psychology international

MDPI

Review

Exploring the Therapeutic Potential of Virtual Reality: A Review on the Simulation of Psychedelic Effects for Treating Psychological Disorders

Mirko Casu [1,2,*], Chiara Farrauto [2,*], Giorgia Farruggio [2,*], Salvatore Bellissima [3], Sebastiano Battiato [1] and Pasquale Caponnetto [2,4]

[1] Department of Mathematics and Computer Science, University of Catania, 95121 Catania, Italy
[2] Department of Educational Sciences, Section of Psychology, University of Catania, 95121 Catania, Italy
[3] Azienda Sanitaria Provinciale di Catania, 95100 Catania, Italy
[4] Center of Excellence for the Acceleration of Harm Reduction (CoEHAR), University of Catania, 95121 Catania, Italy
* Correspondence: mirko.casu@phd.unict.it (M.C.); chiara.farra20@gmail.com (C.F.); g.farruggio@studium.unict.it (G.F.)

Abstract: Psychedelic therapy is increasingly acknowledged as a transformative approach to mental health care, much like how Virtual Reality (VR) technology has emerged as a potent tool in the realm of mental health. Hence, there is potential for integrating the benefits derived from both. This review aims to assess the current state of the art concerning the utilization of VR and psychedelic simulations for treating psychological disorders. The findings clarify the potential of an emerging treatment: the simulation of psychedelic states through Virtual Reality. This treatment has been shown to improve cognitive flexibility and executive functions and, as a result, could be used to prevent conditions such as mild cognitive impairment and dementia. Furthermore, this treatment facilitates the activation of other constructs in the subject, such as creativity, joy, pleasure, and relaxation, which can act as mediators in the treatment of various psychopathological disorders. This review attempts to broaden knowledge regarding the simulation of psychedelic states through Virtual Reality, exposing the results in a clinical setting and highlighting the need for further studies.

Keywords: psychedelic therapy; virtual reality; mental health; psychedelics; cyberpsychology; psychedelic simulation; cyber health psychology

Citation: Casu, M.; Farrauto, C.; Farruggio, G.; Bellissima, S.; Battiato, S.; Caponnetto, P. Exploring the Therapeutic Potential of Virtual Reality: A Review on the Simulation of Psychedelic Effects for Treating Psychological Disorders. *Psychol. Int.* **2024**, *6*, 603–617. https://doi.org/10.3390/psycholint6020036

Academic Editor: Marianna Mazza

Received: 29 March 2024
Revised: 29 April 2024
Accepted: 5 May 2024
Published: 8 May 2024

1. Introduction

Psychedelic therapy, utilizing substances like psilocybin, lysergic acid diethylamide (LSD), and 3,4-Methylenedioxymethamphetamine (MDMA, commonly known as ecstasy), has shown promising results in treating various mental health conditions [1,2]. However, administering these substances comes with logistical and legal limitations. Researchers are exploring alternative methods to capture the therapeutic benefits of psychedelics without the pharmacological intervention. One such method involves simulating the psychological effects of psychedelics [3]. These simulations often involve sensory manipulations (visual, auditory) and virtual environments designed to evoke experiences similar to those observed during psychedelic therapy sessions [4].

1.1. Virtual Reality in Mental Health Treatment

Virtual Reality (VR) technology has emerged as a powerful tool in the field of mental health. VR allows for the creation of immersive and controlled environments that can be used for exposure therapy for conditions like anxiety disorders and phobias [5].

Additionally, VR can be used for training purposes, such as social skills development for individuals with autism spectrum disorder [5–7]. The ability of VR to create realistic and controllable environments makes it a promising platform for delivering psychedelic simulations.

Virtual Reality technology has indeed made significant strides in the realm of mental health. The immersive and controlled environments that VR can create have proven to be particularly beneficial for exposure therapy, especially for conditions such as anxiety disorders and phobias [8–11]. These environments can be tailored to induce provoking situations, allowing individuals to learn from and gradually confront their fears in a controlled and safe setting [9]. In addition to exposure therapy, VR has also been utilized for training purposes. For instance, it has been used to aid in the development of social skills for individuals with autism spectrum disorder [12,13]. The ability to simulate real-life social scenarios in a controlled environment allows these individuals to practice and enhance their social skills in a safe and non-threatening manner [14,15].

Additionally, VR has also been employed in the treatment of schizophrenia [5]. Concerning the negative symptoms of schizophrenia, avatar therapy has proven effective due to the interaction it facilitates. Regarding positive symptoms, VR-based cognitive rehabilitation programs can be utilized, particularly for managing auditory verbal hallucinations [16].

1.2. Employing Psychedelic Therapy in the Treatment of Psychological Disorders

Psychedelic therapy is increasingly being recognized as a transformative approach to mental health care [17]. A growing body of research suggests that psychedelic substances, such as psilocybin, have significant therapeutic potential for a range of mental health disorders, including depression, anxiety, post-traumatic stress disorder (PTSD), eating disorders, and various forms of addiction [17–19].

In support of this, a Randomized Controlled Trial (RCT) involved patients with Major Depressive Disorder. Those in the control group received a single dose of psilocybin accompanied by psychological support. The results demonstrated a significant reduction in depressive symptoms and associated functional disability [20].

These substances belong to a broader class of compounds known as psychoplastogens, which are known to promote structural and functional neural plasticity in key brain circuits [18]. This ability to induce lasting changes in the brain sets psychedelics apart from traditional treatments, and it is this property that underlies their sustained therapeutic effects following a single administration [18].

One of the unique aspects of psychedelic therapy is the heightened state of awareness and feelings of connectedness that these substances can induce [17,21]. These experiences can help patients engage with emotions and internal states that are often avoided or suppressed [17,22]. In fact, feelings such as self-compassion, forgiveness, understanding, and self-acceptance can surface during psychedelic experiences, providing powerful antidotes to negative emotions that are often resistant to traditional therapies [17]. Moreover, the sense of boundlessness or ego dissolution that can occur during a psychedelic experience can be interpreted as a mystical or spiritual event [17,23]. This can help individuals find meaning, perspective, and a sense of connection with others and the world [17,21–23].

The treatment often involves acute administration, in one or a few sessions, where the therapeutic setting allows for the integration of insights that occur during the session. Furthermore, the effects, including adverse ones, enable the maintenance of a favorable safety profile. The responses are clinically significant, with sustained results for weeks or months, although not all patients respond and, therefore, may not be suitable for this therapy [17].

However, it is important to note that psychedelics can also induce challenging experiences and should be used with caution and under the guidance of trained therapists [17,24,25]. The context in which these substances are used, including the psychotherapy that accompanies their administration, is a critical component of their therapeutic effect [17].

Despite the challenges associated with psychedelic-based medicines, their potential as broadly efficacious neurotherapeutics is undeniable [26,27]. The clinical use of psychedelics and other psychoplastogenic compounds represents a paradigm shift in neuropsychiatry,

moving beyond simply treating disease symptoms and towards rectifying the underlying pathophysiology of disorders like depression [18,28].

1.3. Aim of This Review

This review aims to examine the current state of the art regarding the use of VR and psychedelic simulations for the treatment of psychological disorders. The study will explore the efficacy of these innovative treatments over both short and long terms, comparing their benefits to traditional therapeutic methods. It will also critically examine the advantages and disadvantages of VR-based psychedelic simulations, both as standalone interventions and when integrated with existing therapies. This comprehensive review seeks to provide a deeper understanding of the current state of the art in this emerging field, offering insights into the future possibilities of VR in mental health treatment.

2. Methodology

The research was conducted using Primo VE Discovery as a tool to aggregate results from various databases, including PubMed, PubMed Central, Health & Medical Collection, ScienceDirect Freedom Collection, and Wiley Online Library. Additionally, it was conducted through the review of bibliographic references of relevant articles.

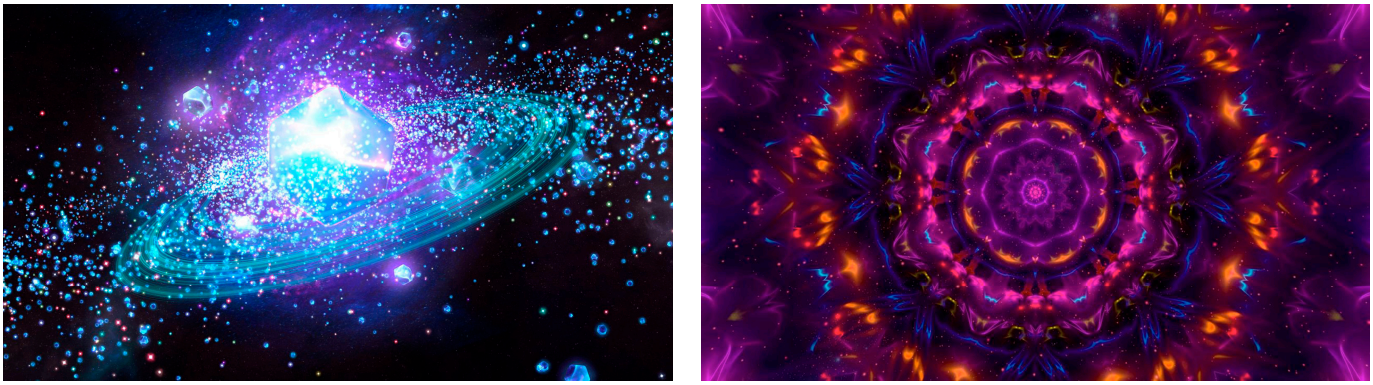
The selection of articles included in this review followed a targeted screening process aimed at identifying relevant studies consistent with the research objective. Keywords such as "simulation of psychedelic effects", "psychedelic therapy", and "Virtual Reality" were utilized, along with predefined inclusion criteria, to select pertinent articles. The choice of keywords is aligned with the main topic of this review: analyzing the emerging field of VR-based psychedelic simulation in the realm of mental health. Included studies were assessed based on their relevance and their contribution to understanding the topic addressed in this review.

3. Commercial Applications/Software Available Featuring Psychedelic Scenarios for Virtual Reality

3.1. Liminal VR

Liminal is an application developed by Damiano Moratti, an entrepreneur, and Nick Busietta, a lawyer specializing in computer science and psychology graduate, in collaboration with various programmers and designers, along with a research team composed of neuroscientists and psychologists. The platform offers short and engaging Virtual Reality experiences to enable individuals to choose how to feel and behave. Its objective is to modify the subject's mood; indeed, at the beginning and end of each experience, users are prompted to select their current mood state to assess changes. All experiences have a duration ranging from 3 to 10 min, divided into 6 categories of experiences to choose from: Calm, Energy, Awe, Pain Relief, Focus, and Sleep, which are continually updated and expanded upon. The Calm section mainly contains experiences characterized by calming elements, aimed at soothing and relaxing the subject (Figure 1a). The Energy section primarily features interactive mini games to increase the subject's energy levels. The Awe section aims to awe the subject with intense experiences, such as the launch of a space shuttle or a journey inside a toy. The Pain Relief section predominantly includes hypnotic induction experiences guided by background voice or relaxation exercises aimed at relaxing the subject and providing pain relief. The Focus section comprises relaxation exercises, meditation, hypnotic induction, and some games to enhance the subject's concentration. Finally, most experiences in the Sleep section are designed to be performed with closed eyes, precisely to help the subject fall asleep.

Liminal's team of neuroscientists and psychologists has leveraged the unique advantages of Virtual Reality to provide immediate positive changes in emotional and cognitive states, creating a convenient, easy-to-implement, fun, and engaging tool to improve people's well-being. The reference website for the app can be found at the following URL: https://liminalvr.com/ (accessed on 29 March 2024).



(**a**) (**b**)

Figure 1. Depictions of Virtual Reality Applications: (**a**) A visual capture from the Liminal VR application; (**b**) An illustrative screenshot from the Cosmic Flow application.

3.2. Cosmic Flow

Cosmic Flow is an application developed by Dmitri Medvedev, which represents a relaxing visual experience, a kaleidoscopic meditation, with both practical and recreational purposes of psychedelic Virtual Reality (Figure 1b). The developer aims to instill the sensation of a relaxed mind, more capable of understanding and expressing itself, so that the sensation continues even after closing the application. The reference website for the app is as follows: https://vedev.cc/cosmicflow/ (accessed on 29 March 2024).

A study was carried out to explore the user experience of the Cosmic Flow application, involving six participants [29]. Cosmic Flow was selected for this study due to its passive Virtual Reality nature, requiring no user interaction beyond head rotation. This allowed participants to concentrate solely on the audiovisual stimuli provided by Cosmic Flow. The aim was to gain insights into the users' experiences, thereby contributing to the psychedelic Virtual Reality research field and aiding designers in optimally crafting Virtual Reality scenarios.

Participants were immersed in the experience for 15 min using a head-mounted display (HMD), with audio delivered through noise-canceling stereo headphones. Following the experience, an unstructured interview was initiated by the experimenter with open-ended questions. The results yielded intriguing insights.

Among the positive effects reported by participants were: self-reflection, a desire to dance in the virtual space, and relaxation induced by sound. Conversely, among the main criticisms, we find: a feeling of being trapped in the virtual space, discomfort due to excessive motifs and colors, and boredom due to lack of interactions.

Considerations were also made regarding participants' previous experiences and personal backgrounds, suggesting that notions formed from previous experiences strongly influence the quality of VR experiences. In this regard, some users, recounting previous experiences with psilocybin and alcohol, stated that it would be interesting to try Cosmic Flow with a psychoactive substance. Furthermore, some users experienced an altered sense of time, stating that the time spent in VR passed more quickly than they thought. Finally, regarding mood changes, two participants reported feeling less stressed and thoughtful after the VR experience; however, one participant claimed to feel more tired following the experience.

Overall, this study provides an initial starting point for understanding the experiences of psychedelic Virtual Reality users. The themes resulting from the study can serve as inspirational and generative elements for creating these experiences and providing contextual knowledge to make sense of psychedelic Virtual Reality.

3.3. Additional Virtual Reality Applications Incorporating Psychedelic Experiences

Other psychedelic VR apps include TRIPP, Lucid Trips, Psyrreal, DeepStates, Ayahuasca, and SoundSelf.

TRIPP is an application that provides access to over 100 fully immersive meditation experiences that allow users to easily let go of external distractions and frenetic thoughts while escaping into breathtaking landscapes and virtual worlds. There are several sections within the application: Focus, which includes games to maintain high concentration; Calm, featuring various forms of meditation in majestic landscapes; Sleep, to help users slip into deep and restorative sleep; and Ascend, with scenarios aimed at encouraging users to stay faithful to their meditation routine. The application also contains guided breathing exercises, which utilize new artificial intelligence-based technology to control body movements; personalized experiences using photos and personal elements; and multi-day challenges to develop awareness and well-being. The reference website for the app is as follows: https://www.tripp.com/ (accessed on 29 March 2024).

Lucid Trips is a VR exploration game that transports users into surreal and dreamlike worlds full of psychedelic images and abstract environments. Players can navigate through engaging landscapes, interact with strange creatures, and discover hidden secrets in a visually stunning and astonishing experience.

Psyrreal is a PC application that simulates the phenomenological components of psychedelic and mystical experiences, as well as deep meditative states. The reference website for the app is: https://psyrreal.mozellosite.com/#belowfold (accessed on 29 March 2024). A feasibility study [30] involving 13 participants with symptoms of depression was conducted to investigate the potential therapeutic effects of this application.

The results suggest that the use of VR experiences in a therapeutic context may be beneficial in treating depressive symptoms, with participants showing a significant reduction in depressive symptoms 2 weeks after the experiments.

DeepStates is an application developed by Mark Zimmermann, designed to relax in captivating natural environments with dense atmospheres. The app also offers the option to activate the DeepGuide function, which uses breathing, buzzing, spatial sounds, and dragging with modulation of brightness, volume, and tactile feedback to immerse the user further. After selecting one of the available environments, users can explore using teleportation or smooth locomotion. In each environment, users can control some parameters, such as the time of day, using the trackpad.

Ayahuasca Kosmik Journey, developed by the Atlas V team, is a Virtual Reality film in which participants are immersed in visions triggered by a dose of Ayahuasca, a powerful indigenous brew. Each virtual journey is a unique experience, as different perspectives and viewpoints will reveal new ways of seeing and understanding. Motion sensors in the headphones allow the system to track movements and posture and react accordingly; in fact, the visions will intensify or diminish depending on movement and viewing angles. The viewer experiences through the eyes of director Jan Kounen, who has been traveling deep into the heart of the Amazon for over 20 years to experience Ayahuasca with local tribes. Remaining true to the original Shipibo tradition of consuming this plant as a transformative and meditative ritual, the psychedelic journey is guided by a South American indigenous shaman. Below is the reference link for the application: https://atlasv.io/projects/ayahuasca/ (accessed on 29 March 2024).

Finally, SoundSelf is a participatory sound bath application that activates all senses and has been measured to produce transpersonal states of consciousness after 15 min of immersion. The app allows the introduction of "surrender practice" and "reactivation of psychedelic memory" into the therapist's toolkit. SoundSelf represents a new class of digital experience, called "technodelic". Comparing it with classic psychedelic therapy, the psychological release intensity of SoundSelf is far greater than a guided meditation or breathing session but less intense than a long journey using classic psychedelic substances like psilocybin. The SoundSelf development team consists of industry experts in immersive technology, health care, and psychedelic medicine. The reference website for the app is as follows: https://soundself.com/ (accessed on 29 March 2024). A summary of the main information of the apps can be found in Table 1.

Table 1. This table shows a summary of the main information of the apps included in the review.

App	Year	Section(s)	Team of Psychologists	Validated by Scientific Studies
Liminal	2022	6	Yes	No
Cosmic Flow	2020	1	No	Yes [29]
TRIPP	2022	4	No	Yes [31–40]
Lucid Trips	2017	1	No	No
Psyrreal	2023	1	No	Yes [30]
DeepStates	2021	1	No	No
Ayahuasca	2020	1	No	No
SoundSelf	2020	1	Yes	Yes [41]

3.4. Organizations behind the Development of Psychedelic Virtual Reality Applications

Virtual Reality comprises experiential and technological factors capable of bringing about a radical shift within the subject's experience of self. Since the inception of Virtual Reality, results and effects associated with clinical applications of Virtual Reality aimed at treating psychological, cognitive, motor, or functional disorders or symptoms across a broad range of health conditions have been demonstrated [42]. For this reason, psychologists and psychiatrists often contribute to the development of certain VR applications that are subsequently utilized for therapeutic purposes.

For instance, the Liminal team includes a research group composed of professionals from the psychological sector. Specifically, the team comprises a cognitive and behavioral neuroscientist with extensive experience in research within the fields of cognitive neuroscience, educational technology, developmental psychology, and the potential uses and benefits of VR applications; a research analyst specializing in emotions and cognition, adept at leveraging the intersection between Virtual Reality and psychology to enhance emotional and cognitive well-being, with the goal of unlocking the full potential of Virtual Reality in the realms of mental health, education, training, and entertainment; and a clinical psychologist and researcher in the field of mental health and Virtual Reality.

Instead, SoundSelf has an advisory board comprised of proven leaders in the fields of mental health and digital therapy. The team consists of a Professor of Neurology, Physiology, and Psychiatry, founder of Akili Interactive and Neuroscape; a clinical psychologist with extensive leadership experience in clinical trials in Virtual Reality; and an Assistant Professor at the School of Medicine and Public Health and the Transdisciplinary Center for Research on Psychoactive Substances at the University of Wisconsin.

4. 360° Virtual Reality Videos Simulating Psychedelic States and Substance Effects

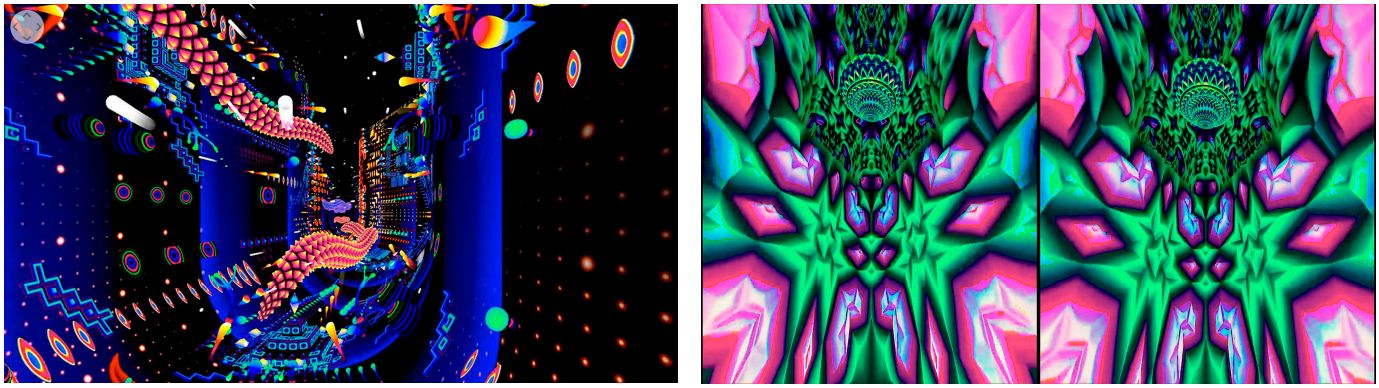
4.1. Analysis of Psychedelic Simulations in Virtual Reality on YouTube

In recent years, various videos capable of simulating psychedelic states or the ingestion of psychoactive substances with psychedelic effects have been created. Among the many videos of this kind, some have been selected as examples (see Figure 2).

In general, these videos showcase a series of visual stimuli characterized by vibrant and dynamic patterns, often mutable in form, color, and intensity, frequently accompanied by synchronized music or sound effects [43]. These visual stimuli can induce perceptual distortions, such as altered color perception, enhanced motion perception, and a sense of visual complexity. The patterns may exhibit fractal-like structures, with intricate geometric shapes transforming seamlessly.

The content often induces a sense of immersion and altered states of consciousness, akin to those experienced during psychedelic experiences induced by substances such as LSD or psilocybin. Furthermore, these visual and auditory effects, comparable to the effects of psychoactive substances, can be understood as stimulating specific neural pathways involved in sensory processing, perception, and cognition. The rapid and dynamic changes in auditory and visual stimuli may engage areas of the brain associated with pattern recognition, attention, and emotional processing, potentially leading to altered

states of consciousness characterized by heightened sensory awareness and a sense of interconnectedness [44].



(**a**) (**b**)

Figure 2. Depictions of Virtual Reality YouTube Videos: (**a**) A digital art video crafted by TAS Visuals, an Austria-based artist, accompanied by the musical composition of David Starfire (https://www.youtube.com/watch?v=7ohzYII08eQ (accessed on 29 March 2024)); (**b**) "LSD TRIP 3D 8K MUSIC 2020 VR BOX SBS", a Virtual Reality experience created by govr8k VVR (https://www.youtube.com/watch?v=-vx14M9_ZBU (accessed on 29 March 2024)).

4.2. Virtual Reality Videos Featuring Fractal Imagery

Fractals, also known as "nature's fingerprints", are geometric figures that contain repeating, similar patterns. An increasing number of studies have investigated the therapeutic effects of fractal patterns on the human brain. Using functional Magnetic Resonance Imaging (fMRI) and other measurements of physiological stress, some researchers have found that observing fractals can reduce stress levels by 60% [45], suggesting that they activate certain brain areas responsible for stress regulation. Additionally, when viewing fractals, physiological resonance occurs within the eye, increasing alpha wave frequency in frontal brain areas, promoting relaxation and a sense of well-being [46]. The study by Hagerhall et al. [47] further demonstrates, through electroencephalogram (EEG) measurements, that during the visualization of fractal images, the frontal lobes produce characteristic alpha brainwaves indicative of a relaxed and wakeful state.

Alpha waves also have effects on attention. Attention Restoration Theory (ART) suggests that restorative environments offer a sense of "being away" from daily life and concerns, measure up to constitute a larger set (i.e., elements in the environment are connected to each other), and are compatible with the viewer's preferences [48]. To elaborate on this theory, further studies propose measures to understand the mechanism underlying these preferences, such as studies on specific environments like "water surrounded by vegetation" or "sunlit forest" [49]. However, these descriptions are challenging to quantify, making it complex to replicate results consistently. A more quantifiable parameter proposed by Purcell, Peron, and Berto [50] is that of fractals. Since the visual complexity of a fractal pattern can be quantified with the fractal dimension D, this could be a reproducible parameter across scenarios. This parameter is a value between 1 and 2, describing how the pattern repeats at different magnifications, which, combined, will result in the final fractal shape [51]. Various studies investigating visual preference and fractal images [46,52,53] have discovered that the optimal fractal dimension for these images is a value close to 1.3, 1.5, or 1.7. These patterns can also influence psychophysiological measurements: preliminary data for skin conductance measurements have indicated that mid-level fractal dimensions have the greatest positive effect on stress, although additional visual features varied among stimuli [54].

Therefore, it is possible to assert that videos including fractals, although not simulating psychedelic states, are capable of inducing relaxation and states of well-being in viewers. Below are some examples of these videos:

- [Example Video 1] (https://www.youtube.com/watch?v=MaTQYFG_pb8 (accessed on 29 March 2024))
- [Example Video 2] (https://www.youtube.com/watch?v=0N5pCR5gvNA (accessed on 29 March 2024)) (Figure 3)
- [Example Video 3] (https://www.youtube.com/watch?v=mQbSJFMmfA8 (accessed on 29 March 2024))
- [Example Video 4] (https://www.youtube.com/watch?v=KSSDoyzyWaA (accessed on 29 March 2024))

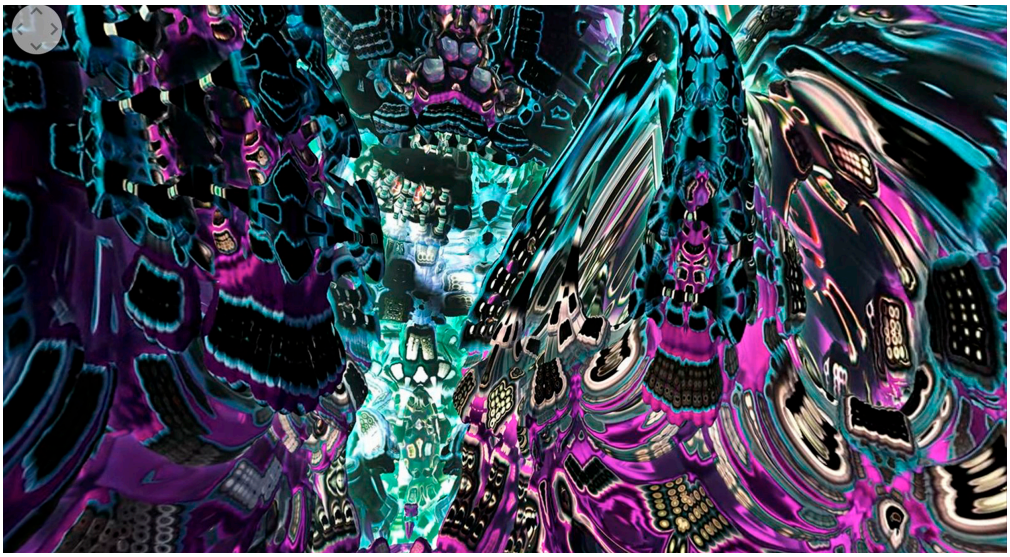


Figure 3. "[8K]—The ULTIMATE 360° VR Fractal Experience—Glitch Between Hidden Worlds!—Trippy Everything", a Virtual Reality experience created by Trippy Everything.

5. Leveraging Virtual Reality for Simulating Psychedelic States in the Management of Psychological and Psychopathological Conditions

The scientific community has demonstrated the ability of Virtual Reality to simulate the effects of psychedelic substances [55,56], and in light of this, this new line of research is aimed at understanding the best applications in clinical and therapeutic fields. There is still limited evidence, and it is certainly a largely unexplored field that presupposes new studies to come. However, there are some interesting findings.

The simulation of psychedelic experiences has been shown to improve Cognitive Flexibility [57,58]. In fact, Cognitive Flexibility is promoted through exposure to diverse experiences and unusual and unexpected events [59], and alterations in simulated perceptions allow for the reorganization of cognitive aspects that inhibit automatic choices and facilitate uncommon decision-making strategies [57].

Specifically, it has been hypothesized that Cognitive Flexibility and creative thinking, both linked to the prefrontal cortex, could also influence other cognitive functions, such as executive functions [60]. Moreover, the frontal lobes, which are implicated in creative and flexible thinking, exhibit the highest levels of atrophy in aging. Indeed, with increasing age, various cognitive flexibility-related capacities such as problem-solving, flexible thinking, and memory retrieval decrease [61,62]. Therefore, considering that VR cognitive training has already demonstrated its efficacy in treating Mild Cognitive Impairment (MCI) [63], a transitional stage between normal aging and dementia, it can be hypothesized that VR-simulated hallucinations could be used during the aging process to maintain cognitive function and prevent pathologies such as MCI and dementia [58].

Furthermore, the simulation of hallucinations via VR has also been used to promote creativity and positive emotions in general [64,65]. Participants who tested this technique often reported experiencing positive emotions, alterations in sense of self, feelings of joy/pleasure, feelings of calmness/peace, relaxation, freedom, comfortableness, and embodied interactions [29,30]; but also negative emotions, tiredness/sleepiness, lack of novel insights, feelings of being trapped, and boredom [29,30].

For example, a feasibility study involved 13 participants with depressive symptoms to investigate the potential therapeutic effect of simulating psychedelic states via VR [30]. The experiments spanned two consecutive days. On the first day, a diagnostic and preparatory session assessed depressive symptoms through psychodiagnostic tests; subsequently, participants received instructions on VR equipment usage and engaged in a 15 min demonstrative VR experience comprising a 10 min guided meditation followed by an additional 5 min in a non-interactive living room environment. On the second day, participants underwent the same guided meditation in VR as the previous day, followed directly by a 45 min VR experience. Post-treatment tests were administered, and a semi-structured interview was conducted. The results indicate that VR experiences in a therapeutic context may benefit in treating depressive symptoms, as participants exhibited a significant reduction in depressive symptoms two weeks post-experiment. In interviews, participants reported experiencing positive sensations such as positive emotions, alterations in sense of self, feelings of joy/pleasure, feelings of calmness/peace, relaxation, freedom, comfortableness, and embodied interactions. These same sensations were replicated in participants in a user experience study [29], reaffirming the potential of VR applications simulating psychedelic states to promote sensations that may serve as mediators in the treatment of various psychopathological disorders.

One could hypothesize a role even in the treatment of Substance Use Disorders and Obsessive–Compulsive Disorder, but research in this field is still in its infancy [66].

Thus, the elements that have emerged so far allow us to affirm that the simulation of psychedelic states via VR promotes constructs and emotions that play a role in the landscape of psychopathological disorders, demonstrating its potential in a clinical setting.

6. Boundaries and Possibilities of Virtual Reality in Psychedelic Therapy

The simulation of psychedelic effects through VR, as an emerging treatment, demonstrates both possibilities and boundaries in therapeutic settings.

6.1. Possibilities

The ability for individuals to immerse themselves in a virtual environment allows them to surpass the physical limitations of a real environment, increasing the sense of safety and confidence [66,67]. Additionally, this helps to reduce distractions from external stimuli, promoting focused attention on the objective [67]. These elements also contribute to the high rates of therapeutic alliance observed in VR therapies. The ability to evoke awe enables users to better focus on thoughts and emotions, promoting well-being [66,67]. Lastly, altering perspectives and thus rigid thought patterns increases compliance and willingness to change [66].

Referring to the mentioned and most utilized apps, a study demonstrates [31] that through the TRIPP app, users have developed numerous positive effects: their meditation capacity has deepened, heart rate has decreased, and their sleep quality has significantly improved [31].

Moreover, a study involving the use of the SoundSelf app [41] has shown that subjects experienced significant reductions in feelings of tension, depression, and confusion, along with significant increases in happiness and calmness. Additionally, participants in this study reported that the app provides a naturally engaging interaction model [41].

6.2. Boundaries

A key element must be patient-tailored treatment. Indeed, the high number of lights, colors, and shapes that can be displayed may be overly stimulating [67], leading to overstimulation that causes discomfort and, in severe cases, seizures [68]. For the same reason, attention must also be paid to trigger stimuli that may be elicited by the headset and may evoke a traumatic experience [67]. Finally, one of the highest limits of using VR in therapeutic settings is certainly CyberSickness [69]. This can cause nausea, dizziness, stomachaches, and other somatic symptoms that contribute to generating significant discomfort in the user. Indeed, it is important to evaluate this component, for which the Simulator Sickness Questionnaire (SSQ) is available [70,71]. For example, approximately 5% of users who participated in a study involving the use of the TRIPP app for meditative purposes exhibited symptoms associated with Cyber Sickness [31].

Referring to the mentioned and most utilized apps, a study on the Cosmic Flow app [29] highlights issues related to VR ergonomics: the weight of the HMD was deemed uncomfortable, the presence of cables caused annoyance to users, and the high screen resolution made the boundaries too evident, thus hindering complete immersion [29].

7. Discussion

Psychedelic therapy, involving substances such as psilocybin, LSD, and MDMA, has demonstrated promising outcomes in the treatment of various mental health conditions [1,2]. However, significant limitations arise from legal and ethical constraints both in administration and experimentation. Therefore, there has been consideration given to the possibility of simulating the psychological effects of psychedelics [3]. Within the scientific realm, Virtual Reality emerges as the prime candidate for fulfilling this role. VR allows for sensory manipulations (visual, auditory) and virtual environments designed to elicit experiences akin to those encountered during psychedelic therapy sessions [4].

This review aims to assess the current situation regarding the utilization of VR and psychedelic simulations for addressing psychological disorders. Increasingly, within the scientific domain, treatments promoting the combination of therapies involving psychedelics and Virtual Reality are emerging [66]. Indeed, both psychedelics and Virtual Reality share effectiveness in treating disorders such as depression, anxiety, PTSD, and Eating Disorders [72,73]. Specifically, some authors highlight the potential of such combined treatment to alleviate the considerable psychological distress caused by phobias and Body Dysmorphic Disorder [74].

Psychedelic substances, when used therapeutically, promise mental health benefits [75]. Facilitating empathy, Self-Transcendent Experiences (STEs), and Altered States of Consciousness (ASC) [55] are among the benefits shared by psychedelics and Virtual Reality. Indeed, they can serve as mediators for treating certain psychopathological conditions. Thus, Virtual Reality can be utilized to simulate the effects of psychedelic substances without the actual administration of the latter [55,56]. Numerous studies support this notion, with many authors demonstrating the close parallelism that exists.

For instance, a new visualization algorithm called Deep Dream has been developed, which employs machine learning through deep neural networks developed for machine vision [55]. This algorithm has been combined with Virtual Reality to enhance the qualities of the immersive experience. The fusion of these two techniques forms the "Hallucination Machine", which has been shown to simulate the hallucinatory aspects induced by psychedelic substances and allows the study of the phenomenological aspects of biologically realistic visual hallucinations [55,76]. Another example is the Isness-distributed (Isness-D), a multi-person cloud-mounted VR experience [56]. Results demonstrate that this tool elicits intersubjective STEs, attenuating egoic identity and promoting a sense of connection, through the design of phenomenological experiences similar to those obtained from psychedelic substances [56,77]. Furthermore, these new techniques enable the enhancement of constructs such as Cognitive Flexibility [57,58] and creativity [64,65]. Additionally, they promote positive emotions, a sense of relaxation, and altered perceptions [29,30].

In general, the simulation of psychedelic states via VR stimulates constructs in individuals that may serve as mediators in the treatment of various psychopathological disorders. A summary of the analyzed articles can be found in Supplementary Materials Table S1.

One limitation of this review is the scarcity of scientific evidence, as it remains a relatively unexplored area. Nonetheless, it undoubtedly underscores the high potential of this treatment, as it circumvents legal and ethical limitations on psychedelic use while harnessing the benefits derived from these substances. VR, therefore, emerges as a highly versatile tool that, owing to its specific characteristics, will play an increasingly significant role in supporting treatments in clinical settings.

Modern VR software offers an ideal space to address issues, not only through dialogue with healthcare professionals but also through virtual environments with well-controlled sensory stimuli [5]. Moreover, this emerging field in clinical practice is not only regarded as a standalone tool but also as an adjunctive tool to enhance therapeutic outcomes, integrating it alongside psychotherapy and counseling [73], thus making VR a broad-spectrum tool in the treatment of mental disorders. For example, a new frontier, still under development, could be the development and creation of avatars representing significant individuals for the patient, to be employed in exploratory therapy aiming to promote self-awareness and the management of past traumatic events [78].

The topic addressed in this review undoubtedly presupposes future studies to come. Indeed, despite its potential, there are few or no studies comparing this technique with other established and effective ones or utilizing a significant sample of participants. Future research could attempt to overcome these challenges by providing reliable and generalizable results; indeed, an absence of RCTs has been noted in this research field.

8. Conclusions

This review examined an emerging field in the clinical field: the simulation of psychedelic states via VR. Both psychedelic therapy and Virtual Reality have proven their effectiveness in treating various psychopathological disorders. Integrating these two approaches to treatment allows us to eliminate the ethical and legal limits linked to the use of psychedelic substances, thanks to commercial apps and software. In fact, Liminal, Cosmic Flow, TRIPP, and the other apps included in the review are all Virtual Reality applications that allow you to simulate psychedelic scenarios and which, therefore, lend themselves to being used in the therapeutic field. The research still requires further studies, but the potential of a treatment of this type for the promotion of psychological well-being is already evident, always taking into consideration the need to create a personalized treatment. Therefore, this comprehensive review aims to provide a deeper understanding of the current state of the art in this emerging field, offering insights into one of the future possibilities of VR in mental health treatment. Indeed, it is noteworthy how an innovative tool like VR can express numerous possibilities in the field of mental health, ranging from assessment to training. In the future, VR could be used to enhance the assessment of mental disorders by refining existing tools and integrating them with Artificial Intelligence (AI) software. Additionally, virtual environments could be utilized to provide more interactive and engaging educational offerings, combining theoretical knowledge with practical experiences. It would also be appropriate to develop guidelines for the use of VR, tailored to each possible application for every known mental disorder.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/psycholint6020036/s1, Table S1: Data extraction.

Author Contributions: Conceptualization, M.C., C.F., G.F. and S.B. (Salvatore Bellissima); methodology, M.C., C.F. and G.F.; validation, M.C., S.B. (Sebastiano Battiato) and P.C.; formal analysis, S.B. (Sebastiano Battiato); investigation, M.C., C.F. and G.F.; data curation, C.F. and G.F.; writing—original draft preparation, M.C., C.F. and G.F.; writing—review and editing, M.C., C.F. and G.F.; visualization, M.C.; supervision, S.B. (Salvatore Bellissima), S.B. (Sebastiano Battiato) and P.C.; project administration, P.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Cavarra, M.; Falzone, A.; Ramaekers, J.G.; Kuypers, K.P.C.; Mento, C. Psychedelic-Assisted Psychotherapy—A Systematic Review of Associated Psychological Interventions. *Front. Psychol.* **2022**, *13*, 887255. [CrossRef] [PubMed]
2. Trope, A.; Anderson, B.T.; Hooker, A.R.; Glick, G.; Stauffer, C.; Woolley, J.D. Psychedelic-Assisted Group Therapy: A Systematic Review. *J. Psychoact. Drugs* **2019**, *51*, 174–188. [CrossRef] [PubMed]
3. Aqil, M.; Roseman, L. More than Meets the Eye: The Role of Sensory Dimensions in Psychedelic Brain Dynamics, Experience, and Therapeutics. *Neuropharmacology* **2023**, *223*, 109300. [CrossRef] [PubMed]
4. James, E.; Robertshaw, T.L.; Hoskins, M.; Sessa, B. Psilocybin Occasioned Mystical-Type Experiences. *Hum. Psychopharmacol.* **2020**, *35*, e2742. [CrossRef]
5. Park, M.J.; Kim, D.J.; Lee, U.; Na, E.J.; Jeon, H.J. A Literature Overview of Virtual Reality (VR) in Treatment of Psychiatric Disorders: Recent Advances and Limitations. *Front. Psychiatry* **2019**, *10*, 505. [CrossRef]
6. Frolli, A.; Savarese, G.; Di Carmine, F.; Bosco, A.; Saviano, E.; Rega, A.; Carotenuto, M.; Ricci, M.C. Children on the Autism Spectrum and the Use of Virtual Reality for Supporting Social Skills. *Children* **2022**, *9*, 181. [CrossRef]
7. Abu-Amara, F.; Bensefia, A.; Mohammad, H.; Tamimi, H. Robot and Virtual Reality-Based Intervention in Autism: A Comprehensive Review. *Int. J. Inf. Tecnol.* **2021**, *13*, 1879–1891. [CrossRef]
8. Carl, E.; Stein, A.T.; Levihn-Coon, A.; Pogue, J.R.; Rothbaum, B.; Emmelkamp, P.; Asmundson, G.J.G.; Carlbring, P.; Powers, M.B. Virtual Reality Exposure Therapy for Anxiety and Related Disorders: A Meta-Analysis of Randomized Controlled Trials. *J. Anxiety Disord.* **2019**, *61*, 27–36. [CrossRef]
9. Freitas, J.R.S.; Velosa, V.H.S.; Abreu, L.T.N.; Jardim, R.L.; Santos, J.A.V.; Peres, B.; Campos, P.F. Virtual Reality Exposure Treatment in Phobias: A Systematic Review. *Psychiatr. Q.* **2021**, *92*, 1685–1710. [CrossRef]
10. Boeldt, D.; McMahon, E.; McFaul, M.; Greenleaf, W. Using Virtual Reality Exposure Therapy to Enhance Treatment of Anxiety Disorders: Identifying Areas of Clinical Adoption and Potential Obstacles. *Front. Psychiatry* **2019**, *10*, 773. [CrossRef]
11. Botella, C.; Fernández-Álvarez, J.; Guillén, V.; García-Palacios, A.; Baños, R. Recent Progress in Virtual Reality Exposure Therapy for Phobias: A Systematic Review. *Curr. Psychiatry Rep.* **2017**, *19*, 42. [CrossRef] [PubMed]
12. Dechsling, A.; Orm, S.; Kalandadze, T.; Sütterlin, S.; Øien, R.A.; Shic, F.; Nordahl-Hansen, A. Virtual and Augmented Reality in Social Skills Interventions for Individuals with Autism Spectrum Disorder: A Scoping Review. *J. Autism. Dev. Disord.* **2022**, *52*, 4692–4707. [CrossRef]
13. Pandey, V.; Vaughn, L. The Potential of Virtual Reality in Social Skills Training for Autism: Bridging the Gap Between Research and Adoption of Virtual Reality in Occupational Therapy Practice. *Open J. Occup. Ther.* **2021**, *9*, 1–12. [CrossRef]
14. Kourtesis, P.; Kouklari, E.-C.; Roussos, P.; Mantas, V.; Papanikolaou, K.; Skaloumbakas, C.; Pehlivanidis, A. Virtual Reality Training of Social Skills in Autism Spectrum Disorder: An Examination of Acceptability, Usability, User Experience, Social Skills, and Executive Functions. *Behav. Sci.* **2023**, *13*, 336. [CrossRef] [PubMed]
15. Ke, F.; Moon, J.; Sokolikj, Z. Virtual Reality-Based Social Skills Training for Children with Autism Spectrum Disorder. *J. Spec. Educ. Technol.* **2022**, *37*, 49–62. [CrossRef]
16. Du Sert, O.P.; Potvin, S.; Lipp, O.; Dellazizzo, L.; Laurelli, M.; Breton, R.; Lalonde, P.; Phraxayavong, K.; O'Connor, K.; Pelletier, J.-F.; et al. Virtual Reality Therapy for Refractory Auditory Verbal Hallucinations in Schizophrenia: A Pilot Clinical Trial. *Schizophr. Res.* **2018**, *197*, 176–181. [CrossRef]
17. Yehuda, R.; Lehrner, A. Psychedelic Therapy—A New Paradigm of Care for Mental Health. *JAMA* **2023**, *330*, 813–814. [CrossRef]
18. Vargas, M.V.; Meyer, R.; Avanes, A.A.; Rus, M.; Olson, D.E. Psychedelics and Other Psychoplastogens for Treating Mental Illness. *Front. Psychiatry* **2021**, *12*, 727117. [CrossRef]
19. Vorobyeva, N.; Kozlova, A.A. Three Naturally-Occurring Psychedelics and Their Significance in the Treatment of Mental Health Disorders. *Front. Pharmacol.* **2022**, *13*, 927984. [CrossRef]
20. Raison, C.L.; Sanacora, G.; Woolley, J.; Heinzerling, K.; Dunlop, B.W.; Brown, R.T.; Kakar, R.; Hassman, M.; Trivedi, R.P.; Robison, R.; et al. Single-Dose Psilocybin Treatment for Major Depressive Disorder: A Randomized Clinical Trial. *JAMA* **2023**, *330*, 843. [CrossRef]
21. Orłowski, P.; Ruban, A.; Szczypiński, J.; Hobot, J.; Bielecki, M.; Bola, M. Naturalistic Use of Psychedelics Is Related to Emotional Reactivity and Self-Consciousness: The Mediating Role of Ego-Dissolution and Mystical Experiences. *J. Psychopharmacol.* **2022**, *36*, 987–1000. [CrossRef]
22. Kaelen, M.; Barrett, F.S.; Roseman, L.; Lorenz, R.; Family, N.; Bolstridge, M.; Curran, H.V.; Feilding, A.; Nutt, D.J.; Carhart-Harris, R.L. LSD Enhances the Emotional Response to Music. *Psychopharmacology* **2015**, *232*, 3607–3614. [CrossRef] [PubMed]

23. Stoliker, D.; Egan, G.F.; Friston, K.; Razi, A. Neural Mechanisms and Psychology of Psychedelic Ego Dissolution. *Pharmacol. Rev.* **2022**, *74*, 876–917. [CrossRef]
24. Wießner, I.; Falchi, M.; Palhano-Fontes, F.; Feilding, A.; Ribeiro, S.; Tófoli, L.F. LSD, Madness and Healing: Mystical Experiences as Possible Link between Psychosis Model and Therapy Model. *Psychol. Med.* **2023**, *53*, 1151–1165. [CrossRef]
25. Timmermann, C.; Watts, R.; Dupuis, D. Towards Psychedelic Apprenticeship: Developing a Gentle Touch for the Mediation and Validation of Psychedelic-Induced Insights and Revelations. *Transcult. Psychiatry* **2022**, *59*, 691–704. [CrossRef] [PubMed]
26. Peacock, B. A-118 Psychedelic Interventions for Neuropsychological Conditions. *Arch. Clin. Neuropsychol.* **2022**, *37*, 1270. [CrossRef]
27. Romeo, B.; Karila, L.; Martelli, C.; Benyamina, A. Efficacy of Psychedelic Treatments on Depressive Symptoms: A Meta-Analysis. *J. Psychopharmacol.* **2020**, *34*, 1079–1085. [CrossRef] [PubMed]
28. Rucker, J.J.H.; Iliff, J.; Nutt, D.J. Psychiatry & the Psychedelic Drugs. Past, Present & Future. *Neuropharmacology* **2018**, *142*, 200–218. [CrossRef]
29. Jung, S.; Buruk, O.O.; Hamari, J. Psychedelic VR Experience: An Exploratory Study on Cosmic Flow. In Proceedings of the 25th International Academic Mindtrek Conference, Tampere, Finland, 16–18 November 2022; ACM: Tampere, Finland, 2022; pp. 23–30.
30. Kaup, K.K.; Vasser, M.; Tulver, K.; Munk, M.; Pikamäe, J.; Aru, J. Psychedelic Replications in Virtual Reality and Their Potential as a Therapeutic Instrument: An Open-Label Feasibility Study. *Front. Psychiatry* **2023**, *14*, 1088896. [CrossRef]
31. VIVE Team Enhance Meditation and Sleep Quality with VR Meditation. Available online: https://blog.vive.com/us/enhance-meditation-and-sleep-quality-with-vr-meditation/ (accessed on 28 March 2024).
32. Kim, Y.; Boo, C.; Suh, A. Harnessing Technology for Mental Well-Being: An EEG Comparison of VR and Mobile-Based Mindfulness Meditation Interventions. In Proceedings of the 57th Hawaii International Conference on System Sciences, Hawaii, HI, USA, 3 January 2024.
33. Poetar, C.-R.; Bradley, N.; Voinescu, A. Immersive Virtual Reality or Computerised Mindfulness Meditation for Improving Mood? Preliminary Efficacy from a Pilot Randomised Trial. *Front. Psychol.* **2023**, *14*, 1157469. [CrossRef]
34. Thompson, A. A Holistic Approach to Employee Functioning: Assessing the Impact of a Virtual-Reality Mindfulness Intervention at Work. Ph.D. Thesis, Florida International University, Miami, FL, USA, 2021. [CrossRef]
35. Schrempf, M.C.; Petzold, J.; Petersen, M.A.; Arndt, T.T.; Schiele, S.; Vachon, H.; Vlasenko, D.; Wolf, S.; Anthuber, M.; Müller, G.; et al. A Randomised Pilot Trial of Virtual Reality-Based Relaxation for Enhancement of Perioperative Well-Being, Mood and Quality of Life. *Sci. Rep.* **2022**, *12*, 12067. [CrossRef] [PubMed]
36. Argüero-Fonseca, A.; Marchioro, D.; Lopez Beltran, I. Effect of a Mindfulness Intervention with Virtual Reality in Adolescents on Attention and Working Memory. *J. Posit. Psychol. Wellbeing* **2022**, *6*, 1810–1830.
37. Seiler, A.; Schettle, M.; Amann, M.; Gaertner, S.; Wicki, S.; Christ, S.M.; Theile, G.; Feuz, M.; Hertler, C.; Blum, D. Virtual Reality Therapy in Palliative Care: A Case Series. *J. Palliat. Care* **2022**, 08258597221086767. [CrossRef] [PubMed]
38. Franzoni, V.; Di Marco, N.; Biondi, G.; Milani, A. Virtual Reality for Enhancement of Emotional Mindset in the First Lockdown of United Kingdom for the COVID-19 Pandemics. In Proceedings of the Brain Informatics; Mahmud, M., Kaiser, M.S., Vassanelli, S., Dai, Q., Zhong, N., Eds.; Springer International Publishing: Cham, Switzerland, 2021; pp. 189–198.
39. Piao, S.; Joo, J. A Behavioral Strategy to Nudge Young Adults to Adopt In-Person Counseling: Gamification. *Behav. Sci.* **2022**, *12*, 40. [CrossRef] [PubMed]
40. Franzoni, V.; Di Marco, N.; Biondi, G.; Milani, A. How Virtual Reality Influenced Emotional Well-Being Worldwide During the COVID-19 Pandemics. In Proceedings of the IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology, Melbourne, Australia, 14–17 December 2021; Association for Computing Machinery: New York, NY, USA, 2021; pp. 268–272.
41. Tarrant, J.; Einhorn, F. Pilot Study: SoundSelf vs. Sham (Guided Meditation VR) Using Quantitative EEG, Altered States, and Mood. Available online: https://soundself.com/research (accessed on 28 March 2024).
42. Harvey, P.D.; Depp, C.A.; Rizzo, A.A.; Strauss, G.P.; Spelber, D.; Carpenter, L.L.; Kalin, N.H.; Krystal, J.H.; McDonald, W.M.; Nemeroff, C.B.; et al. Technology and Mental Health: State of the Art for Assessment and Treatment. *AJP* **2022**, *179*, 897–914. [CrossRef]
43. Kaelen, M.; Giribaldi, B.; Raine, J.; Evans, L.; Timmerman, C.; Rodriguez, N.; Roseman, L.; Feilding, A.; Nutt, D.; Carhart-Harris, R. The Hidden Therapist: Evidence for a Central Role of Music Inpsychedelic Therapy. *Psychopharmacology* **2018**, *235*, 505–519. [CrossRef] [PubMed]
44. Tagliazucchi, E.; Roseman, L.; Kaelen, M.; Orban, C.; Muthukumaraswamy, S.D.; Murphy, K.; Laufs, H.; Leech, R.; McGonigle, J.; Crossley, N.; et al. Increased Global Functional Connectivity Correlates with LSD-Induced Ego Dissolution. *Curr. Biol.* **2016**, *26*, 1043–1050. [CrossRef]
45. Hagerhall, C.M.; Laike, T.; Küller, M.; Marcheschi, E.; Boydston, C.; Taylor, R.P. Human Physiological Benefits of Viewing Nature: EEG Responses to Exact and Statistical Fractal Patterns. *Nonlinear Dyn. Psychol. Life Sci.* **2015**, *19*, 1–12.
46. Taylor, R.P.; Spehar, B.; Van Donkelaar, P.; Hagerhall, C.M. Perceptual and Physiological Responses to Jackson Pollock's Fractals. *Front. Hum. Neurosci.* **2011**, *5*, 60. [CrossRef]
47. Hagerhall, C.M.; Laike, T.; Taylor, R.P.; Küller, M.; Küller, R.; Martin, T.P. Investigations of Human EEG Response to Viewing Fractal Patterns. *Perception* **2008**, *37*, 1488–1494. [CrossRef] [PubMed]

48. van Almkerk, M.; Huisman, G. Virtual Nature Environments Based on Fractal Geometry for Optimizing Restorative Effects. In Proceedings of the 32nd Human Computer Interaction Conference 2018, Belfast, UK, 2–6 July 2018; BCS Learning & Development: Belfast, UK, 2018.
49. Gimblett, H.R.; Itami, R.M.; Fitzgibbon, J.E. Mystery in an Information Processing Model of Landscape Preference. *Landsc. J.* **1985**, *4*, 87–95. [CrossRef]
50. Purcell, T.; Peron, E.; Berto, R. Why Do Preferences Differ between Scene Types? *Environ. Behav.* **2001**, *33*, 93–106. [CrossRef]
51. Mandelbrot, B.B. *The Fractal Geometry of Nature*; Henry Holt and Company: New York, NY, USA, 1983; ISBN 978-0-7167-1186-5.
52. Aks, D.J.; Sprott, J.C. Quantifying Aesthetic Preference for Chaotic Patterns. *Empir. Stud. Arts* **1996**, *14*, 1–16. [CrossRef]
53. Hagerhall, C.M.; Purcell, T.; Taylor, R. Fractal Dimension of Landscape Silhouette Outlines as a Predictor of Landscape Preference. *J. Environ. Psychol.* **2004**, *24*, 247–255. [CrossRef]
54. Taylor, R.P.; Spehar, B.; Wise, J.A.; Clifford, C.W.G.; Newell, B.R.; Hagerhall, C.M.; Purcell, T.; Martin, T.P. Perceptual and Physiological Responses to the Visual Complexity of Fractal Patterns. *Nonlinear Dyn. Psychol. Life Sci.* **2005**, *9*, 89–114.
55. Suzuki, K.; Roseboom, W.; Schwartzman, D.J.; Seth, A.K. A Deep-Dream Virtual Reality Platform for Studying Altered Perceptual Phenomenology. *Sci. Rep.* **2017**, *7*, 15982. [CrossRef] [PubMed]
56. Glowacki, D.R.; Williams, R.R.; Wonnacott, M.D.; Maynard, O.M.; Freire, R.; Pike, J.E.; Chatziapostolou, M. Group VR Experiences Can Produce Ego Attenuation and Connectedness Comparable to Psychedelics. *Sci. Rep.* **2022**, *12*, 8995. [CrossRef]
57. Rastelli, C.; Greco, A.; Kenett, Y.N.; Finocchiaro, C.; De Pisapia, N. Simulated Visual Hallucinations in Virtual Reality Enhance Cognitive Flexibility. *Sci. Rep.* **2022**, *12*, 4027. [CrossRef]
58. Magni, G.; Tuena, C.; Riva, G. A Predictive Coding Approach to Psychedelic Virtual-Induced Hallucinations and Creative Cognition in Aging. *Front. Hum. Neurosci.* **2023**, *17*, 1219052. [CrossRef]
59. Gelfo, F. Does Experience Enhance Cognitive Flexibility? An Overview of the Evidence Provided by the Environmental Enrichment Studies. *Front. Behav. Neurosci.* **2019**, *13*, 150. [CrossRef] [PubMed]
60. Miller, E.K.; Cohen, J.D. An Integrative Theory of Prefrontal Cortex Function. *Annu. Rev. Neurosci.* **2001**, *24*, 167–202. [CrossRef] [PubMed]
61. De Souza, L.C.; Volle, E.; Bertoux, M.; Czernecki, V.; Funkiewiez, A.; Allali, G.; Leroy, B.; Sarazin, M.; Habert, M.-O.; Dubois, B.; et al. Poor Creativity in Frontotemporal Dementia: A Window into the Neural Bases of the Creative Mind. *Neuropsychologia* **2010**, *48*, 3733–3742. [CrossRef] [PubMed]
62. Price, K.A.; Tinker, A.M. Creativity in Later Life. *Maturitas* **2014**, *78*, 281–286. [CrossRef] [PubMed]
63. Zhong, D.; Chen, L.; Feng, Y.; Song, R.; Huang, L.; Liu, J.; Zhang, L. Effects of Virtual Reality Cognitive Training in Individuals with Mild Cognitive Impairment: A Systematic Review and Meta-analysis. *Int. J. Geriatr. Psychiatry* **2021**, *36*, 1829–1847. [CrossRef] [PubMed]
64. Wiederhold, B.; Riva, G. *Annual Review of CyberTherapy and Telemedicine 2020*; Interactive Media Institute: San Diego, CA, USA, 2021; Volume 18, ISBN 1554-8716.
65. Siimon, T.; Tulver, K.; Kaup, K.K.; Vasser, M.; Aru, J. Facilitating Real-Life Creative Insight through Psychedelic Virtual Reality. *PsyArXiv Preprints* **2023**. [CrossRef]
66. Aday, J.S.; Davoli, C.C.; Bloesch, E.K. Psychedelics and Virtual Reality: Parallels and Applications. *Ther. Adv. Psychopharmacol.* **2020**, *10*, 2045125320948356. [CrossRef] [PubMed]
67. Sekula, A.D.; Downey, L.; Puspanathan, P. Virtual Reality as a Moderator of Psychedelic-Assisted Psychotherapy. *Front. Psychol.* **2022**, *13*, 813746. [CrossRef] [PubMed]
68. Meta Meta Quest 2 Safety Hub: Manual and Guides | Meta | Meta Store. Available online: https://www.meta.com/it/en/quest/safety-center/quest-2/ (accessed on 28 March 2024).
69. Saredakis, D.; Szpak, A.; Birckhead, B.; Keage, H.A.D.; Rizzo, A.; Loetscher, T. Factors Associated With Virtual Reality Sickness in Head-Mounted Displays: A Systematic Review and Meta-Analysis. *Front. Hum. Neurosci.* **2020**, *14*, 96. [CrossRef]
70. Kennedy, R.S.; Lane, N.E.; Berbaum, K.S.; Lilienthal, M.G. Simulator Sickness Questionnaire: An Enhanced Method for Quantifying Simulator Sickness. *Int. J. Aviat. Psychol.* **1993**, *3*, 203–220. [CrossRef]
71. Balk, S.A.; Bertola, M.A.; Inman, V.W. Simulator Sickness Questionnaire: Twenty Years Later. In Proceedings of the 7th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design: Driving Assessment 2013, New York, NY, USA, 17–20 June 2013; University of Iowa: New York, NY, USA, 2013; pp. 257–263.
72. Gómez-Busto, F.J.; Ortiz, M.I.; Paz, C. Virtual reality and psychedelics for the treatment of psychiatric disease: A systematic literature review. *Clin. Neuropsychiatry* **2020**, *17*, 365–380. [CrossRef] [PubMed]
73. Kim, S.; Kim, E. The Use of Virtual Reality in Psychiatry: A Review. *J. Korean Acad. Child Adolesc. Psychiatry* **2020**, *31*, 26–32. [CrossRef] [PubMed]
74. Moroz, M.; Carhart-Harris, R.L. Employing Synergistic Interactions of Virtual Reality and Psychedelics in Neuropsychopharmacology. In Proceedings of the 2018 IEEE Workshop on Augmented and Virtual Realities for Good (VAR4Good), Virtual, 18 March 2018; pp. 1–6.
75. Hartogsohn, I. Cyberdelics in Context: On the Prospects and Challenges of Mind-Manifesting Technologies. *Front. Psychol.* **2023**, *13*, 1073235. [CrossRef] [PubMed]

76. Suzuki, K.; Roseboom, W.; Schwartzman, D.J.; Seth, A.K. Hallucination Machine: Simulating Altered Perceptual Phenomenology with a Deep-Dream Virtual Reality Platform. In Proceedings of the ALIFE 2018: The 2018 Conference on Artificial Life, Tokyo, Japan, 23–27 July 2018; MIT Press: Cambridge, MA, USA, 2018; pp. 111–112.
77. Glowacki, D.R.; Wonnacott, M.D.; Freire, R.; Glowacki, B.R.; Gale, E.M.; Pike, J.E.; de Haan, T.; Chatziapostolou, M.; Metatla, O. Isness: Using Multi-Person VR to Design Peak Mystical Type Experiences Comparable to Psychedelics. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, Honolulu, HI, USA, 25–30 April 2020; Association for Computing Machinery: New York, NY, USA, 2020; pp. 1–14.
78. Glanz, K.; Rizzo, A.; Graap, K. Virtual Reality for Psychotherapy: Current Reality and Future Possibilities. *Psychother. Theory Res. Pract. Train.* **2003**, *40*, 55–67. [CrossRef]