



The science has been searching for new medication, treatments and procedures to cure anxiety disorders and depression, but quite few researchers have introduced computer-assisted methods and technologies in the treatment of patients with PTSD

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# COMPUTERS

processes ongoing in the personnel exposed to combat stress, particularly in NATO-led operations and missions. The researchers aim to detect multidisciplinary risk factors to provide an insight into the psychological condition of the combatants and to predict their resilience and vulnerability to stress. The programme is envisaged to be incorporated into the training programmes of members of the armed forces and the police for deployments in missions and combat operations, and will comprise the exposure to stress situations and simulated combat training, which should predict their readiness for missions and operations.



The proposed project aims to detect multidisciplinary risk factors that could be used as predictors of the resilience or vulnerability of combatants to stress situations, to gain insight into the combatants' psychological condition and the pathophysiology of stress and to enhance their resistance to the mission/operation-related symptoms, the post-traumatic stress disorder (PTSD).

## INVISIBLE WOUNDS

The experts of the Faculty of Electronic Engineering and Computing have already developed the models to administer computer-assisted cognitive-

behavioural therapy and training on the military and police personnel deployed in peace operations and missions. The focus in those cases is placed on prevention and identification of resilience to stress and stress situations to act preventively to avoid pathological conditions.

The project envisages a training programme focussed on enhancing mental resilience and on maintaining normal psychological and physical readiness, in order to prepare the combatants to return to normal life following intense stress or trauma.

The team has planned to develop a large database and measured data to predict the risks involved to prevent the chronification of acute stress reactions. The stress associated with the redeployment affect the mental health of the combatant, and by extension the readiness of NATO forces as well, but it can also have social repercussions in the contributing countries (e.g increased treatment costs, unemployment and marital problems) - they are the invisible wounds of soldiers' exposure to combat stress.

**A CROATIAN PROJECT CO-ORDINATOR**

NATO authorities hope that successful completion of the project will introduce the methodology usher in the methodology to decrease the high percentage of mental health disorders following the deployments in NATO-led missions and also enhance the readiness of NATO forces.

The project co-ordinator – Lieutenant General (Ret.) Krešimir Ćosić of the Faculty of Electronic Engineering and Computing – has conducted a decade-long multidisciplinary research in changes induced by intense combat stress in human brain and body. The subject of the research ranges from the molecule- and cell-level changes, the mutation of genes and the gene expression alteration, the changes in the endocrine and the immune system,



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cognitive and emotional changes to behavioural changes, which in extreme cases end in a suicide. The impetus for the research and for programming new PTSD treatment technologies came from the increased incidence of PTSD in Croatian defenders in the wake of the Homeland War.

Professor Ćosić and other experts of the Faculty incepted an intense co-operation with renowned international universities conducting the research on combat stress, particularly the research on PTSD: They have gradually gained new findings in computer technology and its application in treating psychological problems. Professor Ćosić even envisages future psychiatry as a computer science and an increasingly important role of computer-aided diagnostics through the concepts of Big Data. "In the present context the individual physician (particularly psychiatrists') capacities for analytical survey of the course of illness at a multidisciplinary level (the level of large quantities of data which change in an unpredictable pattern) are restricted", says Professor Ćosić, who underlines new concepts in medicine with high potential in predicting of the course of illness and more effective preventive therapy. The Professor claims that future medicine will rest increasingly on artificial intelligence, computer-based learning and analyses of large databases in real time, known as the concept of Big Data.

The science has been searching for new medication, treatments and procedures to cure anxiety disorders and depression, but quite few researchers have introduced computer-assisted methods and technologies in the treatment of patients with PTSD, as Professor Ćosić, who has dedicated much of his academic career to the problem. The Professor emphasised that recent research has suggested that anxiety disorders and depression are whole-body illnesses, induced by a deregulation of a organic systems, in the peripheral systems and in the central nervous system. Pharmacotherapy is still a dominant method of treating mental disorders, despite its potentially harmful side-effects (the risk of dependency and the influence on other organic changes).

**INNOVATIVE APPROACH**

Professor Ćosić notes that world science is still lacking the insight into the complexity and the phenomenology of mental diseases, PTSD included. In view of these facts, the available medications are far from optimal, as they cannot selectively work on certain groups of neural networks responsible for specific neurological dysfunction either on molecular or genetic level. Professor Ćosić has applied research methods and technologies from other disciplines and an innovative approach to PTSD. His objective is to design concrete programme treatment solu-



Photo: U.S. Army



Photo: U.S. DoD

tions and methods by means of computer technology. The approach includes a range of different methods and disciplines, and computing disciplines such as artificial intelligence and the concepts of Big Data. Of particular interest are the computer methods for elicitation and automated analysis of emotions expression, change and manifesting under acute stress. Following the principle of integrated multidisciplinary systematic knowledge, a number of experts have been included in the research and the development of state-of-the-art computer technologies – psychiatrists, psychologists, neuroscientists, molecular biologists and geneticists.

“What we are working on basically is the Computer-Aided Cognitive Behavioral Therapy, which is about the respondent (the patient) learns to shape and change his/her brain’s neuroplastic structure through thinking and reasoning processes and to enhance and accelerate the processes through multimodal elicitation, estimation and regulation of emotions. The new technology we are employing has a critical role in the approach”, says Professor Ćosić. What is the mechanism behind the computer technology surveying the development in patients undergoing cognitive-behavioural therapy?

“The moment when a patient, through his/her unstructured thoughts and associations, consciously or unconsciously, enters into a chaotic and traumatised space of the associative cortex, which stems from the interaction of several neural structures of human brain, is a chaotic condition, as he/she re-experiences the trauma. The ANS (autonomous nervous system) is activated through amygdala, the hypothalamic-pituitary-adrenal axis is activated too, the prefrontal cortex is suppressed, all of which leads to the expression of specific stress hormones and release of inflammatory proteins. The overall bio-regulatory dysfunction can leave anent brain damage and alter the connectivity of neural structures and networks, characteristic of chronic illness”, explains Professor Ćosić.

“The conditions of the kind can and have to be prevented timely, i.e. in the phase of increased resilience to stress and in the acute stress phase. The intention is to enable the patient autonomously regulate the molecule and biological processes, by establishing the balance between the medial prefrontal cortex and the limbic system, or by enhancing the role of cognitive processes and their synaptic inhibition potential on amygdala, the HPA axis and the autonomous nervous system. This is achieved by means of Stress inoculation or Mental readiness training and can be very useful in the

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treatment and prevention of serious mental disorders resulting from long exposure to stress or sudden and unpredicted traumatic events”

The multimodal feedback and the recommended cognitive-behavioural strategies, which are presently employed solely by the Faculty’s Laboratory for Interactive Simulation Systems, could significantly improve the system of treatment of PTSD and other mental disorders.

The Faculty staff asserts the patients’ awareness



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Photo: SEC

## NEW TECHNOLOGIES

of the processes can help them initiate self-healing processes and prevent serious pathogenic changes. The modern technology developed by the Faculty can detect some characteristic changes in the voice suggesting illness or progress in therapy. The system is set to automatically recognise the changes in characteristic face movements and physiology (e.g. the breathing, heart beats etc.) typical of certain illnesses.

The so-called multimodal bio/neurofeedback is a result of focussed multimodal stimulations generated by computer systems during the therapeutic sessions, enabling the survey of hundreds of acoustic, facial or physiological effects underlying the experienced trauma. The therapist shapes the cognitive behavioural strategy through the computer-assisted "cognitive emotion regulation" as a method of stress treatment.

### Vicious circle

"At the moment of trauma a cycle of neurons connects through synapses in a characteristic way. The higher the repetition of the content, the more intense the connection, which becomes a dominant neural circuit in the brain. Put otherwise, any time a person sees a content, an image, a scene from a film and any other stimulus related to the traumatic experience, he/she re-experiences the stress which accumulates and the associations put



Photo: U.S. National Center for PTSD

him/her into a vicious circle that becomes dominant", says Professor Ćosić. The idea of the project was to repress and suppress the neural networks and their effects on hormonal and immunological reactions in the body through the indicated cognitive therapeutical processes. The trauma treatment method adopted by the experts of the Faculty (in co-operation with clinical psychologists) is based on personalised medicine (personalised computer-assisted psychotherapy), featuring individualised approach to each patient.

The initial step was the general multimodal stimulation, imagery and contents, such as the images from war conflicts, whereby the associative complex of an individual is searched. When the computer detects a characteristic change at the level of multimodal neurofeedback (e.g. the respondent reacts to a content by breathing faster, by a changed speech pattern, facial expression, blinking or head movement), it suggests the stimulus has a context, semantics and emotions in the root of a trauma. The encounter with the trauma in the virtual space, guided by the psychotherapist is repeated during the sessions to induce the patient activate his/her cognitive defence mechanisms to overcome the undesired reactions of the experienced stressful situation. The cycle takes minimally three to four months and is repeated at certain intervals to prevent the recurrent episodes.

The Croatian-Israeli-American project is highly up-to-date - in late February the Croatian media reported on the meeting

of experts related to the project Multi-disciplinary Metrics for Soldier Resilience Prediction and Training in the Hadassah Hebrew University Hospital in Jerusalem. The amount of 394,000 EUR assigned by NATO over a three-year period testifies of the Alliance's support for the project.

