A state of self reflexive “flow” and trait of consciousness: a model for the experimental use of hypnosis and neurofeedback in sensorial immersion in a centre for consciousness knowledge

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Abstract

The present model aims to develop and optimize an innovative technological resource. Advanced biometric solutions and innovative technologies specifically designed are implemented, combining bio-direct and bio-indirect signals. The model underpinning is aiming to explore the relationship between states and traits of consciousness, meditative practices/clinical hypnosis and physiology. The additional major outcome is to test and optimize immersive technological systems by developing advanced algorithms in multimodal feedback environments.

States and traits of consciousness are converted into scientific data that will be measured by electroencephalogram, electrocardiogram, galvanic skin response, eye tracking and movement detection, and evaluate the impact of distinct immersive approaches. These full set of biosensing technology will collect these states and traits of consciousness and look for their commonalities and differences. The interest of this model is to study the tacit and explicit knowledge created, and applied in a real multidisciplinary site, the centre for consciousness knowledge, a translational laboratory for induction of different states and traits of consciousness, especially values linked to citizenship, happiness and the sense of self.

Keywords

States and traits of consciousness, happiness, self, brain-computer interface, immersive technologies, biosensing, citizenship

INTRODUCTION

There is at present no satisfactory, universally accepted definition of human consciousness and even less so of self-consciousness [1].

Consciousness is a momentary creation or configuration of neural patterns which describe a relation between the organism, on the one hand, and an object or event, on the other. This composite of neural patterns describes a state that, for lack of a better word, one calls the reflexive self or self-consciousness, possibly following the Buddhist definition [2]. That state is the key to subjectivity.

For the purposes of clinical neurosciences, consciousness consists of two basic elements: arousal (i.e., wakefulness, vigilance or level of consciousness) and awareness of environment and of self (i.e., content of consciousness) [3, 4]. By arousal it is referred the behavioral continuum that occurs between sleep and wakefulness. Awareness refers to the thoughts and feelings of an individual.

Compared to awareness of the environment, awareness of self (or self-consciousness) is an even more complex and ill-defined concept, requiring a representation of self versus other [5].

The creation of neural patterns of the self is accompanied by characteristic observable behaviors [6]. The study of consciousness - with induction techniques, like meditative practices - of a state, trait, process, and intervention has proven to be beneficial across a diverse group of psychological disorders as well as for general stress reduction [7].

Yet, there remains a lack of clarity in the operationalization of this construct, and underlying mechanisms [8], and the possibility of combining it with immersive biosensing technologies.

The neurophysiological changes induced by meditative practices are of two types: (1) state changes and (2) trait changes [9].

State refers to the altered sensory, cognitive, and self-referential awareness that can arise during an activity, whereas trait refers to the lasting changes in these dimensions that persist over time [10, 11, 12]. State changes after meditations are reported to include a deep sense of calm peacefulness and experiences of perceptual clarity and conscious awareness [13, 14, 15].

Trait changes - that persist over time - include heightened awareness of the sensory field, thoughts, feelings, and the experience of self. This experience consists of contentless awareness that is independent of mental activities, that can be present during deep sleep, and produces the perception of an altered self-identity [12, 15, 16, 17]. This awareness is related to the isolated self-identity.
By that point of view, there are simple and complex degrees of consciousness, and therefore different states and traits of consciousness. The simplest kind - (1) “core consciousness” - provides the organism with a sense of self about things they were not synthetic” [24]. Immersive virtual environments in turn, are ones that ‘surround’ an individual and create the perception they are enclosed within and interacting with environments that provide a continuous stream of stimuli [25]. Immersive virtual environments are created through the integration of various hardware and software systems [24, 26]. Augmented reality is a technological system that allows inserting virtual content in the real world in order to run in the same representation and, in real time, enhancing the user’s sensory perception of reality [27]. They are compared to virtual reality systems but characterized by a computer-generated environment that elicits a strong user’s experience of “presence” [28, 29]. Multimodal neurofeedback stimulation is a technique in which the subject, using awareness and auto neuromodulation of its own brain activity in real time, searches for a given desired outcome, for instance, the improvement of a given condition [30]. In this model, through the set of technologies previously described, individuals will be able to modulate and voluntarily control endogenous brain rhythms via multisensory feedback in real-time [31]. The Sensorium [22], presented as proof of concept, is a multimodal neurofeedback environment which allows the user to self-experience the own ongoing brain and body signals in sound and light. This extended self-experience can simulate meditative practices and lead people into an enhanced body experience.

At this point, the authors postulate that immersive environments and brain computer interface technologies may be used to promote subjective happiness states and to train citizenship values. Those techniques might be used to promote subjective happiness states and to promote active learning and training of a specific state and trait of consciousness [33, 34].

The previously described approach to states and traits of consciousness induction allows people to experience their non-perceivable body processes through the modeling of a series of stimuli such as soundscapes and lightscapes [22]. Also it is reported [22] an induction of a subjective state of happiness, as it is achieved through a mindful meditation experience. Moreover, it is possible to create a parallel to the multisensory stimulation provided by snoezelen rooms, where users report being stimulated and soothed [35]. This stimulation allows the achievement and maintenance of a subjective state of happiness and long term well-being, matching the concept of subject orientedness/centeredness, defined as an intervention developed for the subject and by the subject actively [36].

Concluding, virtual immersive realities induced by brain computer interfaces, as in lifelike experiences, create a full immersive state which is needed to achieve a desired state and trait of consciousness [37, 38].

The final aim of this model is therefore the creation of Centre of Consciousness Knowledge, modeled as mixed museum and laboratory with brain computer interface experimentations on states and traits of consciousness. The proposition in this paper is that happiness and self-consciousness, as a learnt skill, might be induced through these different but combined techniques, in different experimental activities.

With it, it is hoped to give contribution to the creation of a uniquely tailored system to address the needs of more citizenship and the population well-being in the future.

METHODOLOGY
Methodological Frameworks
In order to develop activities that integrate biosignals with states and traits of consciousness, a physiological model will be implemented. The purpose is to support the integration of biosignals in the different activities.

This neuroscientific approach of states and traits of consciousness look for neuronal correlates of different activities/tasks. With this set of technologies task specific occurrences are identified and correlated to specific humman characteristics and values, e.g. empathy, compassion, self-consciousness, meditative and hypnotic states, subjective happiness states; focused attention and open-monitoring attention.

The integration of immersive and non-immersive technologies in the Centre of Consciousness Knowledge, comprising virtual and augmented realities, user dynamic interfaces, brain-computer interfaces, biosignals monitoring and biofeedback will comprise the following types of technology:

a) Virtual and augmented realities: are the most immersive technologies (e.g., Oculus Rift (https://www.oculus. com/rift/), holography-like immersive modelion systems). The first one allows the creation of a virtual world that users can interact with. The second one consists on the blending of virtual reality and real life. These two approaches have the potential to recreate completely virtual and mixed scenarios that enhance the user experimentation with a given universal value (e.g. empathy, compassion). This extended self-experience can simulate meditative practices and lead people into an enhanced body experience.

b) User dynamic interfaces: (e.g., Leap motion (https://www.leapmotion.com/) - hand movement detection sensor, Kinect for Windows (https://www.microsoft.com/en-us/kinectforwindows/default.aspx) - body movement detection sensor, EyeTribe (https://theyeetrieb.com/) - eye movement and tracking sensor) can be used to improve the engagement between the user and the activity itself. For the purpose of this model several technologies will be used.

c) Biosignals monitoring and biofeedback: several biosignals will also be acquired in order to assess the physiologica
initial response of the user during the activity performance including electroencephalography (EEG), electrocardiography (ECG), Galvanic Skin Response (GSR) and pulse oximetry. For that purpose three main devices will be used: Neurosky’s Mindwave Mobile (http://neurosky.com), a device that allows the recording of 1-channel EEG and the assessment of one’s Attention and Meditation levels; an in-house developed headset, a device that allows the recording of 2-channel EEG integrated with an accelerometer and also an oximeter; and, finally, an in-house developed emotional device, a 1-channel ECG device integrated with a 1-channel GSR.

Tools Architecture, Development and Processing

A division between bio-direct and bio-indirect signals is considered in order to describe the processing of both types of signals. Bio-direct, in this model, are defined as those who are physiological signals (e.g. electro-encephalogram) and so, they are used as direct biological signals and the bio-indirect, in this model, are defined as signals acquired using sensors that track the human behavior (e.g. eye and body movement tracking).

a) Bio-direct signals: processing algorithms will be implemented to analyze the acquired data. For each one of the acquired biosignals a specific metric will be computed and used to get physiological information about the individual during each activity. In the case of EEG signals, focus will be given to its power spectrum since the analysis of each frequency band (known as Gamma, Beta, Alpha, Theta and Delta bands) allows distinguishing different levels of attention and meditation. Also, using EEG as a physiological response one can identify emotions during different activities. Once again, algorithms will be developed to reach and to make a distinction among positive, neutral and negative emotions.

Both ECG and GSR are commonly used to monitor stress levels of an individual and they are the basis of the well-known polygraph test. Using both measures one aims to reach an algorithm capable of evaluate the human conviction when facing an absolute truth and when facing a disguised preconception. This step forward is crucial to understand states and traits of consciousness in a neuroscience perspective. From pulse oximetry acquisition the goal is to extract the heart beat rate that also correlates with different activities which in turn enhance different emotions causing different biofeedback.

The final goal is to be able to use individual and/or group biofeedback to control sound/light and video environment.

b) Bio-indirect signals: Bio-indirect signals processing will be implemented for both body movement (using Leap motion and Kinect for Windows) and eye tracking (EyeTribe) technologies.

The data processing of the first one, body movement, will allow the identification of both facial and all-body movements regarding different activities and so, regarding different emotions. The output from this technology will provide the tracking of the face and body. The second one, eye tracking technology, will be used by the user to answer questions with the eyes by looking and focusing a specific region of interest (ROI) on a specific picture. The processing of gaze coordinates will allow getting the time spent by the user looking to each ROI which in turn will provide an answer given by the eyes.

The processing of both bio-direct and bio-indirect signals will be performed in C# and MATLAB languages using Windows OS and Android OS, for better adaptation to the Center of Consciousness Knowledge user’s profile, i.e. children, students and museum attenders.

Multisensorial Stimulation in Neurofeedback environment

As an example of the previously described technologies, an application is described.

In an isolated room for sound and light, a set of audio-visual equipment is installed: Yamaha HS7 sound monitors; professional audio interface and Oculus Rift virtual reality goggles and BCI developed for music. Brain waves, recorded with EEG, will be addressed to a synthesizer via MindWave Mobile headset (Neurosky), device which, in turn, will transform brain waves into digital audio and visual stimuli. Brain wave patterns will drive the sound, sequence, and timbre of the musical performance and the correspondent video effects in the multisensory stimulation in neurofeedback environment.

The sonification of the brain wave patterns will be made by attention and meditation algorithms, but also by EEG power spectrum bands modulation described before, an induction technique, namely mindful meditation, should be created in a virtual immersive environment. Depending on the subjects of each activity, the music created, can be more melodic, harmonic and rhythmic, generating a general attention and meditative practice. This meditative state might induce a subjective state of happiness controlled by the participant.

CONCLUSION

The overall scope of the model is to propose an innovative set of technologies of induction techniques of states and traits of consciousness. These induction techniques are made by (1) brain-computer interfaces, (2) virtual and immersive environments, (3) augmented reality and (4) multimodal neurofeedback stimulation. These different technologies are implemented in the Centre of Consciousness Knowledge*

Concluding, states and traits of consciousness, e.g. subjective happiness or self-consciousness and citizenship consciousness, might be induced in a museum setting.

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REFERENCES

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