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SPECIAL ARTICLE

Adaptive immersive Virtual Environments as a treatment for depersonalization disorder

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---**ABSTRACT**---

Depersonalization is a dissociative disorder associated to a profound disruption of self-awareness in the form of emotional numbing and feelings of disembodiment. The salient feature of depersonalization is a breakdown in the familiarity of one's psychological and somatic self (and surroundings when derealization is also present), in spite of being aware of the unreality of the change. At an early stage of research it was realized that people inclined to dissociation find it harder to tolerate discontinuity in perceptual environments, possibly due to a rigid perceptual attitude. Consequently, perceptual discontinuity experienced during momentary immersion into a VE would be expected to increase symptoms of dissociation among individuals prone to develop them. It has been put forward that a tendency toward immersion or absorption, linking to imaginative processes underlying the dissociative experience, significantly relates to the level of change in virtual reality-induced dissociative symptoms. Consequently, it has been implied that increased tolerability of perceptual discontinuities and a more flexible perceptual attitude in people suffering depersonalization/derealization disorder may be of help. We propose the use of adaptive immersive virtual environments to the treatment of depersonalization. In particular, we propose that implementation of biofeedback electrical stimulation to detect somato-sensory processing bias may contribute to selectively targeting deranged neurocognitive processing components, and as an indirect consequence promote, to some extent, the diagnostic process. Psychophysiological approaches may be of help in the treatment of depersonalization via additional series of afferent inputs – virtual reality (VR) stimuli – to alter the receptive fields of the affected proprioceptive systems and reorganize them. The aim of this paper is to stimulate future research towards the development of potential virtual rehabilitation programs based on biofeedback, electrical stimulation and concurrent

measurement of galvanic skin response and EEG targeting selective somatosensory stimulation in patients with depersonalization. Our research hypotheses might constitute a starting point for the development of new treatment tools for depersonalization in particular and depersonalization/derealization disorder in general.

KEYWORDS: Neuropsychology, dissociation, virtual reality, biofeedback, depersonalization/derealization disorder

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Introduction

During the last two decades, virtual reality (VR) has been applied to the field of medicine exhibiting potential benefits for the diagnosis, treatment, counseling and rehabilitation of various physical, neurological and psychiatric disorders. VR technology has recently matured with VR-software and -hardware becoming more robust and affordable; VR quality has been significantly improved, thus making it feasible for VR systems to reach households for everyday use. Whereas once VR was an expensive technology, nowadays Head-Mounted Displays are much more accessible, and their hardware price set at 1300 USD in 2014, compared to 2006 cost was set at 45,000 USD.[1] Immersive virtual environments (VEs) may be seen as highly controllable spaces that facilitate experimental research, given that nearly every aspect of virtual space can be manipulated at will. Additionally, virtual space is amenable to transformations and adjustments as a result of a process of adaptation to the user's particular cognitive, emotional and neurophysiological characteristics. Thus, when used for medical applications, adaptation and personalization of VEs may enable us to tailor certain interventions and treatments to the requirements of specific patients. More specifically, in the fields of clinical psychology and psychiatry, VR has been used for the treatment of addictions and several types of phobia, subclinical fears, and anxiety disorders.[2-6] VR provide real time interaction with software-generated 3D environments, simulating real-life experiences and triggering physiological symptoms of anxiety, including sweating or nausea, thus emphasizing the likelihood of replacing behavioral approaches (i.e., exposure therapy).[7] As such, it is now possible to utilize VR as a research, diagnostic assessment, and treatment tool for a wide variety of mental disorders while keeping the associated costs at a manageable level.

Hypothesis and rationale

Early evidence shows that people inclined to symptoms of dissociation find it harder to tolerate discontinuity in perceptual environments, possibly due to a rigid perceptual attitude.[8,9] Thus, perceptual discontinuity as induced by momentary immersion into a VE would be expected to increase dissociative symptoms among individuals prone to develop them. Aardema and colleagues[10] put forward that a tendency toward immersion or absorption as measured by several different scales, significantly relates to the level of change in VR-induced dissociative symptoms. Authors discussed their findings in the light of the imaginative processes underlying the dissociative experience. Consequently, it has been proposed that by increasing the ability to tolerate perceptual discontinuities and adopting a more flexible perceptual attitude people suffering depersonalization/derealization disorder (DPDR) may ameliorate.[8]

In this paper we propose a VR approach, i.e., the use of adaptive immersive environments, in conjunction with early psychophysiological notions from the domain of motor neurorehabilitation (Perel'man in 1947 as reported by Luria),[11] for the treatment of depersonalization. In particular, we propose that implementation of biofeedback electrical stimulation to detect somato-sensory processing bias along with evidence-based patterns of neuropsychological dysfunction (steaming from the relevant literature), may selectively target deranged processing components serving both DPDR's differential diagnosis and treatment. VR in conjunction to auxiliary psychophysiological equipment may be of help in the treatment of depersonalization. Stimulated by early evidence[11] showing that additional series of afferent inputs (sensory stimuli) may alter the receptive fields of the affected proprioceptive systems and reorganize them, we propose a transfer of such theoretical notion, steaming from soviet psychophysiological and neuropsychological research, to the context of depersonalization treatment.

More specifically, we herewith aim to stimulate future research towards the development of virtual rehabilitation programs for depersonalization based on biofeedback, concurrent measurement of galvanic skin response - since electrodermal activity is a well-documented marker of bodily arousal expression of emotion-, EEG and electrical stimulation targeting selective somatosensory stimulation of the posterior cortical association areas (see below) to establish new afferent links (inputs) to the deranged proprioceptive functional systems.

[INSERT FIGURE 1 ABOUT HERE]

Depersonalization/derealization disorder – related issues

Depersonalization is a dissociative disorder with a profound disruption of self-awareness in the form of emotional numbing and feelings of disembodiment.[12] Traditionally, it has been viewed either as a vestigial form of behavior subserving evolutionary meaningful purposes or as a temporal lobe seizure manifestation.[13] The salient feature of depersonalization is a breakdown in the familiarity of one's psychological and somatic self (and surroundings when derealization is also present), in spite of being aware of the unreality of the change.[14]

Diagnostic Issues

According to DSM-5[15] individuals with DPDR persistently experience feelings of detachment, either bodily or mentally, from themselves or from their surroundings. DPDR falls within the wider diagnostic category of dissociative disorders, which are characterized by feelings of disconnection from reality. DPDR has only one type, although sufferers may experience depersonalization symptoms only, derealization symptoms only, or an equal mixture of both. DPDR phenomena are difficult to understand and interpret because of the complex interwoven of sensory-motor experiences resulting from aberrant integration of perception, identity, memory and also other faculties of consciousness.[16] Moreover, dissociative disorders may become hard to diagnose for a number of reasons, namely, comorbidity issues or differential diagnoses, lack of information about any early childhood trauma, patient's difficulty in recalling unpleasant life-events.

In recent past DPDR as an isolated syndrome has been reported very rarely. Neglecting comorbid DPDR coding and patients' difficulty to find the appropriate terms to describe their symptoms are among the likely reasons accounting for this inconvenience. Provided the scarce literature on DPDR as a primary diagnosis, future research should address the actual prevalence and coding of DPDR.[17]

DPDR symptoms may occur in a great variety of neuropsychiatric conditions such as during epileptic auras, pharmacological intoxication, acute and transient psychosis, manic ecstatic states, as well as acute stress disorder, generalized anxiety disorder, obsessive-compulsive disorder, schizophrenia, and bipolar disorder).[18-20] DPDR symptoms may also represent additional specifiers in the diagnosis of posttraumatic stress disorder, panic disorder and borderline personality disorder.[21] It is possible that due to the severity of many psychopathologies, DPDR symptoms may seldom be overlooked.

Neuropsychological and psychophysiological evidence for dissociation

The study of the neuropsychological backgrounds of various psychiatric syndromes, as a methodological vehicle to shedding light to otherwise inaccessible disease-related components is well-known in psychopathology. In major depressive disorder (MDD) patients, greater severity of derealization was seen in those performing worse in measures of delayed visuospatial recall and verbal recognition memory. Moreover, an association was found between depersonalization and a severe slowing in processing speed, but not depressive symptoms, as well as a higher vigilance performance in a less active environment.[22] The same study found a pathological association between dissociative symptoms and neuropsychological performance in depressed persons, with a frontotemporal anatomic distribution mediating memory and attention in particular. Of note, Aarderma and colleauges[10] showed that exposure to VR may induce an increase in dissociative experience (depersonalization and derealization), including a lessened sense of presence in objective reality. Dissociative symptoms resulting from VR immersion are related to higher idiosyncratic propensity to dissociation and virtual immersion or absorption. Thus, markers of dissociation and derealization could be used to achieve better adjustments of VE to patients' individual characteristics and needs.

Interestingly, it has been put forward that dissociative states strongly associate with creativity and "splinter" skills,[23] since creativity requires the ability to fluently retrieve and recombine remote associative elements.[24] This latter may have important implication for the neurorehabilitative treatment of DPDR in view of the fact that dissociative ability reflects the ability to dissociate from salient concepts and ideas to facilitate the concurrent access to mutually remote concepts, as well as to avoid getting stuck with initial ideas.[25,26] Accordingly, VR adaptations to the above theoretical requirements may aid to target cognitive processes central to DPDR (e.g., decrease mental flexibility and enhance inhibitory control over semantic networks "enabling" patients to access mutually remote concepts).

It has been proposed that the processing of emotional experience can be partly measured through the use of autonomic indices, and in particular, electrodermal activity (EDA).[27] A recent systematic review on emotional response in depersonalization suggest that depersonalization is marked by a high skin conductance level and attenuated skin conductance responses to negative stimuli.[28] EDA studies put forward that depersonalization is associated with hypervigilance and emotional detachment during threatening situations, but EDA in people suffering depersonalization should be also investigated in positive situations.

Treatment approaches to DPDR

The majority of published works on psychological therapies of depersonalization have been anecdotal or confined to small case series.[29] Unfortunately, the lack of quantified, systematic research makes it difficult to assess the effectiveness of these approaches. Psychodynamic treatments focus on triggering and sustaining mechanisms concerning the lack of control feelings and perceived threat to self. Abreactive techniques provide strategies to deal with the more dissociative aspects of depersonalization, while cognitive-behavioural therapy focuses on more cognitive, anxiety-generating mechanisms, which may play important role in the vicious-cycle of the condition and constitute a major source of distress and incapacity.

Psychanalytic psychotherapy can be beneficial in selected cases.[30] 'Fear of losing control' has been emphasized as a central therapeutic target. Indeed, an extreme sensitivity to 'control' threats is at the heart of psychopathological processes triggering and maintaining depersonalization. Early developmental difficulties to establish a healthy 'narcissism' and a trusting relationship with significant others can be seen as laying the ground for such a vulnerability.[31] Psychoanalytic therapists mainly aim at assisting the patient to realize that depersonalization and associated feelings of worthlessness and helplessness originate from parents' unrealistic expectations, while such relational needs later become internalized into a tyrannical idealized self-structure, imposing impossible demands *(representing an indirect reflection of perceived impositions by significant others)*. Accordingly, the person begins to privilege a sense of self as a performing object ('third person viewpoint'), rather than as a source of subjective experiencing ('first person viewpoint').[32]

Similarly, there are no recent systematic studies on the use of abreactive techniques on patients with depersonalization. However, there are few indications that imagery-driven techniques may be helpful in depersonalization patients with a history of emotional abuse.[33,34] Although cognitive-behavioral therapy interventions seem promising,[29] the relevant studies also suffer from methodological limitations such as small size of the samples and lack of control groups.

Little is known about effective pharmacological treatment of depersonalization, and the condition has been generally considered refractory to most medications. A prominent background of anxiety or obsessions may respond better to SSRIs or to clonazepam, while unpublished anecdotal observations suggest that patients whose main complaints are attentional symptoms, underarousal and hypersomnia may respond to stimulants such as modafinil.[35] As to the research on new pharmacological agents two new drug categories loom on the horizon: cannabis receptor antagonists and selective kappa opioid receptor antagonists.[36] Given the fact that cannabis can induced depersonalization in a dose-dependent manner, the cannabinoid CB1 receptor antagonist rimonabant is an intriguing research candidate with potential anti-depersonalization effects.[37] Integration of elements stemming from cognitive-behavioral theory, psychophysiology, and computer science, is expected to enhance our understanding of the condition and our treatment-planning acumen.

Neurobiological evidence

A neurobiological model of depersonalization proposed by Sierra and Berrios[13] suggests a bilateral corticolimbic disconnection with prefrontal activation and limbic inhibition resulting in hypoemotionality and attentional difficulties. However, Sierra, parallels depersonalization to neurological cortico-limbic disconnection syndromes such as pain asymbolia and asomatognosia, referring to depersonalization as a "functional cortico-limbic disconnection".[38]

Increased alertness observed in depersonalization results from activation of the right dorsolateral prefrontal cortex (prefrontal attentional systems) and reciprocal inhibition of the anterior cingulate, producing symptoms of "mind emptiness" and "indifference to pain" often seen in depersonalization. Additionally, left prefrontal inhibitory influences are likely to inhibit the amygdala resulting in dampened autonomic output, hypoemotionality, and lack of emotional coloring leading to feelings of "unreality or detachment."

Interestingly, there is evidence of clinical similarities between the experiential narratives produced by patients with depersonalization and those with corticolimbic disconnections. Early psychophysiological studies reporting a blunting in skin conductance recordings of patients during depersonalization episodes.[39] In line with this, it was recently found that healthy controls undergoing aversive experimental stimulation and manifesting among other experiences of depersonalization, demonstrated fast attenuation of skin conductance responses, i.e., habituation.[40] It was also found that in anxiety disorders the presence of depersonalization accounted for much of the variance of electrodermal habituation rate.[41]

Patients with depersonalization present selectively reduced autonomic responses and prolonged autonomic response latency to unpleasant stimuli but not to emotionally neutral ones. This finding indicates a specific disruption in emotional information processing rather than a non-specific dampening effect on autonomic reactivity.[42] Moreover, the findings suggest that the presence of depersonalization in otherwise anxious patients has a blunting and selective effect on autonomic reactivity.[42,43] An abnormally low tone in the sympathetic autonomic nervous system has been found in patients with depersonalization in comparison to patients with other anxiety, depressive, or psychotic disorders, by using forearm blood flow as a measurement of sympathetic autonomic function while interestedly their anxiety ratings were higher;[42] this indicates a fundamental discrepancy between objective and subjective signs of anxiety encountered among these patients.

Functional neuroimaging studies showed the putative role of abnormal functioning of the posterior cortical section (i.e., temporo-parietal junction, inferior parietal cortex, insula) in the generation of embodiment and agency, which are relevant to the experience of depersonalization. It is currently assumed that the right angular gyrus is responsible for comparing intended actions to subsequently experienced motor acts.[44,45] People with depersonalization exhibit different relative glucose metabolic rate from healthy controls especially concerning BA 22 (a right temporal lobe association area), and 7B (a somatosensory association area), BA 39 (a multimodal parietal; association area), BA 19 (occipital association area). Depersonalization patients were characterized by greater activity than comparison subjects in all these areas, with the exception of the BA 22, where activity was lower.[46] These findings indicate the role of extensive associational brain networks, mainly localized within the occipito-parietal domain, particularly with respect to embodiment. Although, healthy controls as well as OCD patients showed activation in the anterior insula in response to unpleasant and disgusting pictures, such activation was not seen in the patients with depersonalization.[42] Other brain areas related the response to expressions of fear and disgust, such as the occipito-temporal cortex, were also found to be underactive in patients with depersonalization as compared with the two control groups.[47]

fMRI studies of depersonalization showed reduced activity in emotion-related areas, such as the amygdala and the insula, and by attenuated autonomic responses to arousing emotional stimuli. They also propose that such neural unresponsiveness seems functionally coupled with abnormally increased activity in prefrontal regions linked to emotional control.[48,49]

In case of brain injury, depersonalization has been assumed to represent a manifestation of ‘subtle’, no localized brain damage leading to ‘problems with the integration of perceptual, affective and attentional information.[50] From a physiological point of view, there is evidence suggesting that vestibular dysfunction can frequently trigger depersonalization symptoms.[51] However, vertigo and depersonalization did not coexist in the majority of cases.[50]

Finally, it has been showed in healthy controls that experimentally induced sensory mismatch between disordered vestibular inputs and other sensory signals impair the process whereby an ongoing representation of the body within the surrounding space is achieved.[52] Consistently, it has been hypothesized that vestibular and multisensory information becomes integrated in a cortical region known as the temporoparietal junction,[53] the latter thought as relevant in the generation of the experience of being localized within one's body, i.e., embodiment

Virtual Reality in psychiatry

VR has been a significant tool in the hands of medical experts during the last two decades for diagnosis, treatment, counseling and rehabilitation of various physical and psychiatric disorders. Its main use in healthcare can be summed up as (a) a simulation tool and (b) an interaction tool.

In psychiatry, VR in interventions of counseling and cognitive-behavioral therapy has been used for the treatment of addictions and several types of phobia, subclinical fears and anxiety and stress disorders.[54,55] Furthermore, VR rehabilitation allows for adaptive environments, adjusting to the needs and progress of the individual patient using input data from the Head-Mounted Display (HMD) and certain sensors, creating the illusion of realistic interaction with the VE.[55] These types of sensory feedback allow specific targeting of symptoms unique for each group of patients.

From a technical point of view, in-game performance and ability parameters are monitored to ensure appropriate levels of challenge. Game difficulty adaptation in VR rehabilitation platforms is achieved by either simple parameterization,[56] naive adaptive algorithms[57,58] or by using an adaptation strategy by which patient's speed and control are computed to adjust for game difficulty level, through a Markov decision process (MDP) providing a therapist-guided reinforcement learning algorithm. A MDP refers to the process of the agent observing the environment output consisting of a reward and the next state, and then acting upon that. It is a sort of straightforward definition of the learning problem from interaction to achieve a goal. The agent and the environment interact continually, with the former selecting actions and the latter providing him with feedback and presenting new situations. Formally, an MDP is used to describe an environment for reinforcement learning, where the environment is fully observable.

Since, none of the above approaches offers on-line therapist's feedback, recently there has been an attempt to produce a novel algorithm for game difficulty adaptation, by coupling patient's performance and therapist feedback information to efficiently balances adaptation.[59]

VR has been demonstrated to influence higher order cognitive functions and cortical plasticity, with implications for the treatment of phobias (e.g., fear of spiders, heights, public speaking), schizophrenia and pharmacological addictions,[2,3] stroke rehabilitation,[4] and post-traumatic stress disorders.[5] Of crucial importance for successful VR implementation is a high sense of presence – a feeling of 'being there' in the virtual scenario. The cognitive and perceptual underpinnings inducing feelings of presence in VR scenarios, to our knowledge, remain as yet largely unknown. Positive effects in patient treatment have been demonstrated[4-6] suggesting that VR is capable of successfully influencing behavior on a subconscious level.

VR disposes an inherent diagnostic potential as a means inducing increases of dissociative experience (depersonalization and derealization), and a lessened sense of presence in objective reality.[10] The use of VR enables the neurorehabilitation team to take overall control over the selected stimuli in order to meet the needs of the patient, overcoming the limitations of physical world. A number of companies worldwide develop and provide customized VR solutions solely targeting to psychiatric healthcare, including *CleVR*, *psious*, *VirtualRET* and *Mimerse* (https://techcrunch.com/2016/01/06/virtual-reality-therapy-treating-the-global-mental-health-crisis/), each one focusing on different span of disorders.

Moreover, objective bio-signal data measurements of changes in the heart rate and galvanic skin reflex, can be obtained using wearable devices during VR sessions.[60] In particular, anxiety-related bio-signals can be monitored in real time, and exposure to stressful stimulus can be gradually increased in a more reasonable fashion.[61]

Finally, there are many methodological issues to be addressed to verify how effective, harmful, or safe VR interventions are, compared to conventional treatment options. Current VR-related clinical trials limitations are the small size of the samples, lack of adequate controls, and lack of double-blind studies. These important issues should be addressed to design methodologically robust studies. In addition, the problem of ecological validity in terms of similarity between human behaviors in VR to those in real life, still remains an open issue.

Embodiment and Identity in Virtual Environments

There has been a growing scientific interest in the representation of the physical body in VEs and the way embodied experience is connected with the physical, social and self-presence of the users within the virtual space.[61] In immersive VR the interface defines both the boundaries and shape of the body, thus research that has been conducted concerning the (avatar or first person) representation of body image and the distortions of it that occur in the VE.[62] The affordances of the virtual body may lead to different social meanings compared to the user's physical body alluding to the notion that virtual embodiment can alter personal identity and perception.[6] It has been suggested that embodiment in VEs exhibits the potential for increased intelligence levels, through the progress of sensory fidelity virtual worlds. The progressive perfection of the way VEs respond to user actions, by linking physical movement to sensory feedback, lead to a heightened stimulation of human action in a natural environment. Confidence in the cognitive potency of VEs research[62] is due partly to the experience of the high-level reaction via the immersion in high-end VR systems. However, this assumption requires further investigation of the occurring psychological effects and the concept of presence,[63] as a basic state of consciousness.[64] The subject of presence, which is also referred as "phenomenal body" and "self" respectively, does not always correspond with the physical body.[65,66] Thus, the concept of self-presence is defined as "the users' mental model of themselves inside the virtual world and the short term or long-term effect of virtual environment on the perception of one's body (i.e., body schema or body image), physiological states, emotional states, perceived traits, and identity".[66] Furthermore, wearable technology, due to its proximity to the body, becomes a major factor in affecting human identity and transforming the relationship with the physical body. In particular, wearable devices enable the users, while present in the virtual space, to define and present their digital identities, which augment their real ones rather than replacing those.[67] As prosthetic mechanisms, wearables improve the performance of the users, enabling them to cope with the demands imposed on them by the environment, since the capability of the human body is limited within the requirements of the digital environment.[68] Thus, ubiquitous and pervasive computing includes, through the use of wearable devices, the physical body of the user and transforms his/her personal space into a "bodynet", enhancing it with additional capabilities.[69]

A fresh view

The representation of the physical body in VEs and the way embodied experience is connected with the physical, social and self-presence of the trainees within virtual space has recently become a subject of growing scientific interest.[70] Embodiment in VEs exhibits the potential to promote users' mental potential *(in terms of cognitive reserve enrichment)*. However, this concept along with the concept of presence as a basic state of consciousness warrant further investigation. The terms "phenomenal body" and "self" are used to describe the immersion of the user into the VE and are not always identical to the "sense of the physical body". "…*Self-presence is defined as users' mental model of themselves inside the virtual world, but especially differences in self-presence due to the short term or long-term effect of virtual environment on the perception of one's body (i.e., body schema or body image), physiological states, emotional states, perceived traits, and identity*…".[71] As with other forms of presence, VR experts share the assumption that increases in self-presence go alike to higher levels of cognitive performance, and, possibly, emotional development. Furthermore, wearable technology that enhances presence within the virtual space, due to its proximity to the body, may become a major factor in enhancing human identity and transforming the relationship with the physical body. In particular, wearable devices enable users, while present in the virtual space, to define and present their digital identities, by enriching their real ones instead of replacing them. Accordingly, in the following lines we suggest that the impact of new afferent stimulation and feedback may offer a short of corrective proprioceptive experience - *leading to reorganization of deranged brain functional systems* - mainly based upon patient's behavioral outcome during interaction with VEs to achieve therapeutic gains *(enhanced sense of presence), with the latter* hopefully transferred to ecological-everyday life situations. For instance, stimulation of mechanoceptors along the heel of the foot or those distributed along the chest surface, may be of help for the patient suffering depersonalization enhance his/her sense of presence in terms of contact with the ground and his/her weight dynamics, and the required body position adjustment imposed by external sources of stimulation (e.g., a strong wind) to achieve better balance. Changes induced by auxiliary mechanoceptive stimulation (e.g., through peripheral sensors) may in turn produce changes at a cortical level, thus meeting depersonalization patient's cognitive neurorehabilitation needs.

A similar approach using wearable technology in the area of motor rehabilitation is the early work of Perel'man in 1947, as reported by Luria,[11] who had showed that patients with paresis and dystonia resulting from deep penetrating injuries of the white matter of the posterior cortices and subcortical centers, may benefit from the implementation of additional series of afferent impulses (e.g., proprioceptive: plaster splint inducing hand's hyperextension may abolish spasm; nociceptive: squeezing the terminal phalanx of the finger may make spastic contraction disappear) leading their afferent filed to change and normalize deranged movements. For instance, these additional afferent inputs may either take place at a subconscious level (low cortical and subcortical level) or even in a conscious level (high cortical levels). Consequently, compensation of a motor defect may occur by modifying the patient's afferent field of interest.

We hypothesize that manipulation of the somatosensory aspects (i.e., pain, temperature, touch, and proprioception: articular and/or baroceptive components) during VEs immersion in DPD patients, may simulate real-life situations entailing stressful-aversive scenarios as potential triggers of depersonalization to assess self-awareness, in both its somatic and emotional components. Implementation of biofeedback electrical stimulation to the posterior cortical association areas - presenting aberrant processing in these patients -, concurrent measurement of galvanic skin response and EEG, as well as individualized neuropsychological assessment, may help in the detection of somato-sensory processing bias (i.e., baroceptive control bias). Consequently, this may assist clinicians in making necessary therapeutic adjustments. Since a set of wearables and sensors is implemented during interaction with the VE, self-presentation and self-perception of the participants could also be investigated, with the aim of detecting differences and variations between the physical and the virtual environment.

Considering the proposed treatment methodology, a neurobehavioural rehabilitation approach to the treatment of depersonalization should be adopted. To this aim the VEs would be enriched by somatosensory stimulation along with visual, and auditory stimulation offering the trainee multimodal sensory cuing to facilitate integrative processing, the latter being compromised in dissociative disorders.

Additionally, behavioral and psychoeducational treatment components must be included in a virtual rehabilitation tool. Thus, integration of elements stemming from behavioral psychology and cognitive therapy, psychophysiology and computer science, is expected to enhance our understanding of the condition and our treatment-planning

What is expected?

Our research hypotheses steaming from early psychophysiological and neuropsychological theoretical notions and empirical evidence might constitute a starting point for the development of new theory-based restorative cognitive neurorehabilitation approach to depersonalization. We believe that by introducing new afferent links - to provide fresh additional sensory inputs – one may alter the receptive fields of the affected proprioceptive functional systems and reorganize them. Future research may benefit of the neurorehabilitation principles developed by Alexander R. Luria on the basis of his clinical experience with thousands of people suffering brain injuries during the second world-war. Lurian neuropsychological approach to diagnosis and rehabilitation heavily relies upon solid evidence from physiological and experimental psychological research.

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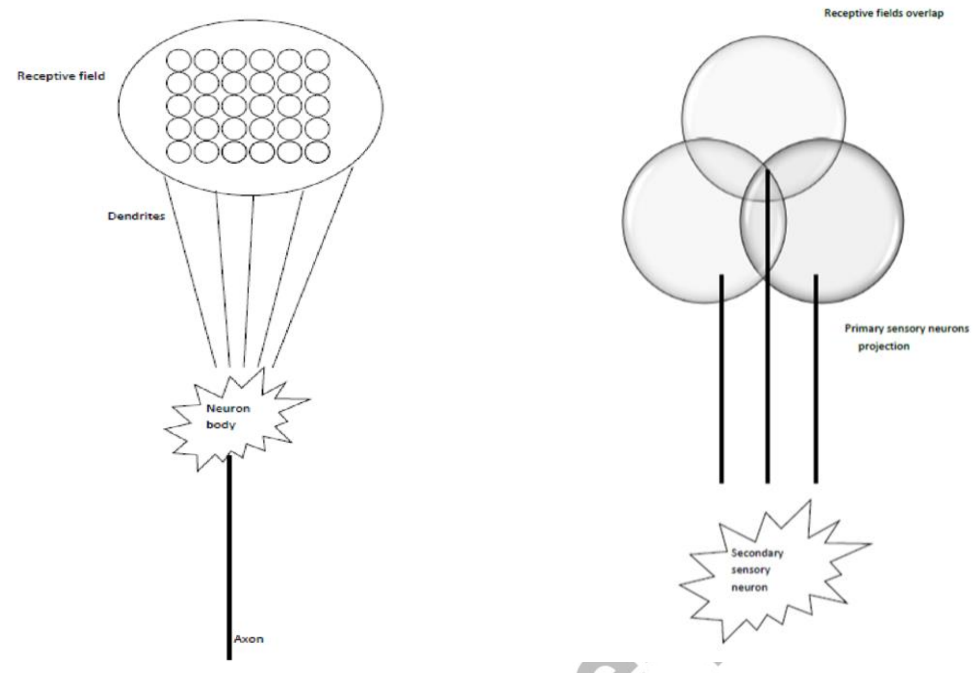

A B

Figure 1. Primary neurons' receptors can gather inputs from specific areas namely their receptive fields-RF, while the latter may assume irregular shape and overlap with other neurons' RFs. Whether primary neurons' RFs converge onto a secondary neuron (A), a sum of the formers features takes place giving rise to a single and complex RF (B), rendering possible for subthreshold incoming information to be summed up and thus processed by the secondary neuron. By appropriately stimulating specific neuronal populations suffering in depersonalization, we speculate that their receptive fields would undergo reorganization.

PSYCHIATRIKI

ΕΙΔΙΚΟ ΑΡΘΡΟ

Προσαρμοστικά εμβυθιστικά Εικονικά Περιβάλλοντα ως θεραπεία για τη διαταραχή αποπροσωποποίησης

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---**ΠΕΡΙΛΗΨΗ**---

Η διαταραχή αποπροσωποποίησης είναι σχετική μιας εκ βαθέων προσβολής της αυτο-ενημερότητας υπό την μορφή συναισθηματικής ψυχρότητας και αίσθημα αποσωματοποίησης. Προεξάρχον χαρακτηριστικό γνώρισμα της αποπροσωποποίησης συνιστά η απώλεια του αισθήματος οικειότητας για το ψυχικό και σωματικό εγώ (καθώς και του περιβάλλοντος όπου συνυπάρχει και αποπραγματοποίηση), μολονότι το άτομο είναι ενήμερο της σφαλερότητας της εν λόγω αλλαγής. Υφίστανται πρώιμες ερευνητικές ενδείξεις ότι τα άτομα τα οποία ρέπουν προς τη διάσχιση παρουσιάζουν μικρότερη ανοχή σε αντιληπτικά ασυνεχή περιβάλλοντα, πιθανά λόγω της υιοθέτησης μιας δύσκαμπτης αντιληπτικής στάσης. Συνεπώς, το βίωμα αντιληπτικής ασυνέχειας κατά τη χρήση εμβυθισμένης εικονικής πραγματικότητας (ΕΠ), αναμένεται να επιδεινώσει τη διασχιστική συμπτωματολογία σε ευεπίφορα άτομα. Ορισμένοι προτάσσουν το γεγονός ότι μια τάση του ατόμου να εμβυθίζεται ή να απορροφάται, η οποία αφορά σε διαδικασίες φαντασίας που υπόκεινται των διασχιστικών βιωμάτων, σχετίζεται σημαντικά με το βαθμό ευκολίας επαγωγής διασχιστικής συμπτωματολογίας από την ΕΠ. Εν κατακλείδι, έχει επισημανθεί το γεγονός ότι η αύξηση του ουδού ανοχής έναντι της αντιληπτικής ασυνέχειας, καθώς επίσης μια περισσότερο ευέλικτη αντιληπτική στάση σε ασθενείς με διαταραχή αποπροσωποποίησης/αποπραγματοποίησης, δυνατόν να αποβούν ωφέλιμες για τους εν λόγω ασθενείς. Στην παρούσα μελέτη προτείνουμε τη χρήση προσαρμοστικής και εμβυθισμένης εικονικής πραγματικότητας για τη θεραπεία της αποπροσωποποίησης. Συγκεκριμένα, φρονούμε πως η εφαρμογή ηλεκτρικής διέγερσης βιοανάδρασης για την ανίχνευση διεργασιακών παρελκύσεων της επεξεργασίας των σωματοαισθητηριακών πληροφοριών είναι δυνατόν να συμβάλει στην επιλεκτική στόχευση συγκεκριμένων νευρογνωστικών συντελεστών που έχουν υποστεί βλάβη και κατά συνέπεια να προάγει σε

κάποιο βαθμό και τη διαγνωστική προσπέλαση της αποπροσωποποίησης. Οι ψυχοφυσιολογικές προσεγγίσεις είναι δυνατόν να βοηθήσουν στη θεραπεία της αποπροσωποποίησης μέσω επικουρικών σειρών προσαγωγών εισιόντων με απώτερο σκοπό την τροποποίηση των υποδεκτικών πεδίων των προσβεβλημένων ιδιοδεκτικών συστημάτων και τη λειτουργική τους αναδιοργάνωση. Η παρούσα ερευνητική εργασία διατείνεται πρωτίστως να ενθαρρύνει μελλοντικές έρευνες ανάπτυξης προγραμμάτων εικονικής νευροαποκατάστασης που θα βασίζονται στη βιοανάδραση, την ηλεκτρική διέγερση και την ταυτόχρονη μέτρηση της γαλβανικής απόκρισης του δέρματος και της ΗΕΓ δραστηριότητας, στοχεύοντας στην επιλεκτική σωματοαισθητηριακή διέγερση σε ασθενείς με αποπροσωποποίηση, μία παρέμβαση που φαίνεται να απουσιάζει από τη φαρέτρα των κλινικών. Οι ερευνητικές μας υποθέσεις δυνατόν να αποτελέσουν ένα σημείο εκκίνησης για την ανάπτυξη νέων εργαλείων νευροαποκαταστασιακών παρεμβάσεων για την αποπροσωποποίηση ειδικότερα και τη διαταραχή αποπροσωποποίησης/ αποπραγματοποίησης εν γένει.

ΛΕΞΕΙΣ ΕΥΡΕΤΗΡΙΟΥ: Νευροψυχολογία, διάσχιση, εικονική πραγματικότητα, βιοανάδραση, διαταραχή αποπροσωποποίησης/αποπραγματοποίησης

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