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Neural Virtual Reality: Bridging Human Consciousness and Digital World

Harsh Patel[1], Atharv Rastogi[2], Dr. Sreerakuvandana[3]

[1,2,3] Assistant Professor Jain-(Deemed-to-be University), Bengaluru.
E-mail: harshpatel21052007@gmail.com[1]

Abstract
Understanding consciousness still challenges the scientific world; it merges the boundaries of neurobiology, artificial intelligence, and philosophy. The rapid growth in organoid technology has led us towards making lab-grown brains. Lab-grown brains are the miniature of human brains, which have the same tissues as those of the human brain. However, they also copy structural and functional features of that of a human brain. This advancement in lab-grown brains has raised profound questions. Firstly, can the synthetically developed neural system hold the power to have its own consciousness? And can they develop on their own? This review paper explores and understands the science behind consciousness and lab-grown brains. It explores everything from neural correlates and information integration theories to synthetically developed brains that can have consciousness. It looks over the recent advances in brain organoid development and the efforts to induce responsiveness into those brains, for example, activity and potentially conscious states in cultured brain matter. The article also considers theoretical frameworks and legal implications of storing or transferring consciousness into such systems, raising questions about identity, rights, and moral responsibilities. The paper aims to highlight the pathways to make consciousness work in these lab-grown brains and reflect on how such advancements could transform science, medicine, and human understanding itself.

Keywords: consciousness, virtual reality, organoids, consciousness transfer, self, embodiment, agency

1. Introduction

Many of the available scientific and philosophical theories of consciousness are disguised in what is known as dualism: the idea that a trigger in the physical brain can give rise to a non-physical feeling. The physical mechanism here is the neural activity, correlates of consciousness. It can be studied, but the offshoot of it, the non-physical, is outside the bounds of science. Dualism has, in this way, influenced modern views of consciousness. Despite this, consciousness remains as one that is understood as the quality of subjective experience. For years and until now, consciousness has remained a central puzzle in philosophy, neuroscience, and cognitive science. All the foundational theories and debates that exist center on defining what exactly consciousness is and if it can exist independently of the body that sustains it. The central point of contention remains thus: the relationship between consciousness and embodiment. Phenomenologists argue that consciousness is tied to embodiment, meaning we experience the world through our lived body that informs our perception, agency, and self. Classical phenomenological approaches argue that consciousness cannot be separated from the embodied existence; all our perceptions, intentions, and self-awareness come from our active engagement with the world [1]. Neuroscientific accounts of the body's regulatory and affective contributions to the various conscious states. The idea of self comes from our continuous interaction between brain, body, and surroundings, thus making embodiment a necessary component of conscious life [2]. On the other hand, contemporary enactive and sensorimotor theories state that cognition is constituted via bodily action rather than internal representation [3]. At its core, consciousness has phenomenal qualities and also has access to functions like reasoning, memory, and decision-making [4].

Neuroscientific and biological theories also quite similarly highlight embodiment as foundational. All the consciousness we earn comes from the interaction between brain structures and the physiological state of an organism. It occurs through a process known as homeostasis and affective regulation [2]. The body, henceforth, is not merely a vessel for the brain but is an important supporter of emotional experience, self, and perceptual unity. Sensorimotor theories additionally state that consciousness is composed via dynamic interactions between organism and environment. Cognition is not something that occurs within neural circuits; it is something that an organism does [3].

With the given conditions, the idea of consciousness passing on to lab-grown brains raises enormous challenges, empirically and philosophically. It questions whether consciousness can be stored in a different form after separating it from its original embodied structure. Also, would consciousness maintain its identity after the transfer of it from one form to another without the bodily history that forms its perceptions, emotions, and memories?

The aim of this paper is to clarify three very closely related philosophical and scientific problems concerning consciousness, embodiment, and identity in technologically mediated contexts. At first, it checks whether transferred consciousness can maintain its own identity when embodied in a lab-grown brain, particularly given that such a brain would lack the developmental trajectory and sensorimotor history that ordinarily shape personal identity and self-experience. Second, it aims to understand if consciousness can be moved from one biological body into a virtual world without changing the flow of the self, which brings upon challenges about whether identity is locked to bodily continuity, neural structure, or experiential patterns. Third, it thinks about if consciousness is located within the virtual environment, then can we sustain it? Will it be a stable and well organized mode of existence, effectively adding up to another reality rather than a temporary simulation? Altogether, these three questions build the central investigation of the review: whether consciousness fundamentally relies on biological embodiment and developmental history or whether it can continue, remain unified, and uphold its identity across radically different physical and virtual substrates.

For oneself to perform actions and interact, agency is engaged in ways not possible in their natural state, identifying that consciousness is not just a conceptual neural process but is deeply embodied, arising from the interaction between neural networks, bodily feedback, and the environment. In easy scientific terms, a person's sense of control and ability to act (agency) appears from the continuous coordination of the brain, the body, and the surrounding world, where decisions, movements, and experiences are formed by constant communication between neural activity, physical sensations, and real-world circumstances.

The view of embodiment represents that consciousness is not only in the brain but also exists in how the body interacts with the world. Embodiment is a process where cognition arises through sensorimotor engagement with the environment [3]. This view underlines that thinking and awareness are modeled by movement, perception, and constant interaction with surroundings, rather than by remote neural activity alone.

While Marr [5] formulated the three levels of analysis computational level, algorithmic level, and implementation level the framework will be much more relevant to understanding conscious experience, with vision occupying the central paradigmatic case of conscious processing. The computational level is the what and why. The central aim of the visual system is to derive a 3D representation of the world from 2D retinal images to allow for navigation and object recognition, without which we would simply be staring at an object or data without knowing its purpose. The visual system does not merely extract features from the sensory input; it generates a stable, meaningful, and action-driven representation of the surroundings in order to build a conscious awareness in the onlooker. The algorithmic level describes the how, or the logic, of the illustrations for the input and output. It tries to answer what might be mathematical steps that need to be taken to change one into the other. (e.g., to detect an edge, the brain might use an algorithm like a Laplacian of a Gaussian, which mathematically calculates where contrast changes most sharply in an image). Essentially, it is at this level where retinal input is transformed into visual experience. This means there is some element of feature detection in this level where visual algorithms become part of the logic through which what we perceive becomes phenomenally experienced. The third level is implementational. It looks at how the portrayal and algorithms can be realized physically in neurons, synapses, and circuits. (As in, how specific neurons in the Primary Visual Cortex (V1) use inhibitory and excitatory connections to fire specifically when an edge of a certain orientation appears.) This means the conscious vision is shaped by embodiment, such as eye movements, our body's orientation, and also the motor movements. Marr's [5] framework is used to help demonstrate how perceptual systems can act as an entry point for understanding consciousness itself. The question of vision in consciousness will help bridge the gap between low-level neural implementation and high-level phenomenal experience.

The computational theory proposed by Hilary Putnam [6] argues that the mind functions like a computer processing symbolic information. Likewise, classical cognitive science [7] views consciousness as the result of internal mental representations and rule-based operations inside the brain. Another traditional view, the global workspace theory introduced by Bernard Baars [8], suggests that consciousness arises when information becomes globally available within the brain's neural workspace. These points of view have emphasized that consciousness is deeply dependent on embodied engagement with how a living system interacts with its environment and is not only a function of isolated neural activity. The idea of embodiment puts forward that cognitive states arise not only from internal computation but also from the whole organism's physical structure and its active exchanges with sensory and motor realities.

2. Embodiment and the Conditions for Conscious Experience

Embodiment has broadly been identified as a primary and important condition for a conscious experience to take place. This forms not only the oneself's point of view of the

world but also how they experience themselves as agents within it. Phenomenological accounts spotlight the fact that consciousness is not just a mental state but is also a lived bodily mode of being. Whereas perception is grounded in a body that can move, sense, and interact with the environment. In the absence of such a bodily engagement, the coherence of the experience gained will be disrupted [1]. This view is also important because it underscores the importance of bodily history, meaning the accumulated sensorimotor patterns that can arise over time and provide the individual with a stable background for a meaningful experience. This essentially means that sensorimotor feedback plays a very important role in this entire process. Consciousness is also seen to arise from dynamic loops of action and perception, where the movement of the organism generates the sensations that the structure might experience [3]. Other scholars, like [2], suggest that core consciousness might emerge from the rigorous and continuous process of mapping internal body states, including that the physical embodiment is inseparable from self-awareness.
Lab-grown organoids are small brain-like structures created in laboratories using stem cells that naturally self-organize into neural tissue. They do not survive for long because they lack blood vessels, which prevents oxygen and nutrients from reaching deeper layers. [9], who first developed brain organoids, reported that growth stops and cells begin to die due to the absence of vascularization. [10] similarly showed that organoids require blood-flow-like support, confirming that limited oxygen and nutrient supply leads to degeneration. To confront this issue, researchers have explored various vascularization techniques. One method adds blood vessel-forming cells called endothelial cells into organoid cultures, so they can start forming vessel-like networks to develop. studies [11] and [12] successfully used this technique and created vascularized organoids. Another approach involves placing organoids into mouse brains, so real blood vessel grow into them which helps them to survive longer. [13] demonstrated this integration. Additionally, [14] and [15] used microfluidic systems that mimic blood flow to significantly extend organoid survival.
Alongside embodiment, agency serves as a defining property in consciousness research. Agency refers to the capacity of a system to intentionally act, make decisions, and respond to feedback. Lab-grown brain organoids present an opportunity to probe the emergence of agency within simplified neural architectures. Contemporary studies support these ideas; Goal-Directed Learning in Mouse Cortical Organoids [16]. demonstrated that organoids can improve performance in a closed-loop reinforcement learning task (here the scientist set up a 3D human brain organoid that is in contact with a computer in a real-time feedback loop to train the organoid to perform directed tasks). Similarly, Organoid Intelligence Models [17] showed that mini-brains adapt to AI-controlled sensory stimulation using MEAs (micro-electrode arrays), displaying feedback-driven learning (by learning, the authors mean that in the emerging field of organoid intelligence, it basically refers to closed-loop systems as mentioned earlier, where brain organoids are the adjustments of nerve activity through selected delivery of a stimulus, such as electrical stimulation or chemical agents). The sentiomics framework ([18], [19], [14]) proposes that organoids may demonstrate adaptive responses when they receive complex electrical stimulation. Here, response is a change in the activity of the organoid or its structure that is linked to an external stimulation such as electrical activity changes or plasticity changes. The aim is to benchmark organoid intelligence by verifying if these synthetic brains can learn from experience, adapt to sensory cues, and perform goal-driven tasks, a process often explored through reinforcement learning patterns. These studies investigate mechanistic aspects of neural function while also indirectly determining whether organoids can exhibit emergent properties akin to the agency observed in conscious organisms.
Lab-grown brains, or cerebral organoids, thus become a thorough platform for these examinations. The capability to mimic structural and functional features of the human brain, positioning them on the frontier of research into consciousness generation, is displayed by these lab-grown brains. If successful in growing the forms of consciousness in vitro, brain organoids could allow scientists to conduct experimental methods previously impossible or unethical in animals and humans. The capability to store or transfer consciousness opens transformative possibilities not only for rehabilitation but also for exploring agency in synthetic systems, where an entity's ability to sense, act, and respond within a virtual environment becomes an actual question.
Building on this, the authors propose that if storing or transferring consciousness is made possible, then it could enable those affected by severe medical conditions to entirely inhabit virtual worlds. In these worlds, patients might smell, touch, feel, and regain a sense of agency and responsibility, living with awareness and engagement absent from their biological reality. If successful, such an investigation would not only advance science but also offer novel therapeutic modalities for severe depression, mental health disorders, and neurorehabilitation, forming new links between embodiment, agency, and artificial neural substrates.

2.1Consciousness

In the final half of the 20th century, neuroscience forced the study of consciousness to its margins. Many scientists even called it unscientific and obscure; it was also said by George Miller [20] that the word itself should be banned. But even in this time of doubt, mesmerizing discoveries were quietly happening. Roger Sperry [21] and Michael Gazzaniga's [22] (early 1960s) split-brain experiments unfolded; two hemispheres of the brain could perceive the world independently, shaking the belief that consciousness must always be merged. The case of patient H.M. uncovered the divide between explicit and implicit memory, reforming how we think about identity and selfhood. Benjamin Libet's [23] evolving work showed that unconscious brain activity begins before we are even aware of deciding to move, raising profound questions about free will and agency.

The study of consciousness had set its place in the scientific mainstream by the 1990s. Evolvements in brain imaging and the influence of thinkers like Francis Crick and Gerald Edelman gave the field new direction. From here onwards, many landmark directions began to form research; Neural Correlates of Consciousness (NCCs), where scientists started depicting the brain activity that accompanies conscious perception, with MRI and other tools offering unprecedented detail. Content-focused studies and experiments such as binocular rivalry and visual masking pointed to the frontal-parietal network, though newer 'no-report' methods raised questions about whether these regions are important for awareness. State-focused studies: Work on sleep, anesthesia, and coma introduced measures of neuronal complexity and integrated information, helping to quantify different levels of awareness:

Theoretical frameworks

The states of mind are conscious if they are broadcast widely over networks in the brain, as suggested by global workspace theory.

The separation between phenomenal and access consciousness provided a clear separation of raw experience from what could be reported or used in thought.

Predictive coding recasts perception as inference, providing new insights into conditions such as psychosis.

Selfhood and embodiment: In a series of studies, researchers began to grapple with questions about identity and our feelings of having a body at all, using VR to understand how the sense of "being me" emerges from ownership.

Consciousness is a vast world where different people have different meanings. But in this review article we will speak about three distinctions.

The first distinction means the level of consciousness (state of being conscious). It refers to the state of consciousness, like switching it on or off for the entire system. "On" means that you are conscious when you are awake and know what you are doing, and "off" refers to not being conscious, like staying in a deep dreamless sleep or a coma. Therefore, these are the only two levels of consciousness, or is better described as global states, of being awake and aware. The contents of consciousness also play a role in this, and by contents, the authors mean what you are conscious of. In simpler terms, if you look at a house, then its shape, size, and color are the contents of your consciousness; if you are feeling pain, then that pain is the content of your consciousness. This consciousness of something is what philosophers call intentionality; the mind is always about or directed towards something. This also means that there is a debate about whether the level (state) and the contents (experience) are completely separate things or if they influence each other. For example, can you have an entirely conscious state with zero content (a truly blank mind)? [24].

The second distinction proclaims that awareness can be broken down into two different parts: perceptual awareness and self-awareness. By the term "perceptual awareness" we understand that it is the subjective experience of the world around you and your body in it. The warm sensation of sun on your skin, how the color red looks, and the sound of music or a bell all of these experiences come under perceptual awareness. Even the experiences in the dream and also the hallucinations come under perceptual awareness. Perceptual awareness is the necessary subjective and experiential character of a sensation, making it a conscious phenomenon. This fundamentally contrasts with mere sensory sensitivity, which is the non-conscious reaction or sensing of environmental stimuli, exemplified by automated systems or organisms lacking a qualitative inner experience. The term self-awareness means that one has its own ability to reflect on its thoughts, feelings, and existence, to distinguish itself from others as a self-individual entity. It ranges from low-level experiences to high-level experiences. Low-level experiences involve feelings such as mood or emotions; these are the states that contribute to the sense of being a self right now. This is the polished experience of being the subject of your own experiences, the "I" that is thinking and feeling. This involves having an inner model of yourself and your mental states, which helps create a sense of personal identity over time. Some theories suggest that the form of metacognition might be a crucial component of all perceptual awareness, not just high-level self-awareness. Theories such as the Higher Order Thought (HOT) Theory. This theory, primarily associated with philosophers like David Rosenthal, suggests that a mental state "M" is conscious if and only if there is a Higher-Order Thought (HOT) that has "M" as its object. The HOT essentially says, "I am now having mental state M." "When you are walking down the street and consciously see a bus, you do not merely have the visual sensation but a higher-order, usually silent or automatic thought, such as "I see the bus." It is this second-order thought that elevates the visual sensation into the realm of conscious perceptual awareness. This comprises a form of self-monitoring, as the mind is monitoring its own activity (seeing) [25]. Two concepts of consciousness. Philosophical Studies [24].

The third distinction separates consciousness on the basis of feel and function. Ned Block [26] made an influential distinction between "feel" and "function." The "feel," also known as phenomenal consciousness, leads us towards the understanding of what it feels like to be in a certain mental state. There is a reference to "qualia," a philosophical term for the felt qualities of certain mental states. Simply put, it is "something it is like" for you to experience a specific taste blend of a cocktail (bitter + sweet) or the internal feeling of anxiety when you present in front of a huge crowd. Complex systems such as ChatGPT-5 or AI Alpha Go do not have phenomenal consciousness; they do function, but there is nothing it feels like to be them or perform those tasks. The "function," also known as access consciousness, refers to the various functions and the abilities that conscious processing enables about what consciousness does. In simpler terms, it is the information accessible for use in reasoning and control, like global availability (the information that can be used by the various parts of the brain), verbal report (talking about the information that we are conscious of), reasoning (using the information in logical thoughts), and executive control (using the information to make informed decisions) [24].

Taken together, there are three important distinctions and contents of consciousness, perceptual and self-awareness, and phenomenal and access consciousness that provide a powerful conceptual framework for the scientific study of mind. By breaking consciousness into aspects such as functions and objects, it allows researchers to approach them more accurately and more precisely localize, measure, and theorize about the neural correlates of subjective experience (qualia); at the same time, it also makes it possible to understand the cognitive mechanism of high-level control and personal identity. This perspective is essential for moving beyond a singular, monolithic view of consciousness toward a nuanced understanding of its multiple, interconnected dimensions in both biological and artificial systems.

2.2 Embodiment

Embodiment is a complex concept. It states that to shape an organism's cognitive process, consciousness, and overall experience, it takes its physical body and interactions with the environment into account. It affirms that the mind is not a disembodied computer or a mere software program running on the brain but is instead constituted by and deeply integrated with the body. The philosopher Edmund Husserl [27] has written in one of his writings [27]; that dealt with how we experience our own bodies, and this became the starting point for the research. As the researchers studied in depth about these themes, they held a search for phenomenological evidence to back or challenge various conclusions about the body experience. There are few forms of evidence, such as General Phenomenological Observations [27]; which details the structure of human consciousness, as experienced by a person, in its first-person point of view; and Phenomenological Thought Experiments which are hypothetical scenarios designed to test the nature of consciousness and experience. The study is the philosophical review that uses established phenomenological literature to find proof for claims about how humans experience and understand their physical bodies, basing its exploration on Husserl's foundational work [28] and [29].

Theories about how we develop (development theories like how newborns learn to walk and speak) are one of the base pillars for studying embodiment. There is a difference of opinion among the researchers about whether focusing on development for understanding embodiment is useful or not. Some researchers say that a developmental perspective even helps to explain the underlying mechanisms of embodiment phenomena. The authors of the text Lux et al. [30] strongly do not agree with the skeptics; they argue that embodiment necessarily involves developmental processes and would significantly benefit from explicitly including a developmental perspective such as Agency Approaches that sheds light on how an individual develops the capacity to act in and control their environment, and Environmental Approaches which details how the body and mind are shaped by changing the physical and social surroundings. The authors believe that because embodiment fundamentally relies on action (agency) and context (environment), the study of how these things change and grow over a lifetime (development) is important, even if many current studies overlook it [30]

Based on the individual's ability to act and interact with the material world, the mind develops and functions, and this is what "Agency Approaches" highlight. Theories like Implicit Acceptance claim that over a lifetime an individual's abilities (like sensory motors and cognition) change (lifespan developmental changes). Gibson's Ecological Theory, which emphasizes that perception is shaped by an individual's opportunities for action in the environment (called affordances). Piaget's Cognitive Development; focuses on how children actively construct their understanding of the world through sequential stages of interaction. The main idea is that the mind (including functions like perception, imagination, language, and judgment) develops directly from individuals' interactions with their physical surroundings. Dissimilarities between people (individual differences) in how they perform high-level tasks like judging art or processing language are understood as outcomes of their unique history of interaction and movement. When the tests are done on the embodiment, then the researchers look for some indicators such as bodily groundedness (to show that a high-level cognitive function, like thinking about running, is truly bodily grounded, researchers look for activation in the brain's sensorimotor cortex) and measurement (activation of internal sensation networks (interoceptive) and movement planning networks (motor processing) during a cognitive task (like reading a verb) is taken as evidence that the function is tied to the body). These approaches do not empirically investigate the specific impact of developmental changes on the actual embodiment phenomena they are studying [30].

Is embodiment possible without a body, or does a mind need a body?, The experiment "Brain-in-a-Vat" is for a specific view of embodiment. It says that only the function as an information conduit is essential and not the body's specific physical form. The basis of this quarrel is that what matters for consciousness is the information entering the brain, not the physical way the information gets there. Imagine a human brain is removed from its body and kept alive in a vat of nutrients. "The lifespan of an acute brain slice is approximately 6–12 hours, limiting potential experimentation time. The researchers have designed a new recovery incubation system capable of extending their lifespan to more than 36 hours. This system controls the temperature of the incubated artificial cerebrospinal fluid (aCSF) while continuously passing the fluid through a UVC filtration system and simultaneously monitoring temperature and pH. "The extension of the lifespan of a brain slice can be achieved with the help of a recovery chamber known as the BRAINCUBATOR that reduces the temperature of the aCSF and keeps the bacterial growth minimal in aCSF using UVC irradiation (UVC irradiation uses short-wavelength ultraviolet light to kill the microorganisms and prevent them from reproducing) [31]. The Conduit: the brain's natural senses (eyes, ears, and skin) are replaced by electronic and chemical input**s** (wires and chemical soup) that feed signals directly into the brain. The Emulation: the argument assumes we could successfully imitate the exact electrochemical activity that the brain normally receives from a body and the external world. The mind in the world would still subjectively experience the world, as the information being provided to it is identical to that which a real body would provide; it would feel and pursue just as if it had a real body. The body is necessary only in its functional capacity as a complex input system for the brain. The mind would need some physical structure to supply it with complex sensory inputs. For this, the physical structure could be any sufficiently complex body; it could be a human body, a robot body, or even a vat of wires as long as it performs the function of supplying the necessary sensory information. To conclude, if we only know the mind by its abstract operations (its functionality) and not by its physical essence, then we cannot say definitively what it is or where it resides. If a mind's location is not known, then we cannot say that the mind requires a specific physical shell, such as a given biological body. If we can't definitively place the mind in our body, then we cannot definitively say that a mind needs a body at all (or at least, not the specific body we have). The mind needs a body; this idea depends on the inaccurate idea that the mind can be totally assessed and minimized to physical terms. As the argument for complete reduction fails (we cannot quantify consciousness fully), we don't possess the power to claim that the mind needs a body that is significant or philosophically important [32].

3. Lab-grown brain:

Organoids derived from hPSCs (human pluripotent stem cells), usually referred to as lab-grown brains, involve 3D cells, combining several separate elements grown in laboratory settings using these versatile embryonic-like cells. These highly advanced and adaptive cells, which have the power to turn into several types of tissues, come directly from the patient's own cells through reprogrammed adult somatic cells known as iPS cells (induced pluripotent stem cells). When placed with utmost care in the controlled environment, these cells self organize, they resemble early brain development. This advantageous capability makes them an important tool that helps to study brain development, diseases, and treatment. They provide insights on traditional techniques that other methods cannot, such as monolayered tissue samples and laboratory animals [33].

Brain organoids accommodate a diverse mix of cells involving neurons, astrocytes, stem/progenitor cells, and various types of glia, which closely resemble the types of cells found during fetal development within the human central nervous system. The unique charm of these entities is that they can organize themselves without the need of significant outside intervention. Cells naturally arrange into brain-like layers similar to those found in early stages of developing brains, although their development remains incomplete; even though they are incomplete they still exhibit basic neural activities including electrical signaling, synapse creation, and basic networking patterns. This helps the researchers to study how brain networks form while still being practical for experiments and easy to study for experiential use [33].

The organoid development follows a developmental pattern similar to that of early brain development. When the stem cells are in the initial stage, they cluster into small spherical structures known as embryoids within a supportive mixture such as Matrigel, which is a gel like substance, after which they are placed on tissue culture plates for further study. Within this nurturing environment, specific indicators regulate cell growth and specialization processes. Over time these cells undergo neurogenisis, giving rise to both specific nerve cells and supportive brain cells. Depending on the various cultural conditions, these organoids can develop into different brain regions resembling the cerebral cortex, hippocampus, and cerebellum, among other structures. Researchers now possess techniques or have developed methods for combining multiple

organoids to form more complex systems known as "assemblyoids." This approach allows scientists to investigate how signals travel across separate parts of the central nervous system and provides a deeper insight into neural activity patterns within the brain [33].
Brain organoids provide several advantages, as they significantly surpass those found in conventional methods. Their three-dimensional design allows realistic interaction similar in ways to a real human body, leading to a more realistic tissues and responses are more accurate. Organoids provide a model that is far more aligned with human physiology, unlike traditional animal models. In addition they allow personalized studies using induced pluripotent stem cells derived from patients' tissues, which reflect unique genomic profiles, thereby helping in understanding hereditary conditions and contagious illnesses through detailed analysis of these cell aggregates [33].

Even so, they have made significant advancements; brain organoids still have several limitations. Out of a few limitations, a major limitation is that many cells remain immature and fail to show characteristics of mature neurological processes typical of adults. Even though important cellular components like vascular endothelial cells and microglial cells are missing, which results in reduced accuracy, compromising biological precision. Limited electrical activity is shown by the organoids, and they also do not develop into fully functional neural systems. Oxygen and nutrients in limited amounts cause internal pressure, resulting in compromised tissues due to insufficient oxygen and nutrients, causing hypoxemia, cell death, and persistent cellular distress. In scientific research and medical studies, these brain organoid technologies are widely used. These models are very useful in modeling diseases such as microcephaly, Angelman syndrome, infections like the Zika virus, and degenerative diseases like early-onset Alzheimer's and Parkinson's disease. They also provide a platform for testing drugs and understanding toxicity in conditions similar to that of the human body. Additionally, researchers are exploring a potential source of neural cells for treating brain disorders through potential therapeutic interventions, opening doors to possible future medical uses. In addition to these efforts, scientists can also understand how specific genes interact with external influences on neural formation through these miniature organs, offering crucial knowledge about embryonic development processes [33].
The advancements in brain organoid research are growing rapidly. The research behind reducing the oxygen limitations and improving tissue health by adding more cell types is under way right now as we speak of it. In addition, developing organoids that resemble brain structure more is under a developmental process. Scientists study how brain organoids interact and form networks by combining different brain regions. The improvements in the organoids will help us to use them for personalized treatments and for better understanding of the human brain [33].
To conclude, brain organoids are a major step forward in neuroscience. Scientists study brain development, test treatments, and understand the diseases more efficiently with the help of these brain organoids. Future improvements in techniques may increase their usefulness despite the current constraints. The task involves restating the statement using different language while maintaining its core message [33].

3.1What major constraints limit brain organoid usefulness?

Brain organoids represent a potential tool in understanding the neurological development of the brain and how they cause neurological disorders, but there are many limitations to their effectiveness. They include limitations to full maturation of cell populations, lack of specific cell types, stress over cell populations induced by tissue culture conditions, unfavorable intercellular connectivity, and issues with achieving reproducible results. As a result, these barriers affect the ability of the organoids to meticulously recap the way the human brain functions [33].
One of the main issues is the inability of the organoid-induced cells to reach proper maturity. Continuation in an infantile phenotype rules out the development of functional intercellular relations, hence interfering with the capability to simulate neurodevelopmental and neurodegenerative disorders precisely. Despite organoids containing primitive neural elements, namely, the stem cells, neurons, and astrocytes, they do not develop to form the necessary types of specialized cells. As an example, cortical organoids are often characterized by the lack of the formation of the appropriate type of neurons or the expression of the key genes that are critical to the normal developmental patterns. Such an incomplete development makes them an incomplete source of disease research.
Further, organoids do not recap aging, which is of particular importance since most cerebral pathologies, such as Alzheimer's and Parkinson's diseases, among others, occur later in life. In their ability to model age-related neuropathology, they are crippled without senescence. Lack of vascular systems denies them of the necessary system of nutrients and oxygen that is involved in the metabolic process as well as makes them less viable during prolonged periods. Together with the absence of immune elements, microglia in particular, which are indispensable in investigating neuroinflammatory processes, organoids are further limited. This is worsened by the fact that oligodendrocytes are also concomitantly scarce, so research on myelination, a process underlying axonal conductance, is not feasible [33].
The organoid integrity is significantly affected by the cultivation environment. Constant stress also distorts the expression levels of genes as compared to those seen in a real brain, hence compromising the fidelity of

their development. This environmental stress affects growth and reduces the anatomical similarity of the human cerebral tissue. Moreover, the intrinsic 3-dimensional form does not allow diffusion of oxygen and nutrients to the central areas, leading to cellular apoptosis. These extrinsic cues, including vascular perfusion or cerebrospinal fluid stasis, are lacking, and this further makes it impossible to recapitulate gene-environment interaction during neurodevelopment [33].

In the end, the neural synaptic connections and networks of organoids are generally weaker and less developed than those of the real human neural tissues, which makes it challenging to understand how circuits function and process information. When it comes to reproducibility, it is a problem and is a challenge that is still there [33].

3.2Can a lab-grown brain gain consciousness?

One of the most debated and controversial topics in modern neuroscience and philosophical discussions is whether Human Brain Organoids (HBOs) should ever develop consciousness. While many scientists and researchers still remain doubtful and skeptical, some believe the possibility should not be completely dismissed. This debate depicts that current organoid models still have limits, but even with advancing technology the idea is biologically possible while still being quite uncertain [34].

Critics highlight that Human Brain Organoids (HBOs) are immature and not developed enough to support attention or awareness. Current organoids are extremely small, frequently no larger than a fingernail, and contain only tens of millions of neurons, far fewer then 86 billion found in adult human brain. They also lack the complex structure of a mature cerebral cortex, missing key regions such as the cerebellum, hippocampus, and bilateral structure seen in mature brains. In the absence of blood vessel formation, their growth is further constrained, and as a result, they are not able to help cells like microglia, which are important for sustaining development and regulation of neural activity. Most importantly, organoids are completely cut off, lacking sensory input, motor output, or any meaningful environmental interaction. This disembodiment is regularly described as a fatal flaw, preventing any meaningful emergence of cognizance. From this attitude, the proof suggests that HBOs cannot gain the structural or purposeful sophistication required for proper conscious experience [34].

Proponents, although they project this skepticism as premature, argue that HBOs are derived from human mind cells and comply with the same intrinsic genetic applications that, in vivo, supply upward thrust to focus. The very purpose for organoid research is their ability to duplicate the shape and features of native organs, which includes the brain. Given that their development is self-organized and directed with the aid of inner biological cues, proponents contend that cognizance should be considered an inherent possibility. The emergence of a few diplomas of aware-like hobby, even at notably early stages, would now not be sudden given that organoid version of human mind improvement in miniature [34].

People who support this idea also highlight recent technological progress and newly observed brain related signals as proof that the obstacles preventing progress are rapidly disappearing. It has been observed that Human Brain Organoids already produce brainwave patterns like gamma, alpha and delta along with the connection patterns resembling those observed in EEG recordings of premature infants. These results suggest that the early signs of brain activity linked to awareness may already be developing. Furthermore, advancements in new technologies such as microfluidic systems, three dimensional structural support, and methods to add blood vessels and immune cells are expected to largely increase organoid size, complexity, and hyper realism in the near future [34].

Arguments made by supporters of this view are strengthened by the philosophical theories related to attention and awareness. Integrated information theory suggests that consciousness comes from how information is combined or integrated within a system and it does not necessarily need an external outside source. This perspective is often set side by side with dreaming and phantom limb sensations, where people even without real physical sensory signals still have conscious experiences. Additionally it also suggests a very minimum threshold for basic consciousness, implying that even simple systems might as well display some limited forms of awareness. Another theory is The Global Workspace concept which hints that consciousness arises when data propagates widely through interconnected nodes or brain networks. The natural coordination of activity already been observed in HBOs fits this theory and indicates that they may possess an inborn potential to organize activity in a similar way like conscious systems [34].

4. Merleau-Ponty

According to Merleau-Ponty's [1] phenomenological perspective, the mind and body are not independent entities but operate together as an inseparable, unified system. He believes that human intelligence arises through the continuous interaction between the physical body and mental processes, where our movements and responses naturally express our underlying intention. To explain this idea, he uses habits as an example, showing how repeated actions reveal how the body adjusts itself based on what we want or intend. Through habits, the body develops what can be described as "embodied intelligence"; it means that consciousness is not just in the brain but also in how we react or interact with the environment [35].

Diving deeper in this embodied perspective, Gallagher [36] and Zahavi [37] say that the body is simply not a container for experience, but it actually creates it. From their point of view, the lived body enables us to think, perceive, and be self-aware. From a cognitive science point of view, this view challenges the traditional notion of the mind as something located merely inside the brain. Instead, it proposes that neural processes are significantly shaped by the body's physical structure and by how it interacts with the environment. For example, the simple fact that humans stand and navigate the world on two legs influences how we perceive space, interpret actions, maintain balance, and ultimately form our cognitive understanding of reality. This backs the idea that cognition is fundamentally embodied, arising through the constant interplay between biological form, sensory experience, and meaningful action. [35].

4.1The Idea Of Self

Since the Scientific Revolution, many philosophers have shaped the idea of the self. During this era, philosophers like Descartes [38], Locke [39], and Hume [40] developed early perspectives on identity. Descartes [38] said that the mind and body are not one; Locke [39] suggested that personal identity comes from the continuity of consciousness, and Hume [40] introduced the bundle theory, proposing that the self is only a collection of ever-changing perceptions. As philosophical ideas evolved, scholars expanded the concept of the self by exploring how experience, awareness, and embodiment contribute to our sense of identity. Philosophers have described different types of self: the mental self, empirical self, phenomenal self, and minimal self, and recent advancements in brain science have allowed researchers to connect these ideas with modern scientific findings. Researchers have begun linking philosophical ideas of the self with advances in neuroscience, especially through discoveries like the cortical midline structures that support self-related processing, helping develop a more neurophilosophical understanding of the self, as highlighted by Northoff and Chan [41], [42].

The Self is known by acknowledging one's own actions; a person who identifies his/her actions as the doer (e.g., I did that action), and it links the individual to their responsibility and agency. William James [43], states that self is complex and has multiple parts (also known as "soul" sometimes); these are generally categorized as "I" (knower) and "Me" (known) and further classified into three components.

1) Material Soul (self): This includes all the materials that are owned by the person, such as wealth and clothes, and also includes the body. (e.g., feeling joy when you acquire a good thing or feeling depressed for the loss of your favorite thing).

2) Social Soul (self): This is defined by the person's various roles or social groups (family, friends, profession); the reputation of a person plays a vital role in this (e.g., the way we act differently in front of our family versus friends).

3) Spiritual soul (self): It is the highest part ever known; this is where one finds one's true self (e.g., the core nature, qualities, and conscience of the individual).

The founder of analytical psychology, Carl Jung [44], understands self as a deep, organizing principle. Jung [44] holds the self responsible for providing organization and stability, and he also views it as a semi-symbol. Jung believed that self is understood through an innate human effort to achieve mental perfection and integrate all aspects of personality (both conscious and unconscious), known as "individuation."

The authors discuss the difference between self-awareness and self-consciousness, as both of them have different sets of meanings. Self-awareness is understood as a simple realization that one exists as an individual entity, separate from others (a neutral state). Self-consciousness, on the other hand, implies that a person is preoccupied with oneself and how he/she appears to others. It is a heightened, often uncomfortable, sense of self-awareness. It occurs when we feel we are being observed by others, known informally as feeling like everyone is looking at us. Some individuals are naturally more introspective or more prone to being self-conscious than others. Therefore, while self-awareness is the simple knowledge of one's existence, self-consciousness is the feeling of being highly visible and judged by others [45].

5. Potential outcome driven by the research

The aim of our paper is to explore the possibilities of consciousness transfer into a virtual environment. The concept of building a virtual world that is closely linked to understanding consciousness itself. As the article explains, consciousness arises when neural processes, sensory images, bodily states, and environmental interactions all work together [46], [47]. Philosophical approaches such as phenomenology and embodiment theory suggest that consciousness does not only arise from the brain, but it comes from the interaction of brain, environment, and body [3], [1], [2]. This has acted as a foundation for various scholars' visions, such as [49], a system where neurological signals, sensory integration, and artificial environments converge to generate a virtual reality that can produce experiences, emotions, and sensations with the same richness as biological life.

Modern brain organoids offer a unique scientific platform that could support aspects of the authors' vision by providing biological structures capable of processing information in human-like ways. As described earlier, organoids naturally self-organize into neural architectures containing neurons, glia, synapses, and basic electrical signaling patterns reminiscent of early developing brains [9], [33]. Recent work demonstrates that these mini-brains can learn, adapt, and respond to sensory stimulation in closed-loop systems, suggesting early forms of goal-directed behavior and responsiveness [48], [49], [50]. We believe these biological systems could eventually serve as intermediaries capable of storing, interpreting, or transmitting patterns of consciousness-related activity, offering a biological basis for linking human cognition with the immersive digital realm.

The concept concedes that there is no evidence yet that human consciousness can be transferred, but it's still a valid question within various scientific fields. The article draws on various theories such as Kurzweil's [51] Mind Uploading Theory (2005), Bostrom's [52] Digital Minds hypothesis (2003), and Koene's Whole Brain Emulation roadmap (2012) to explain how consciousness can be sustained in artificial systems. Other theories such as Integrated Information Theory (IIT) and Global Workspace Theory (GWT) state that consciousness emerges from information integration and global neural broadcasting, mechanisms that could theoretically be reproduced in synthetic systems (Wood et al., 2025). By being involved with these theories, our vision presents consciousness transfer as a serious hypothesis rooted in ongoing philosophical and neuroscientific discussions.

A major and most important point of this idea lies in its use of embodiment and agency research to explain how a virtual world could be experienced as real and meaningful. Consciousness is deeply embodied: perception, thought, selfhood, and decision-making arise through continuous interaction between the organism and its environment [36], [37], [27], [30]. VR technologies that replicate sensorimotor feedback (touch, movement, balance, spatial navigation, and interoceptive signals) could therefore reproduce the very conditions under which consciousness normally arises. A sufficiently advanced VR system could become an alternative body for consciousness, similar to the philosophical "brain-in-a-vat" model, where accurate sensory emulation enables a mind to experience a world as real as physical existence [32].

This paper helps one understand the outcome of a vision such as this. By uniting neural activity into a fully immersive virtual environment, individuals with severe medical limitations, such as those who cannot walk, speak, or move, could regain agency, experience, interaction, and emotional connection that their biological body no longer permits. As discussed in this article, if we succeed in transferring thoughts or awareness into a controlled virtual space, patients might be able to perform actions or experience environments that they couldn't perform in this physical reality [53], [54]. Such an approach would shift virtual reality from being purely environment focused to a therapeutic tool, which could help people live better lives even with physical constraints, which could give them opportunities for rehabilitation, emotional support, and a more meaningful sense of existence.

5.1Towards a Future of Immersive, Conscious VR Worlds

By integrating organoid intelligence, embodiment, and neurotechnology, this idea could promise a future where virtual environments become part of human existence. Even though the transfer of consciousness is still far away from possible, the growing advancement in organoids, neural interfaces, AI-based sensory systems, and virtual embodiment backs the statement that we are moving towards very realistic and immersive virtual worlds [55], [14], [34]. Although the concept is in its early stages, continued research and inventions in this field will lead to more immersive virtual worlds capable of supporting deeply authentic experiences while including a sense of identity and control.

6. Conclusion

The understanding of consciousness, embodiment, and emerging neural technologies uncovers a rapidly evolving field where philosophical ideas meet modern science advancements. Theories such as phenomenology and embodied cognition to neural correlates and global workspace models showcase that consciousness is not a fixed property of the brain but something that changes constantly based on the body and its interaction with the surroundings. On the other hand, advancements in brain organoid research illustrate that lab-grown neural systems can organize themselves, form functional connections, and display adaptive behavior [33]. Although these systems are far from reaching full consciousness, their ability to develop and respond suggests that the boundary between biological and artificial systems is beginning to change.

In this vast and expanding field of science, concepts like building immersive virtual realities that closely resemble real-life experiences are becoming increasingly important. If we understand how consciousness is dependent on bodily interaction and how the brain sends signals to the body, then by replicating these, we can give virtual worlds another reality with the help of growing technology in this field. However, we stand empty on the proofs of how consciousness can be transferred, but the theories in philosophy and neuroscience suggest that it remains a valid and open area of inquiry rather than discarding these concepts entirely. Even if completing this idea is far away, it still holds far-reaching consequences. It could open new therapeutic pathways for individuals whose biological bodies limit their movement, agency, or participation in the world, letting them inhabit virtual spaces with a sense of presence, control, and emotional engagement.

Altogether, the studies in this review article indicate that the convergence of organoid intelligence, neurotechnology, embodied cognition, and virtual immersion may gradually reshape our understanding of what consciousness can be and where it might reside. Even though there are many scientific, ethical, and technological obstacles that still exist, the current studies point towards a future in which biological and digital realities increasingly overlap. By studying consciousness coming from a complex system (not only as a philosophy), biological or synthetic, we move closer to envisioning virtual worlds that are not merely simulations but meaningful extensions of human experience.

Author Contributions
H conceptualized the idea. H, A and S collectively wrote the manuscript and analysed the data used

Competing interests
The authors declare no competing interests

Data Availability
All data generated or analysed during this study are included in the published article

Ethical Approval
The current study does not involve human participants or their data

Informed Consent
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Author Contributions
The authors contributed equally to this work

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