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Identity: Experience and Extension in the Metaverse

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Abstract

The promise of the future metaverse is to enhance immersion by offering a rich and vivid illusion of reality through high-tech human-machine-interfaces (HMI). The next iteration of social networks relies on virtual reality and many electronic devices that have long been part of the mass consumer market. Considering the pervasive interaction between technology, biology and culture, our aim is to explore the ethical challenges that might arise on the development of identity, a malleable construct. This is a preliminary theoretical study on the impact of technology-based experiences on the *self*. The very conceptual complexity of the term requires breaking down silos and creating alignment between different knowledge areas: scientific, cognitive, ethical, philosophical, technological, social, legal, among others. Understanding the scope of virtual worlds and the potential of neurotechnology, key features of immersion, places us on the threshold of a new reality of human nature under the promise of neural protection. All this can only be achieved if we understand more explicitly how our interdisciplinary knowledge niches fit into a bigger picture. Digital and virtual trust demands the development of a common multidimensional conceptual framework and a standardised terminology, based on ethical principles and also on the promotion of human rights.

Keywords: Metaverse, Digital Identity, neurotechnology, Virtual Reality (VR)

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1. Introduction

Virtuality and neurotechnologies are increasingly pervasive in contemporary society as mediators of subjective experience, in a dynamic interplay where biology, technology and culture continuously feed back into each other.

Within the wide range of neurotechnologies, the brain-computer interface (BCI) is of major importance, from a social, legal and ethical point of view, since its ability to establish a direct connection between our neural processes and artificial computation was described by experts in the field as "qualitatively different". As such, the potential applications of brain-computer interface (BCI) technologies promise to enhance the metaverse user experience. By communicating directly with the brain, the most complex organ in the human body, they can become the most efficient system, one that operates at the *speed of thought*.

Advances in imaging, brain activity acquisition and recording techniques, and the evolution of artificial intelligence systems that increasingly decode and analyze neural data, provide brain-computer interfaces (BCI's) with improvements in accessing, monitoring and manipulating mental states for mental health, neurological rehabilitation, cognitive enhancement and device control purposes. This has opened a growing debate about protecting the autonomy of our minds. The brain is a fundamental determinant of the meaning of "being human" and therefore also plays a determining role in the shaping and development of our identity.

The establishment of an ethical, legal and governance framework that guarantees the protection of our privacy, our sense of self and identity is essential in an era, where the biological body reconfigures its limits in symbiosis with hardware and software systems and where representations of the identity through avatars give life to the metaverse. All this can lead to a transformation of the human dimensions.

In addition to BCI, research and innovation on neuroscience and digital technologies includes, among others, biometric identification, eye, facial and body tracking, emotion recognition, and systems underlying extended reality (XR). The complexity of these technologies, which are also desirable constituents of metaverse, requires an interdisciplinary approach, bringing together the legal, philosophical, neuroscientific and technological perspectives. The aim is to develop a common conceptual framework guided by responsible ethics, providing precision in meaning and scope to ensure the protection of our mental sphere.

As Sjors Ligthart (2024) points out in the *European Convention on Human Rights Law Review*, many of the central notions and concepts that are relevant to the protection of human rights, referring to personal identity, remain underdeveloped and ill-defined in the jurisprudence of the European Court of Human Rights (ECtHR). Likewise, he pointed out that this Court develops and applies, on a case-by-case basis, a right to personal identity and personality, referring to the importance of preserving mental stability, although without defining these notions or elucidating a clear conception of what identity and personality require and what they consist of. To address the legitimate concerns about the sustainability of current human rights expressed by scholars such as Marcello Ienca and Roberto Andorno (2017), there is a strong need to bring greater clarity and precision to the existing legal concepts relevant to the protection of the human mind, and how these concepts (should) relate to each other.

As Ienca and Andorno have claimed, the protection of the human rights of personal identity and, more specifically, of psychological continuity, is becoming increasingly important in the era of emerging neurotechnologies.

2. Neurotechnologies and the metaverse

Nowadays, beyond the clinical and research fields, we find wearables that monitor and report on biological and neurophysiological processes of our daily activities. We are dealing with health data such as sleep quality, parameters related to physical activity or stress level. This raises new ethical, social and questions worldwide because of the risks involved in the violation of fundamental rights such as mental privacy, the agency of our nervous system and the autonomy of our decision making.

We are also witnessing how devices such as eye tracking, facial tracking and body tracking collect our real gestures and movements in order to synchronise us with our avatars in virtual reality.

Neural interfaces are already available in the consumer market for leisure and entertainment activities as well as for cognitive enhancement and wellness purposes. We are talking about helmets, bracelets or headbands that interact directly with the nervous system. They are electronic devices placed on the outside of the brain or nervous system to record and/or stimulate neural activity. These non-invasive or wearable interfaces are also known as brain-computer interfaces. The nomenclature also encompasses implants placed inside the brain or body that are known as internal, invasive or implanted technologies and, for the time being, are still only performed under surgical intervention in the medical setting.

And although neural interfaces are still in the early stages of development, there is a demand for a solid legal framework capable of ensuring maximum protection of fundamental rights, especially in relation to the European Commission's work on Web 4.0 and virtual worlds.

Organisations such as the Human Rights Council of the United Nations, the Council of Europe, UNESCO and the OECD, among others, are already insisting on the necessity of responsible neurotechnological innovation and the need of addressing risks related to human dignity, freedom of thought and freedom of mind due to the threat that such developments could pose to privacy and discrimination.

2.1. Mind surveillance and data extraction

Thus the imperative to work together in order to establish the ethical, social and legal connections to address the risks of techniques and tools that can record and alter brain activity. Such records may contain extremely sensitive coded information about individuals, including predictive characteristics of their health and mental states. In accordance with this informative potential, brain recording technologies have often been categorised as “brain reading” techniques, as they make it possible to decode information and mental states from neural data. Several studies have shown that it is possible to decode mental contents, intentions and hidden information, images, visual experiences, and the unconscious generation of free decisions from individual neural data previously collected by electroencephalography (EEG), functional magnetic resonance imaging (fMRI) or other techniques.

And although the debate about the possibilities of decoding both the neural correlates of mental information and the actual mental contents is still open, it is undeniable that the quality and quantity of information collected from neural activity recordings have been improving progressively and rapidly in recent years. Decoding mental

information is expected to become increasingly affordable in the near future thanks to coordinated advances in the fields of sensor technology, spatial resolution of brain recordings and, above all, improved analysis techniques, supported by Artificial Intelligence, for pattern recognition and feature extraction.

Current privacy risks resulting from technological expansion and the proliferation of device-generated data could be leveraged with neural interfaces by providing new, even more ethically sensitive data for further sophisticated analysis of the psychographic profile of individuals (based on mental characteristics) and predictive behavioral modelling.

This is how the ethical challenges posed by BCIs, among other neurotechnologies, compel us to face a fundamental question: whether it is legitimate to access or interfere with a person's neural activity, and under which circumstances. The motivation is threefold: first, scientists explain neural activity as the critical substrate of personal identity and, therefore, also as the critical substrate of moral and legal responsibility. It follows logically that the decoding and manipulation of neural activity by means of neurotechnology may have an unprecedented impact on the personal identity of individuals and may provide them with a kind of "blurring effect", or even produce a real threat in terms of uncertainty in determining moral and legal responsibility.
The treatment of such issues must involve, as we have mentioned, an interdisciplinary approach, in addition to their consideration in the light of fundamental human rights.

2.2. Human rights for the neural domain

In recent years, as Marcello Ienca refers in his paper *On Neurorights*, "philosophical-legal studies on neuroscience (mainly in the fields of neuroethics and neurolaw) have given increasing prominence to a normative analysis of the ethical-legal challenges in the mind and brain sciences in terms of rights, freedoms, entitlements and associated obligations. This way of analysing the ethical and legal implications of neuroscience has come to be known as "neurorights". Neurorights can be defined as the ethical, legal, social or natural principles of freedom or entitlement related to a person's brain and mental domain; that is, the fundamental normative rules for the protection and preservation of the human brain and mind".

All our freedom is based on the fundamental freedom to control our thoughts. When it disappears, all other freedoms disappear accordingly. The notion of Neurorights suggests not to focus only on the externalisation of thoughts, but also on the internal forum: the literal interpretation of thought in the sense of the neurobiological processes of the brain (neurobiological support of thoughts).

The need to establish new specific human rights for the mind has been challenged by many legal scholars. One of the main arguments against the recognition of specific neurorights is that most of the proposed rights are already covered by the established framework of human rights law. The creation of new rights would be just a repetition of the existing ones and would risk rights inflation.

In their paper "Towards new human rights in the age of neuroscience and neurotechnology", Marcello Ienca and Roberto Andorno advocate, however, for the establishment of four new rights that may become highly relevant in the coming decades: the right to cognitive freedom, the right to mental privacy, the right to mental integrity and the right to psychological continuity. Both researchers argue that the degree to which

advanced neurotechnology impacts the current ethical-legal framework demands a normative update to protect privacy, personal integrity and identity.

Furthermore, Yuste, Genser and Herrmann in a report by the NeuroRights Foundation claim that, of all the potential "neural rights", the right to identity is, at present, the "worst protected" in the existing human rights framework. This is in alignment with the arguments and proposals for strengthening the protection of personal identity through the right to psychological continuity by Ienca and Andorno. Both authors point to technologies and techniques that enable stimulation and modulation of brain functions. One example is transcranial direct current stimulation (tDCS), which delivers a constant low current to specific brain areas through electrodes on the scalp in order to modulate brain function. Other examples referred to by the authors are deep brain stimulation (DBS), a neurosurgical procedure that uses implanted electrodes and electrical stimulation, and transcranial magnetic stimulation (TMS).

The researchers explore the possibilities that brain stimulation can bring beyond the context of conventional medicine, for example, to reduce aggression in certain criminal populations. In addition, Ienca and Andorno highlight the context of military and intelligence agencies, where presumably human rights violations have been reported in connection with experiments with brain electrodes.

Ienca and Andorno stress that modifying a person's brain functioning through emerging neurotechnology could sometimes cause alterations of mental states critical to personality, which can affect the individual's personal identity. Cases in which patients claim to have stopped being themselves after or during DBS treatment, or patients who have felt themselves as another person after a treatment with a brain-computer interface.

In addition, a recent study on the policy implications of emerging neurotechnology, approved by UNESCO's Executive Board, highlights that neurotechnology could also alter personal identity. For instance, through memory modification techniques individuals may choose to alter the content of a memory and thereby alter personal identity. Deep brain stimulation (DBS), which allows people to regain autonomy of movement, may also pose a threat to an individual's authentic self as the mind may be disoriented by the active presence of a technical device.

For all these reasons, Ienca and Andorno advocate the recognition of a right to psychological continuity, which ultimately tends to preserve the individual's sense of personal identity, self-determination and consistency of behaviour against modifications not consented to by third parties. It protects the continuity of a person's habitual thoughts, preferences and choices, protecting the underlying neural functioning.

In this paper we are focusing on the referred right to psychological continuity, related to the right to personal identity, the right to self-determination and the right to personal integrity. From different approaches, we will address the foundations of personal identity. As Ienca and Andorno allude, the right to psychological continuity can be seen as a special neuro-focused case of the right to identity.

3. Identity

While «psychological continuity» may be a well-known term in ethics and philosophy, it is not a concept with which human rights law is familiar. As the report commissioned by the Committee on Bioethics of the Council of Europe (2021) explains, this terminology comes from a specific moral philosophical conception of personal identity. It is based on the concept of psychological continuity of personal identity. In order to better understand the

meaning and scope of the right to psychological continuity, we would like to address different theoretical approaches to identity, with the intention of contributing to the definition and the establishment of the above-mentioned conceptual framework.

In its origins, the concept of "identity" refers to the human view of the world and the view of oneself, to the reflection on one's own actions, that is to say, to one's own existence. Identity is the way of being and being in the world, both physically and virtually.

The perspective of the language invites us to approach another key related concept, "intimacy": a person who, through the elaboration of the multiple forms of experience, manifests and expresses him/herself.

Identity already encounters, in the origins of its constitution as a fundamental concept, some important discrepancies. A text from the Platonic Banquet by Diotima poses a reflection on how, in spite of alluding that an individual is the same person, from his childhood to his old age, he is constantly renewing himself in certain aspects and destroying himself in others. And not only in the tangible, in his body, but also in his essence, his habits, desires, opinions, pleasures, fears, interests, hopes.

But, despite the ephemeral nature of each instant, there is a certain consistency in human time: memory. Memory, articulated in different ways in the development of a human being, allows its coherence. Memory is in the essence of a person, giving meaning and allowing the distinction of each being. Each individual is made up of a mixture of circumstances and chances that shape life, and within the landscape of conditioning factors individuals are permeable to the increasing influence of technology, which, instead of being transparent, is increasingly difficult to understand.

Language is not only an element of communication, it is a creator of culture. Since identity arises from consciousness, from knowing, from feeling, from understanding, through obtuse languages that go against the most elementary principles of reason, the human capacity to understand can be distorted and corrupted.

All this implies that this consciousness of unity, integrating the multiple experiential elements that constitute us, expresses not only the individual's reference to himself, but also to others. The conscious being allows the integration in a differentiated and at the same time consistent self. A coherent personality that embraces the diversity of roles that it has to assume and, so to speak, represent in its life. The self is perceived from this constitutive unity, as an existence that has to develop within a social reality, which undoubtedly includes virtuality.

3.1. Identity from a neuroscientific perspective

Current neuroscience supports the idea that the unique and distinct identity, which we also refer to as the «self», is a set of multiple functions distributed in neural circuits throughout the brain. It also refers to functions integrated at a certain level of neural representation that makes human beings reach a "consciousness" of their individuality expressed in behaviour.

According to Churchland (2002), this distribution over the brain structures is organized in a very labile way. We see the slow emergence and elaboration of the self in children and the tragic failure or vanishing of these capacities in patients with dementia.

According to Llinás (2001), the subjective experience is generated by a constant activity in a thalamo-cortical system activated in wakefulness that relates the sensory stimuli of the external world with the internal brain activity (memory). The "self", therefore, is a cerebral construct that gives unity to the human being in connection with the world and

that does not have only an "internal" reality, but its reality appears when this internal activity is coupled to the activity generated by the external world, given that we are social animals.

Learning and memorizing has its neurobiological basis in the changing pattern of synaptic connections in the brain. And it is from these synaptic changes throughout the brain that a constantly rewired, changed and updated self arises, using time codes in both cerebral hemispheres. Codes that recruit the information required at each moment and for each situation stored in multiple and different areas of the brain. Therefore, the self is the same when we are reading, brainstorming a real use case, as when we participate in a role-playing game or an avatar video game. The self is always recomposed around every situation and every morning after sleep.

All this is due to the fact that the brain is a dynamic neuroplastic and ever-changing organ in its physics and chemistry, biochemistry, anatomy and function over time. The traffic of molecules (biochemistry) gives rise to changes in the structure (anatomy) and the latter in the brain function (physiology) in a constant and incessant process that is expressed in the behavior of all living beings. Learning, memorizing, forgetting is inherent to the nature of *our being* and *being in the world*. In fact, the human being, in its essence, is what learns and memorizes.

Acknowledging all of the above-mentioned, it is important to highlight that it is still a pending challenge to understand how this functional brain state, the integrated, unique and singular self, emerges from this world of synaptic connections in multiple and different brain areas.

3.2. Further approaches

In moral philosophy, the psychological-continuity account of identity is often distinguished from a biological, narrative view of identity. Instead of the idea that identity depends on the continuity of psychological connections with oneself, a biological view holds that identity consists in the continuity of physical relationships; the continuity of being the same biological organism through time. This standpoint argues that what really determines our essence is our existence as a biological entity.

Narrative identity, on the other hand, refers to the question (of characterization) of what beliefs, values, desires, and other psychological traits make someone the person he is. The answer to this question is embodied in the narratives that people tell about themselves to make sense of who they are. Unlike the psychological continuity and the biological view, narrative identity is not about a person's essence or metaphysical identity. Rather, from this point of view, identity is about a psychological unity, about the embodiment of experiences over time into an evolving self-conclusive story about a person's sense of self. This is the type of identity that is often at stake when a person suffers an identity crisis.

As Pugh (2020) describes, from a narrative point of view, identities are inherently dynamic, as individuals constantly change and evolve, while making sense of themselves by reconciling those changes into a coherent narrative of themselves.

4. Mind, affect and emotions

On account of all the aforementioned, the self is a multimodal, hierarchical construct containing both complex high-level and low-level mental functions. Human brains shape

different types of minds, minds with a diversity of traits. While it is true that humankind shares a single brain architecture -a complex network- each individual brain adjusts and prunes itself according to its environment. Likewise, mind and body are closely linked, with the demarcation between the two being blurred.

In short, a particular brain in a particular body, developed within a particular culture, will produce a particular kind of mind. A mind is something that arises from an innate brain configuration and continuous transactions between brain and body in an environment inhabited by other brains in other bodies that are immersed in a physical world and constructing a social world. We understand that because of many of the characteristics we will discuss below, we can extend this description to virtual worlds.

According to research scientist in psychology and neuroscience, Lisa Feldman Barret (2020), the human mind has no universal defining features. But one that comes closest to being universal is what scientists call affectivity: a basic sense of feeling, ranging from unpleasant to pleasant (called valence), and from idle to activated (called arousal). We know it as "mood", a general feeling that comes from our body. This also underlines the close link between mind and body, and their blurred boundaries.

Affect occurs in every moment (whether you're aware of it or not) because interoception, representations of sensory input that signal the physiological condition of the entire body, occurs in every moment. Affect is not specific to emotion; it is a feature of consciousness. Emotion is a much more complex mental construction.

Most neuroscientists claim that objective categorizations of emotional states do not exist. It seems that emotion categories are largely culturally learned. Hence the suitability to consider two features (valence, arousal) that are universal not only across human cultures but also across the animal kingdom.

The universality of affect can also be seen in our biology. There are clear neurophysiological signatures that differentiate levels of arousal, such as heart rate, perspiration, pupil size, adrenaline, blood pressure. And there are clear neurophysiological signatures that differentiate levels of valence, such as stress-hormone levels, dopamine levels, and the activations of specific brain regions. This also reinforces the fact that our body is part of our mind; tangibly and biologically.

5. Virtual Reality (VR)

Although the Metaverse is still under construction, it seems appropriate to allude to Ball's definition (2022) since many of the concepts considered can also define virtual reality. The metaverse is "a massively scaled and interoperable network of real-time rendered three-dimensional (3D) virtual worlds that can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications and payments".

Virtual reality (VR) is a computer-generated simulation of a three-dimensional (3D) image or environment that can be experienced in a seemingly real way by individuals equipped with electronic devices that create the sensory illusion of being present, and thus allowing a first-person interaction by means of an avatar or a virtual body.

Given the contextual framework of this paper related to Neurotechnologies and Neurorights, it is pertinent to try to answer whether virtual reality, foundation of the Metaverse, can also be considered a neurotechnology. The term "neurotechnology" denotes devices that measure brain structure or function (particularly brain activity) or

intervene into brain activity (e.g. through electrical stimulation). Typical examples of neurotechnology are brain-computer interfaces (BCIs), i.e. systems that measure and analyze brain activity to control an "effector" (such as a robotic arm, or a software for text generation)(Ligthart et al., 2023).

Taking into consideration that virtual reality enriches the immersive effect through physiological data, collected by devices such as eye tracking, facial tracking, body tracking, non-invasive brain-computer interfaces (BCI's), we can infer that through the mapping of such data we can "read" mental activity and, above all, influence such activity through persuasion or even manipulation.

Virtuality is thus not only a physical experience, but also a psychological one. Through interactions in the virtual world, users can experience intense emotions due to the illusion of realism and fostered by the sense of presence and agency.

If sensory perceptions are effectively substituted, our brain infer its perceptual model from the virtual stream of sensory data. If we look into the majority of VR solutions, they are mainly centered in vision, a certain amount may offer sound, and some may have some sort of tactile feedback. However, although perception is a whole body action, even visual perception alone is oftentimes enough for the sense of presence, due to our evolutionary perceptually visual-dominance.

5.1. Presence, perception, and immersion

The feeling of *being there* is considered by researchers to be a fundamental characteristic of VR. This means that the sensory and motor systems interact with the virtual world in a similar way as they do in the physical world. This is also why in the field of research and clinical practice it has been proven to be effective in many cases related to health and physical and psychological well-being.

Presence is defined by Matthew Lombard (1997), researcher on individuals' psychological and physiological processing of media presentations and experiences, as the perceptual illusion of non-mediation. In other words, the virtual experience may become indistinguishable from everyday reality. Presence is also the subjective correlate of immersion, which describes the technical capabilities of a system to create a rich and vivid illusion of reality.

Consciousness of our immediate surroundings depends on data picked up by our sensory systems. Perception combines a bottom-up processing of the sensory inputs with top-down processing (including previous experience, beliefs, expectations), based on our model of the world.

After a few seconds of entering a room we believe we "know" it. In fact, eye scanning data show that our field of view is targeted only on a very few number of key points of the room. VR technology provides us with enough cues for our perceptual system to hypothesize "this is a room" and then based on an existing mental model infer a model of this particular room using a perceptual fill-in mechanism. It was argued by Stark (1995) that this is the reason for VR effectiveness, even in spite of poor rendering of surroundings.

Since VR relies on the brain "filling in" details, just like in physical reality we find ourselves responding with physiological and reflex actions before we consciously reason the situation i.e. that in fact nothing "real" is happening. This high-level cognitive process arises more slowly, after the autonomous bodily responses and first thoughts have already emerged. For example, the heart of someone approaching a cliff may start pounding very strongly, even though he knows that a physical precipice is not there.

5.2. Reality and unreality simulator

According to Slater et al. (2016), since VR evokes realistic responses in people, it is fundamentally a "reality simulator." Subjects can be placed in a scenario that depicts everyday life real events, with a likelihood that they would act and respond quite realistically. VR, however, is also an "unreality simulator". The events that it depicts may be highly unlikely to happen or cannot happen because they violate fundamental laws of physics, such as imaginary and fantastic environments. Similarly, social conventions can be violated. But still, giving rise to the illusions of *being in* participants can convey realistic responses.

In this regard, VR has the infinite power to extend the range of human experiences way beyond anything that is likely to be encountered in physical reality. Hence, the outstanding capability of VR to give rise to realistic behaviour, in both cases. As such, VR techniques could represent a more reliable method than thought experiments for understanding how people might behave in the face of moral dilemmas in "real cases".

5.3. Physical vs. psychological realism

This feeling of *being there* is also referred to as "place illusion" (PI) (Slater, 2009). It was coined by Marvin Minsky to describe the similar feeling that can arise when embodying a remote robotic device in a teleoperator system. This fundamental aspect of VR to deliver an experience that gives rise to an illusory sense of place and an illusory sense of reality is what distinguishes it fundamentally from all other types of media.

Having addressed the process of how we react and respond in virtual worlds allows us to understand the difference between "belief" and "illusion". It is therefore worth noting that there is a difference between physical and psychological realism, the former referring to the physical appearance of the virtual features and the latter to the psychological sensation that what happens in a virtual world could be happening in reality. It is expected that (physical) *superrealism* in VR systems achieved through advances in computer graphics enabling more photographic realism, improvements in sensory feedback, and the possibility to interact with virtual elements through neurotechnologies, among others, also increases the sensation that the virtual experience is real, i.e. psychological realism.

So although the experience is based on virtual sense data and virtual actions, it is nevertheless "real as an experience". For example, when a virtual character smiles at a user and the user automatically smiles back—the "being smiled at" and the smiling—are real experiences (Chalmers, 2017).

Through experiences, identity changes the body and the mind. As real-life experiences have after-effects in our identity, virtual ones may have physical, cognitive, and emotional after-effects which may be beneficial or harmful. And more importantly, some of the consequences may be long-lasting. A defining feature of the affective states is that, although often triggered by external stimuli, they persist for long after the stimuli are gone.

6. Identity, embodiment and body awareness

Body perception is a core issue in cognitive science. Since the body is considered a pillar of the self, the ground of science of the self relies primarily on the *bodily self*. The "embodied cognition" approach claims that cognitive processes are deeply rooted in the body's interaction with the world (Wilson, 2002). Thus, embodiment, our experience of simultaneously *being* and *having a body*, addresses our mental processes in connection with their bodily foundation and expression. Therefore, the body is defined as an essential component of human experience and self-perception. In everyday life, these sensations are perceived as emerging from only the biological body, giving coherence to our self and our body representation.

Within virtual reality "embodiment" extends its scope raising new questions regarding our self-representational avatars as a source of the experienced sensations: What happens to our embodiment experience and to our identity when we interact through a digital replica of ourselves? To what extent a virtual body is perceived as a part, extension, or substitute of our physical body?

The sense of embodiment (SoE) is associated with: sense of body ownership (conscious experience of self-attribution of a body); sense of agency (sense of body ownership that enables global motor control, including the subjective experience of will); and sense of self-location (concerned with the relationship between one's self and one's body). It is worth remembering that presence refers to the relationship between one's self and the environment.

One essential aspect of body perception within embodiment research is "body awareness": the ability to recognize subtle internal body signals, especially the interoceptive ones. Body awareness is a core element of our self-perception, and is related to psychological and physical wellbeing. Body awareness is twofold, a core element of integrity being an essential part of self-awareness and an individual's capacity and ability for embodiment. Self-awareness can provide us with a more accurate model for understanding both phenomenal consciousness and the notion of self. Distinguishing between oneself and others is not only crucial for self-awareness but for awareness of others, because our brain must correctly attribute mental states, sensations, and events to oneself and to other selves.

Interoceptive signals arise within various internal systems. The cardiovascular system has become the research cornerstone due to the rich informational content and bidirectional connections between the heart and the brain. Furthermore, psychological research on interoceptive awareness has focused to a large extent on cardiac awareness in view of the known role that heart-brain interactions play in emotion processing.

Awareness of all sensory modalities confers significant biological advantages. However, unlike other senses, understanding of interoceptive awareness is constrained by challenges to causally manipulate interoceptive states, and by the available measurement methods. Since VR experiences also rely on augmenting, modifying, or replacing particular parts of body signals with virtual stimuli, can we expect that all this will improve our body awareness?

7. About measurement

A variable whose evaluation is of particular interest for immersive environments is presence. Presence shows a high correlation with the effectiveness of virtual treatments, the influence on user studies and persuasiveness, as well as other parameters.

There are still many debates about how presence can be measured and which methodology is reliable, valid, sensitive and objective enough. As with other data collection methods, the feeling of presence can be measured either by subjective measures such as questionnaires or objective measures such as behavioral measures and physiological response to the virtual environment.

Physiological signals correlate to certain activities that we perform or that we react to. Electroencephalography (EEG), electromyography (EMG) galvanic skin response (GSR), skin temperature (SkT), heart rate variability (HRV), heart rate (HR), respiration sensor (RESP), etc. provide us with some examples of physiological signals that can be measured, allowing researchers to use them for two main use cases: as an input and interaction modality, or as implicit feedback. The latter has shown that physiological signals can reflect the humans' physiological, cognitive or emotional state.

8. Ethical considerations in virtual environments

In this section we only focus on some of the risks and challenges, which are more directly related to the content covered. It should be noted that there are other ethical issues that have not been included, but need to be taken into consideration.

8.1. Information overload

Highly vivid virtual environments release a huge amount of information, whose pervasiveness or complex and confused structure may exceed the user´s cognitive ability to process it. Information overload may lead to stress, impaired judgement and bad decision making. From an ethical perspective the consequences undermine basic pillars, especially the requirement of participant's autonomy/self determination and the non-maleficence principle.

8.2. Intensification of experiences

VR experiences may foster more intense sensations, since they are connected very closely to the subjects' perceptual system allowing a high level of presence. Thus, feelings such as disorientation, fear, anger, or joy, may reach higher degrees of intensity. Such intensifications of experience may strain the subjects' coping abilities and cause undesirable responses by exceeding tolerable limits of psychological burden.

8.3. Reentry into real world

Users who are exposed to a highly immersive VR environment often display some familiarization to the system's content and adapt to its perceptual and physical

parameters. This can lead to some difficulties during and after the transition into the real world. These reentry problems refer to the tasks of leaving the virtual environment, readapting to reality and its physical and social parameters, and differentiating between VR and everyday reality. If reentry problems occur, cognitive, emotional, and behavioural disturbances may arise. Cognitive disturbances may include difficulties in detecting differences between knowledge gained in the virtual environment and knowledge acquired in real life. Behavioural problems can result from the alteration of the individual body schema that is caused by its distorted perception in a VR environment. Again, ethical conflicts related to autonomy/self-determination and non-maleficence principles need to be addressed.

8.4. User privacy

By its nature, user mental privacy is also a key concern in virtual reality. The psychological aspects of immersion pose additional risks to user's privacy because this technology has long reached the mass consumption market diminishing the guarantee of privacy. The high amount of data, of diverse nature, provided by the aforementioned electronic devices in the aim of enhancing the immersive experience, processed through artificial intelligence algorithms, discloses a dynamic and comprehensive profile of an individual. Heller (2020) introduced the term "Biometry psychography" to refer to biological information, linked to a specific mental identity. All this data regarding the inner self are derived from pupil response, eye-tracking, facial scans, galvanic skin response electrocardiography (ECG), electroencephalography (EEG), electromyography (EMG), among others.

8.5. Physical and psychological harm

Physical harm can be caused by the deliberate actions of a third party. This can be possible, for example, through the hacking of devices. It includes cases such as unconscious manipulation of spatial perception, emotion hacking, emotional distress, etc. Such behaviour may result in psychological harm although it is not so feasible to establish the existence of psychological injury in a legal proceeding. Compelling evidence of non-preexisting psychological harm and identifiable neuro-psychological biomarkers (severity of the harm and individual variations that may influence the effects) are required. Moreover, it would be necessary to establish a causal link between the psychological injury and the specific virtual interaction experienced.

9. Conclusions and future work

Building interdisciplinary knowledge that underpins digital and virtual trust demands the development of a common multidimensional conceptual framework and a standardized terminology, based on ethical principles and also on the promotion of human rights. To the steady advance of these tasks, we recommend further understanding of presence phenomena and also thorough research of the real potential and impact of the high-tech human-computer-interfaces (HCI) that increasingly shape our identity throughout our interactions within the digital and virtual sphere. On the one hand, there is a need to deepen the human dimensions underlying the "mediated" or "artificial" experiences created

or modified by technology. On the other hand, advances in the world of neurotechnologies require a continuous interdisciplinary debate to ensure the protection of our mental sphere.

It is still being elucidated whether the legal doctrine and human rights in force can ensure such a defence. In the case of the identity, characterised by its continuous malleability, there is already plenty of research that highlights the modification of underlying neural and mental states through brain modulation, such as Deep Brain Stimulation (DBS). The key concern is that the emerging neurotechnology may have the capacity to modify psychological traits essential for the continuity of a person, or in other words that neurotechnology may be able to induce profound changes in authenticity by altering character and personality, in such a way that it makes alterations to our identity and turns us into another person. In accordance with what was stated above, we also propose to continue this research with the following broad objectives: a compilation and analysis of the existing literature that reports such alterations, as well as to deepen in that which argues that the current brain modulation is not yet capable of inducing those effects in such a radical and comprehensive way. And also delve more deeply into brain technology and their increasing capability to track and influence our mental states. Both actions will allow us to elucidate more precisely which theoretical approach(es) to identity is/are the one(s) of concern in this neurotech-driven world.

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