will modify the displayed virtual sets without intervention of the therapist.

Methods: Developed in 3ds Max® software, the CT is composed of scenarios and objects that are in the habit of marijuana and cocaine dependent individual's daily life. The interaction with the environment is accomplished using a Human-Computer Interface (HCI) that converts incoming physiological signals indicating anxiety state into commands that change the scenes. Anxiety was characterized by the average variability from cardiac and respiratory rate of 30 volunteers submitted stress environment situations. To evaluate the effectiveness of cue reactivity a total of 50 volunteers who were marijuana, cocaine or both dependent were accompanied.

Results: Prior to CT, the results demonstrated a poor correlation between the therapists' predictions and those of the chemically dependent individuals. After exposure to the CT, there was a significant increase of 73% in awareness of the risks of relapse.

Conclusion: We confirmed the hypothesis that the CT, controlled only by physiological signals, increases the perception of vulnerability to risk situations of individuals with dependence on marijuana, cocaine or both.

1. Introduction

Chemical dependence is characterized by a set of psychophysiological phenomena that develop with the repeated use of a psychoactive substance. The main symptoms are compulsion and loss of control. According to the World Health Organization (WHO), chemical dependence is a progressive and fatal disease, though it is treatable. However, treatment is a slow and painful process that is full of obstacles. Several researchers [1] have shown that no specific effective treatment exists for cocaine dependence but several medications marketed for other indications have shown efficacy in clinical trials.

Recently, researchers in Brazil have shown that the relapse rate for chemically dependent individuals (CDI) is high, occurring with 50% of individuals in the first 6 months and 90% in the first year [2]. Similar situation occur in treatment of depression, where 1 in 3 patients does not fully recover even after several treatment trials [3–5]. In addition, the American Psychiatric Association [6] states that the first 12 months of remission are considered a high-risk period. These high relapse rates indicate that the current treatment approaches still need adequate methodological advances.

According to [7] and [8], there are different risk situations that lead to the relapse of chemically dependent individuals. Recently, researchers [9,10] observed that relapse can be reduced decreasing stress. Others [11,12] demonstrated that situations that might

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originate negative feelings would favor a self-rejection as well as dependents' indiscipline during treatment. Among the negative emotions, anxiety would act as a trigger to the use of drugs by the chemically dependent individuals to satisfy "temporally" their needs [13–15]. The use of psychoactive substances can be a fugue of personal conflicts, negative emotions, or stressors [16]. But can also influence the development trajectory of the symptoms of anxiety [17].

However, chemically dependent individuals often do not believe that they are vulnerable to certain external stimuli. The disagreement between patient and therapist on factors that could favor relapse [18], along with the optimal therapeutic approach, is a typical topic of discussion [19]. One of the greatest challenges for therapists is to help patients' recognize their anxiety in a risk situation without provoking them. But, the relapse triggers are questioned and are rarely accepted by the patients. The relapse generates an emotional discomfort that associated with feelings of mistrust, interpersonal stress and deprivation of liberty; contribute to the denial of chemical dependency [19]. These facts highlight the importance of self-awareness of his vulnerability. Therefore, cue reactivity procedures were used to raise chemical dependent's awareness in avoiding relapses. The cue-reactivity procedure exposes addicted to stimuli related to drugs while monitoring their physiological signals [20–22]. This method based on the conditioning theory of Pavlov [23,24] shows that coping skills can be taught. Initially real environments and simulations with actors were used, but currently virtual environments are used.

Virtual cue reactivity has been used as promising interventions in anxiety disorders [25] as well as to assist during treatment of cocaine and crack cocaine [26], methamphetamine [27], alcohol [20,28,29], and marijuana [30] addiction. Some researchers [31] use the procedure to nicotine users. These cue reactivity methods have provided relevant results during the treatment of chemically dependent individuals. The chemically dependent individuals experiencing anxiety in risk situation presents physical symptoms that are controlled by the autonomic nervous system, such as breathing difficulties and palpitations.

Several researchers [32–35] have demonstrated that changes in physiological signals are intrinsic associated with emotions. Other researchers [36] reported that some emotions such as stress could be detected by measuring the patient's physical and physiological signals. Since the physiological signals are involuntary were used them in this study to directly control the actions in the CT without any other intervention. In our proposed computer tool (CT), changes in the scenarios were directly produced by the patient's emotional state and not by a peripheral factor such as a joystick, keyboard, or mouse, which removes doubt and subjectivity from the results. Thus, patients are presented to virtual scenarios that are direct consequences of their emotions during risk situations, such as the exposure to drugs and familiar conflicts. In this way, the dependents can be confronted with their own evaluation regarding its anxiety and vulnerability without creating a conflict with the therapist.

2. Method

2.1. Ethical approval

Approval was obtained from the Local Ethics Committee (Research Ethics Committees from University of Mogi das Cruzes, CAAE-0094.0.237.000-07, process CEP/UMC-093/2007). All procedures were performed after written informed consent from all participants. The study is registered at https://clinicaltrials.gov/show/NCT02535858.

2.2. Study participants

Eighty volunteers were engaged to realize this research.

First we determined the limits of emotional the normal and anxious states of a first group (VG) of thirty volunteers. As inclusion criteria stands out: age range between 20 and 50 years, have no disease associated with anxiety or mental disorders and not being a drug user or taking medication.

One trained psychiatrist and two mental health professionals (PG1), specialized in chemical dependency, evaluated the emotional state of the volunteers.

A second group with fifty male's adults (CDG) was selected to test the computer tool having as inclusion criteria: age range between 20 and 50 years with diagnosed dependence of marijuana, cocaine or both, in treatment for chemical dependence, not taking medication and abstaining from psychoactive substance for at least 2 months.

For this group, two psychiatrists and five mental health professionals therapists (PG2) specialized in chemical dependency and responsible for monitoring the group's treatment evaluated their emotional states.

Exclusion criteria for all volunteers were: present evidence of consumption of medicines or drugs, present psychotic symptoms or have made any physical effort before the test. The evaluation for inclusion and exclusion of volunteers was conducted by doctors responsible for the clinic who were not involved in the research. The inclusion criteria were performed using the ICD-10 protocol [37].

To elaborate the scenarios and characterize the characters for the computer tool eight specialists, professionals from the chemical dependency field (PG3), recommended situations, places, objects, signs, or cues thought to trigger craving.

2.3. Validation of the psychophysiological signals

As the relationship between physiological measurements and their psychologic meaning is complex [38,39]. We established the psychophysiological validation in laboratory, relating the variation of BMP and RR with the changes in body posture of 30 volunteers [40].

Two physiological signals, BMP and RR, were used as indicators of anxiety following the model two-to-one of the physiology mapping on computer systems [38] and [39].

Respiration rate and tonic heart rate produces continuous information over the duration of the stimulus [41]. In our research stressors, presented in the sceneries, are only one minute long with intervals of one minute in between. The tonic heart rate and respiration signals produce contiguous information over the duration of the stimulus. The selection of the scenery was accomplished by the program used in our research and was only based on the variation of the rate (frequency) of the physiological signals and not on the variation of its amplitude. To measure the heart rate we used a Polar M32 (Polar Electro, Kempele, Finland). The respiratory frequency was measured using a device developed by the Brazilian company Engecer. It was used to monitor the breathing rate of newborns in intensive care using a temperature sensor to monitor the air exhaled through the nose.

Initially, the PG1 specialists evaluated the VG group measuring heart rate and respiratory rate while they were in a normal state (basal levels). The volunteers have been submitted to 'stress' situations that could favor the change of their emotional state to anxious. Therefore, it was requested that the VG volunteers access the commercial computer game: A-BLAST. In this free available game, the user drives a spacecraft vehicle aiming to destroy the surrounding aliens present at the scenario. Aiming to influence the increment of anxiety's levels, the mouse sensibility was altered