Positive Technology in the Metaverse: Experiential Technologies Meet Mental Wellbeing

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Abstract. The Metaverse is a big step forward for the Internet that lets people live in a multisensory digital world anywhere and at any time, giving them a "deep feeling of presence." On the one hand, these features are attracting tech companies and multinational corporations that are interested in the economic and commercial potential of the metaverse. On the other hand, they are creating new opportunities for well-being: the Metaverse can be a "positive technology." This chapter will look at how Virtual Reality (VR) and Augmented Reality (AR), the two core metaverse technologies, can be used to improve mental well-being. First, it will talk about their clinical results in different clinical pathologies where VR and AR are better than other treatments and have long-lasting effects that work in the real world. More, it will discuss about their clinical results in different clinical pathologies where VR and AR are better than other treatments and have long-lasting effects that work in the real world. Lastly, it will use recent discoveries in neuroscience to explain why metaverse technologies can be very effective for assessing mental health and treating it: our brain and the metaverse use the same fundamental process, termed "embodied simulations," to function. As a result, the metaverse could serve as the foundation for a new field of study defined as "embodied medicine," the purpose of which is to use experiental technologies to repair malfunctioning brain simulations and improve people's mental health and wellness.

Keywords. Metaverse, Mental Health, Virtual Reality, Augmented Reality, Anxiety Disorders, Eating and Weight Disorders, Pain Management, Psychosis, Embodied Medicine.

1 Introduction

In 2021, Mark Zuckerberg proposed a new era for the internet – the Metaverse - in which individuals will live in a multisensory digital world in every place and at every time, experiencing a "deep feeling of presence" that will change the way we communicate and connect with each other (Cerasa et al., 2022). In fact, the main feature of the metaverse is the merging of the real and virtual worlds: what we do in the real world affects how we feel in the virtual world, and vice versa (Riva, Di Lernia, et al., 2021; Riva & Wiederhold, 2022).

"Digital twins" are virtual copies of real objects that are directly connected to their real-world counterparts. This is what makes the two worlds talk to each other. Thanks to them, we will be able to see and interact with people and digital objects in

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our real world while wearing VR/AR glasses all day. Or, see real people and things in virtual environments and interact with them. For example, if I move in the real world, my virtual avatar will also move. Or, if the avatar is touched in the digital world, the physical body will feel something. Lastly, if I turn on the virtual washing machine in virtual reality, the real washing machine in my apartment also starts to work.

These characteristics are attracting technological companies, investors, decision-makers, and multinational corporations interested in the metaverse's economic and commercial potential. At the same time, they are creating new opportunities in the area of health and well-being (Wiederhold & Riva, 2022): the Metaverse can be a "positive technology."

"Positive Technology" is a new research topic that combines a scientific and applied approach to using technology to improve the quality of our personal experience (Gaggioli et al., 2017; Riva et al., 2012). The "Positive Psychology" approach (Cohn & Fredrickson, 2010; Riva, 2012; Seligman, 2002) is the basis for this vision. Positive psychology is a growing field whose main goal is to understand human strengths and virtues and to build on these strengths to help people, groups, and societies grow and prosper. Positive Psychology highlights three aspects of our personal experience (Riva, etal., 2020; Villani et al., 2016) that may be regulated and strengthened to promote personal well-being: affective quality, engagement/actualization, and connectedness.

According to Positive Technology, three different types of technologies can be employed to achieve this goal (Riva et al., 2020; Villani et al., 2016):

- Hedonic: Technologies that are utilized to create good and pleasurable experiences.
- Eudaimonic: Technologies that assist people in having engaging and self-actualizing experiences.
- Social/Interpersonal: Technologies that aid and increase social integration and/or connectivity among individuals, groups, and organizations.

In this chapter, we will argue that Virtual Reality (VR) and Augmented Reality (AR), which are at the heart of the metaverse experience, can greatly improve our personal experiences and mental health. First, the chapter will describe their clinical outcomes in different clinical pathologies. More, it will discuss their added value in transforming our external experience, by focusing on the high level of self-reflectiveness and personal efficacy induced by their emotional engagement and sense of presence. Finally, it will use the recent discoveries of neuroscience to explain why experiential technologies are so effective as assessment and treatment tool for mental health: VR and AR shares with our brain the same basic mechanism, embodied simulations.

2 Augmented Reality and Mental Health

2.1 Clinical Potential of AR

Augmented reality (AR) is an interactive visual system (like a head-mounted display, a computer, a game console, a smartphone, or a tablet) that lets the user merge virtual content with the real world around them (Chicchi Giglioli et al., 2015). In simpler terms, AR lets us add to our real-world experiences by mixing "real-world elements" and "virtual elements," which can include not only what we see but also what we hear, feel, and smell (Juan et al., 2005).

AR's additional digital data can be a powerful tool for mental health because it can help users become more self-aware and confident in their own abilities. For these reasons, augmented reality (AR) seems to be a promising and useful tool for treating specific phobias (Baus & Bouchard, 2014; Juan et al., 2005), as also supported by a systematic review (Chicchi Giglioli et al., 2015). However, its potential to promote mental wellness is likely greater. Different AR applications are emerging in this field: from post-stroke (Trojan et al., 2014) and physical rehabilitation (Kaber et al., 2014; Lin & Chang, 2015), cognitive assessment (Tasnim & Eishita, 2021), social (Chung et al., 2015) and emotional (Chen et al., 2014) training for children with autism, to pain reduction (Mott et al., 2008).

2.2 Clinical Applications of AR

Here, we propose that the added value of augmented reality is associated with the assistance it provides for all phases of the experiential learning cycle (Kolb, 1984). According to David Kolb's classic model, experiential learning is a four-stage process: experience, observation and reflection, abstract reconceptualization, and experimentation (Kolb, 1984). The individual's learning process begins with a spiral of immediate experience that leads to observations and thoughts about the experience. These reflections are then analyzed, linked to prior information, and translated into recommendations. Finally, recommendations generate new actions and strategies that can be tested and explored in order to adapt to the experience.

Treatment of a specific phobia, such as a fear of cockroaches, may benefit from AR's use of experiential learning in relation to therapeutic transformation (Breton-Lopez et al., 2010). In the "concrete experience" stage, the patient actually feels the cockroaches in the "here and now" that the AR provides. This experience is the "base for observation and reflection" (reflective observation): the patient can think about the actions (like avoiding the cockroaches) and emotions (like anger and fear) he or she felt and think of ways to improve the next time he or she will see them (abstract conceptualization). During the second try, AR can help the patient in real time by giving real-time information about his or her status, such as the level of emotional arousal, and practical suggestions, such as bringing the patient's hands closer to the therapist's hand.

AR can also speed up the process of change during the whole treatment. For example, Botella and colleagues (Botella et al., 2011) used an AR-based serious game on a mobile phone to make the exposure treatment go more smoothly. Before the AR exposure session, the goal of this game was to lower the level of fear and avoidance. After the AR exposure session, the goal was to encourage overlearning as homework.

In this way, AR helps people change by making experience, thought, and reflection work together in a loop (active experimentation). In other words, AR is the best way to learn through experience. On the one hand, it lets people interact in real time in an ecological setting, which helps people focus and get motivated (Di Serio et al., 2013). On the other hand, it gives targeted and nondirective suggestions and guidelines that help users learn skills and knowledge more effectively (Wu et al., 2013).

3 Virtual Reality and Mental Health

3.1 Clinical Potential of Virtual Reality

For many clinicians, Virtual Reality (VR) is mostly a set of powerful technologies (Riva, et al., 2019): a computer or mobile device with a graphics card capable of interactive 3D visualization, controllers, and a head-mounted display embedding one or more position trackers. The trackers detect the location and orientation of the user and relay this data to the computer, which then refreshes the displayed graphics in real time.

This description enables us to identify the essential technological components of a VR system (Parsons et al., 2017): input devices, output devices, and the simulated world (i.e., the virtual environment).

Input devices consist of all the sensors and trackers that collect the user's actions (e.g., head and hand motions) to enable interaction with the virtual environment.

Output devices consist of all technologies that offer the user with continual computer-generated information. Even while the visual channel is the most essential sensory modality for the majority of VR clinical applications, more advanced VR systems also include audio, olfactory, and haptic (tactile) feedback.

Lastly, the simulated scenario is the 3D virtual environment created by a computer (VE). VEs are intended to be explored, allowing users to interact with their contents (e.g., moving, pushing, picking up, rotating, etc.). Multi-user virtual environments (MUVEs) permit two or more people to interact with the same simulated scenario simultaneously.

VR is therefore more than a collection of technology. The term "virtual reality" consists of two words: "virtual" (almost or near as described) and "reality" (the actual state of things). Therefore, we might say that "virtual reality" essentially means "almost reality" or "near reality," implying that VR is a type of reality simulation.

In this context, VR is defined as (Schultheis & Rizzo, 2001) "an advanced form of human-computer interface that allows the user to interact with and become immersed in a computer-generated environment in a naturalistic fashion" (p. 82). From a cognitive point of view, VR is mostly a subjective experience that makes the user feel like he or she is there and that the experience is real (Riva, Baños, et al., 2016). Specifically, what differentiates VR from traditional media is the sense of presence: the sensation of "being there" within the virtual experience created by the technology.

Virtual reality's sense of presence is a powerful treatment tool because it enables patients to learn through reflection on doing. Glantz and his colleagues (1997) explain it well: "One reason it is so difficult to get people to update their assumptions is that change often requires a prior step – recognizing the distinction between an assumption and a perception. Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change" (p. 96).

Through the VR experience, it is easier for the therapist to demonstrate to the patient that what looks like a fact is actually a result of his/her mind. Once this concept is understood, individual maladaptive assumptions can be challenged more easily.

VR can also be thought of as an advanced way to imagine: a form of imagery that is as good at making people feel things as reality (North et al., 1997; Vincelli, 1999; Vincelli et al., 2001). Multiple studies have demonstrated this result. For example, Slater and colleagues (2006) re-created Stanley Milgram's experiment from the 1960s using VR. They asked a group of people to give a memory test to a female virtual human (avatar) and give her a "electric shock" if she got the question wrong, with the voltage getting higher each time. During the VR experiment, just like in the original version, the electric shocks made the avatar feel more and more uncomfortable until it finally asked for the experiment to end. Their results show that VR is effective at simulating reality. Even though all of the participants knew that neither the avatar nor the shocks were real, they reacted to the situation as if it were real on a subjective, behavioral, and physiological level.

More than that, Balzarotti and his colleagues (Balzarotti et al., 2014), have shown that VR avatars are seen as intentional agents, and users change their emotions and nonverbal behavior based on how the avatar acts.

VR can also make clinical patients feel different emotions. As we'll talk about later, many studies have shown that VR can make phobic people feel more anxious when they're put in a threatening virtual situation, which is similar to what they feel when they're in real life (Opris et al., 2012; Powers & Emmelkamp, 2008). Accordingly, as established by a recent meta-analysis, virtual reality is an equally effective and equivalent medium for exposure therapy.

3.2 Clinical Applications of Virtual Reality

In mental health, VR is already a reality (Cipresso et al., 2018; Guazzaroni, 2018; Stone, 2020). Recent meta-reviews, (Riva, Baños, et al., 2016; Riva et al., 2019) of more than 53 meta-analyses and systematic reviews show that existing scientific literature supports its use in the treatment of anxiety disorders, stress related disorders, obesity and eating disorders, and pain management, with clinical results that compare favorably to those of existing treatments and with long-term effects that generalize to the real world. Moreover, more recent studies indicate that beneficial results are also developing in the treatment of psychosis (Pot-Kolder et al., 2020; Rus-Calafell, et al., 2018), addiction (Segawa et al., 2020) and depression (Ioannou et al., 2020).

In the next paragraphs, we will talk about how VR has been used in these different fields and the clinical results that have come from it.

Anxiety Disorders. Exposure-based therapies are a reference treatment for the treatment of obsessive-compulsive disorder, post-traumatic stress disorder, panic disorder (PD), specific phobias, and social anxiety disorder, according to the empirically supported treatment guidelines of the American Psychological Association (A.P.A., 2006). However, only a tiny percentage of people with anxiety disorders receive this treatment (Olatunji et al., 2010); VR technology can help more people get treated this way (Fernández-Álvare et al., 2020).

A recent meta-analysis shows that VR exposure-based therapy for anxiety disorders works very well (Carl et al., 2019): When compared to waitlist conditions, VRET had a big effect size (Hedge's g=0.88). When compared to psychological controls, it had a medium to big effect size. Also, VRET was neither more nor less effective than in vivo. A recent study (Fernandez-Alvarez et al., 2019) that looked at the deterioration rates of VR-based treatments for anxiety disorders found that the number of patients who got worse was the same as with other types of therapy and that deterioration is less likely than in waitlist conditions.

Clinicians tend to agree that VR may cause more people to quit than other methods. A recent meta-analysis of VRET dropout rates (Benbow & Anderson, 2019) showed this opinion is wrong: only 16% of the 1057 people who took part in 46 different studies dropped out. These results are similar to what would happen in real life. Also, the meta-analysis shows that giving homework is the most important predictor of not dropping out, which suggests that it should be used in any VRET protocol (Benbow & Anderson, 2019).

Specific phobias were the first anxiety disorders to be treated with VRET, and now many meta-analyses (Opris et al., 2012; Powers & Emmelkamp, 2008) show that it works.

VRET is now supported by a growing body of research for different anxiety disorders. A meta-analysis (Carl et al., 2019) strengthens the case for using VR to treat social anxiety disorder and performance anxiety (Hedge's *g=0.96),* post-traumatic stress disorder (Hedge's *g=0.59),* and panic disorders *(Hedge's* g=1.03). VRET has also been used to help people deal with stress (Pallavicini et al., 2016; Shah et al., 2015) and people with generalized anxiety disorders (Repetto et al., 2013).

Recently, some researchers have also looked into how low-cost VR hardware could be used to make consumer-ready, gamified self-help VRET applications (Lindner et al., 2017). A randomized controlled study by Freeman and colleagues (2018) to usual care (control group). Immersive VR's automated psychological intervention was very good at making people less afraid of heights. In a second randomized controlled trial, Lindner and his colleagues (2019) looked at how well therapist-led VRET and self-led VRET helped people who were afraid of public speaking. Both kinds of VRET made a big difference in how much anxiety a person felt. Also, the self-led arm's improvements were maintained at the six-month follow-up, and the therapist-led arm's patients continued to get better at the twelve-month follow-up. These results back up the use of self-led VRET and suggest that internet-based treatments that are already available might benefit from adding VR exposure tools.

Pain Management. Since the 1990s, VR has been used to help people deal with acute pain caused by medical procedures (Chan et al., 2018). Most interventions still use pharmacological methods, but they have a lot of problems, such as short therapeutic windows, bad side effects, and drug abuse and dependence. VR-based interventions are becoming a good alternative (Wiederhold et al., 2014).

Distraction is the most popular method of VR acute pain management. This method uses VR to redirect the patient's attention from incoming pain signals to a computer-generated reality (Ahmadpour et al., 2019). As highlighted by a systematic review (Triberti et al., 2014), the feeling of presence in a VR experience affects how well it works as a distraction tool. Anxiety and positive emotions also have a direct effect on how painful something feels. In fact, it is well known that when the insula cortex is active, negative emotions make pain feel worse. From this point of view, using VR to make people feel good can also help distract them (Sharar et al., 2016).

Focus shifting (Ahmadpour et al., 2019) is a more advanced form of distraction that uses agency to improve engagement and shift of attention. Focus-shifting VR experiences require the user to interact with the virtual environment and reach certain goals.

The last way VR relieves pain is through skill building (Ahmadpour et al., 2019). This method uses VR to help people learn the skills and abilities they need to control how they react to painful stimuli. As with focus shifting, the user is an important part of the process. In this case, however, the goal of the VR experience is to help patients learn how to control their own pain. For example, they can control their breathing during the pain experience to feel more in control.

A recent meta-analysis (Chan et al., 2018) showed that these methods work: it looked at 16 trials and found a -0.49 standardized mean difference reduction in pain score with VR.

In recent years, VR-based interventions have also been used to help people with chronic pain (Austin, 2021; Garcia et al., 2021; Jones et al., 2016). Even though there are many psychological factors and central nervous system processes that make chronic pain very different from acute pain, most VR interventions for chronic pain are based on the same three approaches we've already talked about. In a recent study, a commercial VR system (EaseVRx) was compared to a fake VR system (Sham VR) over an 8-week period. The results showed that VR was clinically better and had a moderate to substantial clinical importance for reducing pain intensity and how it affected activity, mood, and stress (Garcia et al., 2021). As underlined by a recent scoping review (Austin, 2021, p. 105): “Studies show virtual reality to be an effective analgesic intervention for people with chronic pain. Given user satisfaction, a lack of side effects such as cybersickness, and relief of comorbid symptoms, virtual reality has potential as a worthwhile adjunct to chronic pain management programs, thus enabling patients to take control of their symptoms.”

For chronic pain management, some researchers are also beginning to explore synthetic embodiment — the use of virtual reality to replace multisensory bodily elements with synthetic ones — to improve long-term outcomes (Martini et al., 2014). A narrative review by Matamala-Gomez and colleagues (2019b) suggests that this approach can modulate body representation and change pain perception in healthy and clinical populations. Again, research in this area is still pretty new (Matamala-Gomez, et al., 2019a), but the way it is being done is very promising.

Eating and Weight Disorders. In the past 25 years, virtual reality has provided innovative solutions for reducing food cravings, improving body image, and enhancing emotion regulation skills in eating and weight disorders (Riva, Gutierrez-Maldonado, et al., 2016; Riva, Malighetti, et al., 2021). In particular, four different randomized controlled trials (Cesa et al., 2013; Ferrer-Garcia et al., 2019; Manzoni et al., 2016; Marco et al., 2013) have shown that VR is more effective at treating eating disorders and obesity than the gold standard in the field, which is cognitive behavioral therapy (CBT).

The first time VR was used in this field was in body image research. This was done to learn more about the idea of body image and to help evaluate body image disorders. Technology has come a long way and now makes it possible to use "avatars" that are more realistic and more interactive. This makes it easier to make VR apps that explore body representations. The word "avatar" refers to digital self-portraits in places like online collaborative virtual worlds (like Second Life) as well as video games and clinical virtual environments (Gaggioli et al., 2003).

Typically, these apps have a 3D human figure whose parts can be changed using sliders. The main benefit of this method is that the software lets clinicians measure different aspects or indices of body image (such as the perceived body, the desired body, the healthy body, etc.) and body weight (actual weight, subjective weight, healthy weight, and desired weight) in different situations.

A new neuroscientific model (Riva & Dakanalis, 2018; Riva & Gaudio, 2018) suggests that eating disorders may be caused by a problem with how the brain processes and combines information from different parts of the body (multisensory body integration). This deficit could make it harder for a person to: (a) identify the relevant interoceptive signals that predict possible pleasant (or unpleasant) outcomes; and (b) change or correct the allocentric (observer view) memories of body-related events from their own life (self-objectified memories).

VR can be used in two different ways to help people with problems with multisensory body integration (Riva, Malighetti, et al., 2021) — reference frame shifting (Akhtar et al., 2017; Riva, 2011) and body swapping (Gutiérrez-Maldonado et al., 2016; Normand et al., 2011)—that can be integrated within classical cognitive behavioral training (CBT).

The first method, called reference frame shifting (Akhtar et al., 2017; Riva, 2011), focuses on and reorganizes body-related memories to try to change the person's sense of their own bodies (Osimo et al., 2015; Riva, 2011). To reach this goal, the subject re-experiences in VR a negative body-related situation (like being teased) from both a first-person and third-person point of view (like watching and helping his or her avatar in the VR world). In general, the therapist will ask the patient to describe in detail the virtual experience and how it made them feel. The patient is also taught how to deal with these feelings using different cognitive techniques.

This method has been successfully used in different randomized trials with obese patients (Cesa et al., 2013; Manzoni et al., 2016), allowing them to both update the information in their body memory and get better results than with traditional CBT.

In the second method, called "body swapping"(Gutiérrez-Maldonado et al., 2016; Normand et al., 2011; Serino & Dakanalis, 2017)— VR is used to make people feel like they own a different-shaped or-sized virtual body. As for chronic pain management, the clinical objective of body swapping is to rectify the defective body representation. Although body illusions have not yet been evaluated against active treatments in a randomized controlled trial, preliminary results support the rationale for this strategy (Keizer et al., 2016; Preston & Ehrsson, 2014, 2016; Serino, Pedroli, et al., 2016; Serino et al., 2019; Serino, Scarpina, et al., 2016).

VR can also lower eating-related anxiety before and after exposure to virtual food by disrupting the reconsolidation of negative food-related memories and modulating food craving, which is the intense desire to consume a particular food (Riva, 2017). An experimental study (Gorini et al., 2010), found that actual food and virtual reality (VR) food create equivalent emotional responses in patients with eating disorders, and that these responses are stronger than those induced by food images. According to this theory, cue exposure treatment (CET) utilizing virtual reality (VR) food has been utilized to extinguish/habituate hunger and anxiety reactions, hence reducing the likelihood of overeating. A randomized controlled intervention with a six-month follow-up (Ferrer-García et al., 2019) validated the effectiveness of this technique in a group of patients with bulimia and binge eating disorder: VR CET achieved superior outcomes compared to CBT, the gold standard for these diseases.

Exergames based on virtual reality have been used to treat obesity. Exergames, a combination of "exercise" and "gaming," refers to video games that deliver a form of exercise (Rizzo et al., 2011). Exergames boost the motivation to engage in calorie-burning cardiovascular exercise through the use of interactive digital games that require body movement. Specifically, virtual reality experiences assist the three components that influence motivation and compliance (Lyons, 2015): feedback, challenge, and rewards.

Psychosis. In the past 15 years, researchers have sought to verify the safety of using virtual reality (VR) with psychotic patients and to comprehend the psychological mechanisms underlying the emergence and persistence of psychotic symptoms (Valmaggia, 2017).

According to different systematic reviews (Riches et al., 2021; Rus-Calafell et al., 2018; Valmaggia et al., 2016), VR was originally introduced in this field to investigate the psychological processes and mechanisms related with the onset and maintenance of psychosis. Specifically, VR has been employed as a controlled environment to examine the effect of negative life events on real-time responses to social situations. Researchers are able to manipulate the levels of paranoid ideation and auditory hallucinations by the manipulation of population density, the ethnic density of avatars, or even the height of the user (Freeman et al., 2014; Veling et al., 2014). Researchers can also test functional capacity, social cognition, and social competence by using virtual agents and virtual scenarios (Freeman et al., 2017). In general, participants were asked to explore social environments or have conversations with avatars that were programmed to talk and act in certain ways.

All these studies suggest that VR is a safe setting for assessing psychotic symptoms and social competence. Patients did not show any worsening of psychotic symptoms after being in VR, and they did not say that the VR experience generated distress (Rus-Calafell et al., 2018; Valmaggia et al., 2016).

More recently, VR has also been utilized to enhance cognitive remediation therapy for psychotic disorders, a clinical strategy that tries to improve cognitive processes with the goal of achieving long-term improvement and generalization to daily functioning (Wykes & Spaulding, 2011). VR enables the development of unique situations for training and developing problem-solving, social, and interpersonal abilities (Fernández-Sotos et al., 2020).

Patients are far more inclined to test their skills in virtual reality because they are aware that it is a simulation, yet what they learn in virtual reality translates to the real world. Additionally, VR therapy can incorporate engaging tasks that make treatment significantly more fun. Finally, VR scenarios can provide graded experiences that allow the user to repeatedly test tough situations and acquire new abilities (Freeman et al., 2019).

Despite the still limited number of published trials, all research found short-term gains in social skills and/or social cognition to be promising (Fernández-Sotos et al., 2020). As a next stage, as for anxiety disorders, is the use of automated VR apps utilizing low-cost, commercially available VR devices. A running trial (Freeman et al.,

2019) is evaluating the efficacy of this method with psychotic individuals who have difficulty navigating anxiety-inducing social situations.

Addictions. Since almost 15 years ago, VR treatments have been applied in the assessment and treatment of addiction illnesses (Mazza et al., 2021; Segawa et al., 2020). VR was first used in this field to study cue reactivity (Bordnick et al., 2005; Bordnick et al., 2008). In particular, researchers used VR cue environments to test how much people wanted drugs and how they reacted to drug cues. In these studies, people were exposed to cues in a virtual reality (VR) setting, and both subjective and objective measurements (like craving or desire to use) were taken. The VR experience can also be changed to see how people act when they are in a stressful situation.

A systematic review (Segawa et al., 2020) shows that VR has been used to elicit craving and cue exposure in people addicted to alcohol, cocaine, gambling, marijuana, methamphetamines, and nicotine. In particular, VR exposure can cause cue-driven attentional bias and cognitive distortions, as well as interoceptive responses like changes in heart rate.

VR cue exposure has also been used in therapy in recent years. But the results of treatments that only use virtual exposure to drug-related cues have been mixed (Trahan et al., 2019). However, a recent randomized controlled trial (Pericot-Valverde et al., 2019) found that adding VR exposure to a CBT protocol for smoking addiction led to the same rates of staying in treatment and quitting smoking as CBT alone, both in terms of retention and quitting rates.

Autism. Since 1996 (Strickland et al., 1996), VR has been applied in the assessment and therapy of autistic children to improve social skills, nonverbal communication, and emotional abilities (Lorenzo et al., 2019).

One of the first practical things that was done was to use VR to teach social and communication skills (Miller et al., 2020). In particular, virtual reality (VR) social simulations that mimic real-life events (like a virtual café, a bus, or a street crossing) have been used to teach autistic children how to handle different graded situations (Moon & Ke, 2019). During the VR experience, they have to interact with simulated social actors and talk to them in order to reach training goals and build their sense of self and social identity. Using VR to improve emotional skills is another important area. For example, Ghanouni and colleagues (2019) made a validated library of VR social stories that focus on taking other people's points of view and have varying levels of emotion and difficulty. In a recent randomized controlled trial (Maskey et al., 2019), clinicians used VR to help autistic children with specific phobias.

In general (Shahmoradi & Rezayi, 2022), the results we have so far show that VR is a promising tool for helping people with autism improve their social skills, cognitive skills, and ability to function. However, existing studies don't show if autistic children can use the skills they learn in real life (Lorenzo et al., 2019). Also, there are still problems with making VR experiences that are robust and simple to use and can really make a difference in real-world classrooms (Parsons & Cobb, 2011).

Other Mental Health Diseases. The VR protocols and tools we've talked about so far are not the only ways that VR can be used to improve mental wellbeing. But there isn't a sufficient amount of evidence that VR helps with other mental health problems, and many studies have problems with their methods or leave out important information.

VR has also been used to diagnose and treat people with sexual disorders. In this area, combining VR with psychodynamic therapy for erectile dysfunction and early ejaculation has shown some promising early results, even in a small case series with no controls (Optale, 2003; Optale et al., 2004). Renaud and his colleagues (Renaud et al., 2013; Renaud et al., 2014) were also able to figure out how people with deviant sexual preferences responded to sexual stimuli shown by virtual characters in VR (e.g., pedophilia).

Depression is another important area (Zeng et al., 2018). Falconer and her colleagues (Falconer et al., 2016) looked into body swapping, which is the illusion of feeling like you own a virtual body that is a different shape or size, to help depressed people feel more compassion. Other researchers used VR-based exergames (like treadmill or stationary bike exercises) to reduce depressive symptoms. In both cases, the results were positive, However, further studies are needed to investigate the real effects of this technology in the long run.

4 From VR/AR to the Metaverse: Future Research Agenda

AR and VR are already useful clinical tools for mental health, as we've seen in the past pages. But the metaverse might be able to make them even better by turning them into positive technologies that can really change how people feel about their wellbeing. To understand this potential, we will start to explore the neuroscience of metaverse.

4.1 The Neuroscience of Metaverse

“Predictive coding” (Clark, 2013; Friston, 2010, 2012) is an increasingly prominent theory in neuroscience that suggests our brains actively simulate the body and the surrounding environment. This model is utilized to make predictions regarding the anticipated sensory input and to minimize prediction mistakes (or "surprises").

To interact effectively with the environment, our brains develop an embodied simulation of the body that represents its anticipated future states (intentions and emotions). This simulation possesses two primary qualities (Riva et al., 2019). First, it simulates sensory-motor experiences, including visceral/autonomic (interoceptive), motor (proprioceptive), and sensory (e.g. visual, acoustic) information. Second, embodied simulations are based on the subject's expectations and reactivate multimodal brain networks that previously generated the simulated/anticipated result. A crucial objective of this procedure is to reduce the average of surprise (i.e., the gap between intentions and the effects of implementing them) across the various representations and to learn how to model and forecast incoming content most accurately. In other words, the embodied simulation is modified according to the (dis)agreement (Talsma, 2015) between the perceived sensory activity (perception) and the contents of the simulations used to forecast the impacts of the action on the individual's surroundings.

Metaverse works the same way (Riva et al., 2019): it uses technology to create a digital experience that people can interact with and explore as if they were there. In other words, metaverse technology tries to predict how users' actions will be carried out by showing them the same result that our brains expect in the real world. As underlined by Riva and colleagues (2019): “To achieve it, like the brain, the system maintains a model (simulation) of the body and the space around it. This prediction is then used to provide the expected sensory input using the hardware. Obviously, to be realistic, the XR model tries to mimic the brain model as much as possible: the more the model is similar to the brain model, the more the individual feels present in the digital world” (p. 89).

4.2 Transforming Personal Experience: the Positive Side of the Metaverse

But what is the real wellbeing potential of the metaverse as a technology for simulation and experience? Neuroscience says that in our brain a complex network called the "body matrix" (Finotti & Costantini, 2016; Finotti et al., 2015; Gallace & Spence, 2014; Moseley et al., 2012) controls the body's integrity at both the homeostatic and psychological levels by managing the cognitive and physiological resources needed to protect the body and the space around it. In particular, the body matrix is important for high-level cognitive processes like motivation, emotion, social cognition, and self-awareness (Maister et al., 2013; Maister et al., 2015; Tsakiris, 2017). It also has a top-down effect on basic physiological mechanisms like thermoregulation (Gallace et al., 2014; Macauda et al., 2015) and the immune system (Finotti & Costantini, 2016).

Also, the contents of the body matrix are shaped by predictive multisensory integration(Apps & Tsakiris, 2014; Calvert et al., 2004; Sutter et al., 2014). Higher-order networks make predictions about expected sensory inputs with the goal of using these predictions to coordinate all bodily inputs into a coherent and functional mental representation (Bayesian principle). In this way of thinking, multisensory integration conflicts (Ehrsson, 2012) are a failure in this functional adaptation process that can lead to a number of diseases. As Ho and colleagues point out (2020): “Impaired feedback affecting any level of the multisensory hierarchy could disturb the coherent integration of lower-level signals with the bodily self and disrupt the individual’s optimal interaction with the external and social world” (p. 528). In particular, changes in the way the body matrix and/or multisensory integration processes work could lead to bodily self-disorders that are at the root of many neurological and psychiatric conditions (Brugger & Lenggenhager, 2014; Ho et al., 2020; Riva, 2008; Riva, et al., 2017; Schoeller et al., 2022; Tsakiris & Critchley, 2016).

If this theory is true, and many evidences are supporting it, the metaverse could be at the center of a new field of research called "embodied medicine" (Riva, 2016; Riva et al., 2017). The main goal of this field is to use the metaverse to change the body matrix to improve people's health and well-being. Using metaverse could change the body matrix in three ways:

- *By replacing multisensory bodily contents with synthetic ones (synthetic embodiment)*: As we've seen, VR lets people have different kinds of synthetic bodily experiences. The most advanced of these is *full body swapping*, in which the individual’s body is substituted by a virtual body (Petkova & Ehrsson, 2008). But the metaverse's ability to simulate is also making possible a different way to change the signals our bodies send us (Di Lernia et al., 2022): interoceptive technologies. Interoceptive technologies use three different methods to reach this goal (Schoeller et al., 2022): artificial sensations, which involve direct manipulation of interoceptive signals; interoceptive illusions, which use contextual cues to cause a predictable shift in body perception; and emotional augmentation technologies, which combine artificial sensations with personal contextual cues to create specific moods or emotions.

- *By structuring multisensory bodily contents through awareness and reorganization (mindful embodiment)*: People have different levels of body awareness, which is how sensitive and aware they are of signals and sensations in their bodies (Ginzburg et al., 2014). When combined with other technologies like biosensors, VR and AR can be used to make people more aware of their bodies. For example, when combined with biofeedback training, it can be used to measure and control specific body signals, like heart rate, galvanic skin response, electromyography, or electroencephalography (Gaggioli et al., 2014; Repetto et al., 2009) that are normally not consciously perceivable and to report these signals back to the patient.
- *By augmenting multisensory bodily contents by altering/extending their boundaries (augmented embodiment)*: By combining experiential technologies with biosensors, stimulation, and haptic devices, it is possible to map the contents of one sensory channel to another (for example, vision to touch or hearing) to increase sensitivity and replace channels that aren't working (Riva, et al., 2021; Waterworth & Waterworth, 2014).

These methods allow for the utilization of the metaverse to achieve the following two goals (Riva, 2018). First, it can be applied to enhance multisensory integration processes and make it easier to integrate external and internal body signals (Azevedo et al., 2017; Suzuki et al., 2013). A possible strategy is the one suggested by the Virtual Regenerative Therapy (VRT) described in Figure 1.

In particular, VRT is based on the steps below (Riva et al., 2021): (a) the creation of a synthetic full-body illusion in VR that is synchronized with an interoceptive modulation (inner body), which can generate a significant amount of prediction error; (b) the use of brain stimulation techniques to lessen the impact of predictions made from the top-down; (c) the use of conscious awareness to improve the accuracy of the multisensory experience; and (d) reconstructing and re-explaining the emotional content of the multisensory experience.

This process should cause the brain to turn on its own regenerative systems that can fix the problem and start the healing process.

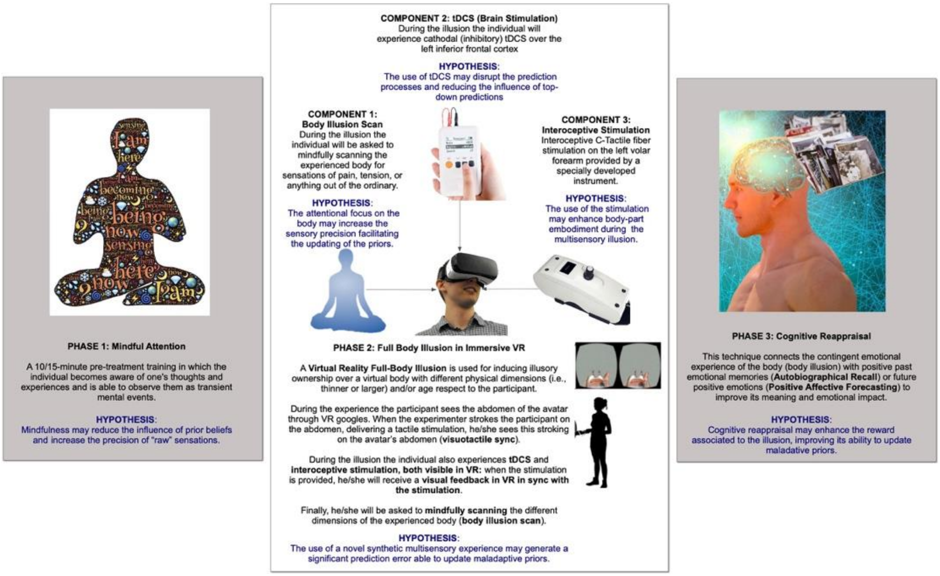

Figure 1: Regenerative Virtual Therapy (From Riva et al. 2021, with authorizatiion)

Second, by creating a controlled mismatch between the sensory input and the expected or malfunctioning content, experiential technologies can be utilized to correct dysfunctional brain's prediction (Serino, Pedroli, et al., 2016).

5 Conclusions

From a technological viewpoint, metaverse is the outcome of different advanced technologies: googles, trackers, sensors and a 3D visualizing system. But from a psychological point of view, the metaverse is both a simulation technology and a cognitive technology at the same time.
First, metaverse is a form of reality simulation. Specifically, what makes experiential technologies, and VR in particular, different from other media is the sense of presence: the feeling of "being there" inside the digital experience made by the technology. The metaverse is a great way to learn by doing because it can simulate real life. On the one hand, it lets individuals learn by looking back on what they've done. On the other hand, VR can be thought of as an advanced imaginal system or an experiential form of imagery that can make people feel the same way as reality. The metaverse is also a cognitive technology that can copy the way the brain works. Recent research in neuroscience suggests that our brains are simulation machines that build an internal model (simulation) of the body and the space around it to make predictions about the expected sensory input and to reduce the number of prediction errors (or "surprises"). Metaverse works the same way. It uses technology to create a virtual world that people can explore and change as if they were really there. In other words, experiential technologies try to predict how a user's actions will be carried out by showing them the

same result our brain expects in the real world. In this view, the person feels more present in the digital world when the simulated experience is more like the brain model.

All these characteristics make experiential technologies effective clinical tools as demonstrated by existing research. But the metaverse might be able to make them even better by turning them into positive technologies that can really change how people feel about their wellbeing. In particular, the metaverse could be at the center of a new field of research called "embodied medicine" (Riva, 2016; Riva et al., 2017). The main goal of this field is to use the metaverse to change the bodily experience to improve people's health and well-being. Using metaverse could change our experience of the body in three different ways:

- *By replacing multisensory bodily contents with synthetic ones (synthetic embodiment)*;
- *By structuring multisensory bodily contents through awareness and reorganization (mindful embodiment)*;
- *By augmenting multisensory bodily contents by altering/extending their boundaries (augmented embodiment)*.

These methods allow for the utilization of the metaverse to achieve the following two goals (Riva, 2018). First, they can be applied to enhance multisensory integration processes and make it easier to integrate external and internal body signals. Second, by creating a controlled mismatch between the sensory input and the expected or malfunctioning content, they can be used to correct dysfunctional brain's prediction. The wellbeing potential in both scenarios is enormous and includes clinical and subclinical applications: improving mood regulation, impulse control, and enhancing cognitive, autonomic, and stress adaptive responses using non-pharmacological treatments that do not require medical regulation or prescription.

Unfortunately, the positive technology potential of the metaverse is still far from being realized at this time. Rather than established interventions, the aforementioned paradigms are promising visions based on computational neuroscience concepts. Before the metaverse can be incorporated to the methodologies used by psychiatry, psychology, and psychotherapy to improve wellbeing and mental health, further study and clinical trials are required.

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