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L'UTILIZZO DI TECNICHE DI RILASSAMENTO IN UN AMBIENTE VIRTUALE PERSONALIZZATO

THE USE OF RELAXATION TECHNIQUES IN A PERSONALIZED VIRTUAL ENVIRONMENT

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Contents

Abstract

This bibliographic research addresses the innovative approach to relaxation that introduces the use of personalized virtual reality (VR) in the relaxing process. It is conceptualized as a critical integration of literature that considers the subject. Research is divided into three chapters. First of all, it defines virtual reality and its properties, with particular attention given to the “sense of presence” as it is one of the key characteristics of VR that makes it a particular form of human experience.

Furthermore, this chapter takes a perspective on VR showing to be a successful technology in different research areas, with the accent on its usefulness in clinical psychology. In the second chapter, the concept of relaxation and the main relaxation techniques have been described with particular attention on Progressive Muscle Relaxation and Body Scan’s use in medical, and more specifically, psychological settings. The final chapter introduces the concept of personalization. In the end, it finally integrates literature that highlights the importance of personalized VR in relaxation practice but also criticizes current studies defining possible directions for the future advances of the concept.

Keywords: relaxation techniques, virtual reality, personalization, Progressive Muscle Relaxation Training (PMRT), Body Scan

Introduction

New technology and the limitations of methods and techniques used in the treatment of mental disorders have led to the consideration of alternative ways of practicing them. VR has been proved to be effective as a supportive tool for the treatment of various psychological disorders and a supporting tool for practicing relaxation. Literature evidenced the efficacy of relaxation techniques (e.g. Progressive Muscle Relaxation Training, and Body Scan) and the question of how VR and relaxation protocols should be integrally used and further developed brought to the main purpose of this thesis: to collect and critically analyze literature that considers the innovative use of practicing relaxation techniques through personalized virtual environments that would be adapted to the user's personality and needs.

This work has been divided into three chapters, each arranged to present, moving from a broad subject to the most specific one. These are going to be briefly described in the following section:

1. The core subject of the first chapter was VR. It began with its broad definition with particular mention of its importance in behavioral sciences. The characteristics that make VR a helpful tool in managing disorders were described, with particular attention being given to its ability to create a sense of presence. After presence was defined, the chapter continued with factors that influence the level of presence, and a single subparagraph was dedicated to the methods used for measuring presence. VR is an interactive technological tool, so the mediating tools that make that interaction possible were described. The attention at the end of the chapter moved forward to

the description of VR's application in psychology, with collecting of evidence for its successful use in treating diverse mental health disorders.

2. The second chapter started with the general view on relaxation and the definition of the "relaxation response" which is contrary to the "stress response". Then, by mentioning Mind-Body medicine as their root, relaxation techniques were introduced and identified as techniques that can be used to elicit a relaxation response voluntarily. The attention was further given to summing up literature that proved that natural environments can be associated with mental health benefits and can help reduce stress levels in people. The theories that tried to reason this connection were considered. Subparagraphs were each dedicated to the Progressive Muscle Relaxation training (PMRT), Body Scan, and the evidence supporting their success in producing mental health benefits.

3. The third chapter introduced the subject step-by-step to reach the crucial part of the thesis. At first, the use of VR as a supportive tool for the relaxation practice was introduced, with particular attention to the VR's support in relaxation techniques. Then, after defining the importance of personalization and adaptation of virtual environments to the user's needs, models of personalized virtual environments were identified and deeply described ("The user-centered" VR approach, Pizzoli et al., 2019; "VRelax", Heyse et al., 2019). The chapter ends by focusing on the importance of introducing the personalized virtual environments in practicing specific relaxation techniques like PMRT and Body Scan, which is an area that needs further investigation and development.

1. Virtual reality and its application

1.1. General aspects of Virtual reality

Virtual reality (VR) is primarily defined as a set of advanced technologies built by several technological components: output devices (all technologies that provide continuous computer-generated information to the user), input devices (which include all the sensors and trackers that capture the user's actions), and the simulated scenario (computer-generated 3D virtual environments) (Riva, 2020). However, its definition changes as it becomes perceived as more than a set of technologies. Its term is the combination of the words "virtual" (almost or nearly as described) and "reality" (the actual state of things), suggesting that it is a form of reality simulation (Riva et al., 2016). From a philosophical point of view, it can be defined as the most appropriate alternative to a human's conscious experience (Metzinger, 2018). Taking a cognitive point of view, VR is mainly a subjective experience that makes the user believe that he is present and that the virtual experience is real (Riva et al., 2016). It is hard, however, to find a universal definition that would be shared by all the researchers, as its definition varies as the perspective it is being given changes and it is hard to find a universal definition that all the researchers would share. Physicians, for example, typically define it as a set of technologies that enable people to engage with three-dimensional computerized data in real-time utilizing their natural senses and skills (McCloy & Stone, 2001, as cited in Riva, 2002). As attention transfers to the behavioral sciences, VR becomes described as an advanced form of human-computer interface that allows users to interact with and immerse themselves in a computer-generated environment in a realistic manner (Schultheis & Rizzo, 2001). The difference between definitions is based on the heterogeneous perspectives these research areas have. For physicians, the ultimate purpose of VR is to present virtual objects to all of the human senses in a way identical to the natural object they represent (Székely & Satava, 1999, as cited in Riva, 2002), by offering real-like body parts or avatars that interact with external devices such as surgical instruments as near as possible to their real models. In the case of clinical psychologists and rehabilitators, virtual environments are appealing tools because they can provide a high level of control of the human-computer interaction and in enhancing patient's experience (Schultheis & Rizzo, 2001).

Jaron Lanier (1989, as cited in Slater & Sanchez-Vives, 2016) defined VR as a form of reality that achieves the same effect as a physical world but can give the infinity of possible scenarios that do not exist in the physical world. The unlimited possibilities of conducting research that could not be possible to conduct in a traditional setting have been the reason for VR's expansion in science. In a situation where the properties of the real world aren't limited, the variety of testable hypotheses expands. Although scenarios generated by VR may represent a model of a real-world object, they can also present a world that doesn't exist in a real sense. However, if these scenarios are representations of non-existent objects and environments, they should still be understood by humans as real so that the user can feel like a part of the virtual world (Gorini & Riva, 2008).

The possibility to interact with the computer-simulated environment is made possible by the computers' properties: First of all, computers can synthesize a three-dimensional graphical environment from numerical data. Furthermore, the fact that input devices can sense the subjects' reactions and motions gives the computer the ability to modify the environment accordingly, creating within the user the illusion of interacting with and thus being immersed with the scenario (Gorini & Riva, 2008).

One of the key characteristics of VR that makes it a helpful tool in managing disorders is the ability to create a sense of presence (Slater & Sanchez-Vives, 2016). Since there is a range of definitions in literature used to describe presence in relation to VR, Wilkinson et al. (2021) conducted a meta-review to list some of the definitions, and try to construct a general one. Taking all definitions into consideration (Roettl & Terlutter, 2018, Triberti & Riva, 2016, Zahorik & Jenison, 1998, Lombard & Ditton, 1997, Slater, 2018, Pan & Hamilton, 2018, Cooper et al., 2018, Makransky & Lilleholt, 2018, Kisker et al., 2019, Slater, 2003, Diemer, 2015, as cited in Wilkinson et al., 2021), presence is a construct generally associated with the experience of being in another place or a situation – a detachment from everyday reality and a perceptual attachment to a different one. That "feeling of being in a world that exists outside the self" (Riva et al., 2004) distinguishes VR from other media. Furthermore, presence is the quality that enables VR to be characterized in terms of human experience rather than as a collection of technological hardware and software (Gorini & Riva, 2008). Felton and Jackson (2021) proposed that presence consists of two core dimensions: spatial presence and social presence. The first refers to the subjective sense that one is physically located within the perceived environment and is subject to physical consequences. Social presence refers to the degree to which another animate object appears to coexist in the same environment as the user. As presence is produced by removing the medium from the subject's conscious attention, VR has to reduce the experience of mediation offered to the user to increase the level of presence (Riva, 2022). However, there is no need to try to completely displace users from the physical place, as humans experience varying degrees of presence that depend upon different factors (Witmer & Singer, 1998).

The first necessary step in achieving the state of presence is changing of location of attentional resources, defined either as the ability to *focus*, that enables an individual to be broadly aware of the entire environment of the task (Fontaine, 1992, as cited in Witmer & Singer, 1998) or more specifically, as the ability of *selective attention,* that refers to the ability to focus on a set of stimuli in the virtual environment, while excluding unrelated stimuli in the physical location (Witmer & Singer, 1998). The other important factor that influences the degree of the individual's presence is the *involvement,* a psychological state experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events. Higher involvement in the experience and increased significance or meaning they attach to the stimuli leads to an increased sense of presence in the virtual environment. Therefore, it is important to ensure that users feel comfortable with the equipment and are not affected by external difficulties or stimuli that can reduce their involvement and, consequently, their sense of presence (Witmer and Singer, 1998).

The important factor whose intensity is positively correlated to the intensity of the subjective sense of "presence" is the *level of immersion* (Slobounov et al., 2015, as cited in Garcia-Betances et al., 2015; Witmer and Singer, 1998). Its variety of definitions was also included in Wilkinson et al. (2021) meta-review, where immersion was described in a more objective quality of VR, measured by technology's capacity to provide realistic feedback, general interaction, and its ability to allow the user to move and behave as they would normally. However, Witmer & Singer (1998) defined it as a psychological state where one perceives oneself as being included in and interacting with an environment that provides a continuous stream of stimuli and experience. VR can vary from being non-immersive, when it is no different than the simple video viewing experience with limited interactive capabilities, to being fully immersive when it can sensory separate users from the physical world and replace their sensory stream with the simulated scenario generated by the computer (Gaggioli et al., 2009, as cited in Riva, 2022). The difference between involvement and immersion is that high levels of involvement can be obtained with media other than the virtual environment. In contrast, immersion depends on perceiving oneself as part of the virtual environment's stimulus flow. The immersion exists when users perceive that they are interacting directly, not indirectly or remotely, with the environment (Witmer & Singer, 1998).

Like any other human experience, presence is related to emotions (Banos et al., 2004). It was proved that presence could induce emotions, which gave it the epithet of an "affective medium". Sense of presence and emotions interact circularly: The feeling of presence is higher in the environments that are emotionally important to the user but on the other side the emotional state is influenced by the level of presence (Riva et al., 2007). Their relation was proved when the interaction with "anxious" and "relaxing" virtual environments successfully produced anxiety and relaxation in the user (Villani et al., 2007). Banos et al. (2004) took one step further by proposing that it could be possible to consider emotions as a key indicator of the degree of presence. The highlighted importance of emotions in the context of virtual environments is related to Slater and Wilbur's (1997, as cited in Wilkinson et al., 2021) definition of immersion which indicates that the way participants become successfully immersed in an environment is through self-contained plots and narratives that represent the emotional life of the user.

As the sense of presence is a subjective experience (Bowman & McMahan, 2007, as cited in Paquay et al., 2021), it is important to give attention to the users' differences related to the experience of presence in VR. Personal characteristics such as *degree of absorption* and *hypnotic suggestibility* may mediate the effectiveness of VR. Other possible predictor variables for the sense of presence are *the propensity of participants to get involved passively in some activity* (like reading a book and watching movies), *the ability to concentrate*, and *alexithymia* (Emmelkamp, 2005). Among the factors that could influence the user's sense of presence identified by Servotte et al. (2020, as cited in Paquay et al., 2022) are: the user's ability to control the environment; personal and cognitive characteristics of a user; cybersickness; social factors. Paquay et al. (2022) found females to have a higher sense of presence than males. The quality of the interaction can be influenced by the user's attitude towards VR. The technology acceptance model (TAM; Davis, 1989) measures two factors that influence an individual's acceptance of technology: perceived usefulness and perceived ease of use. Studies that researched VR application in the field of mental health from the TAM perspective have demonstrated increased users' acceptance of VR (Costa & Carvalho, 20014; Garcia-Palasios et al., 2007, as cited in Chandrasiri et al., 2019), which is an optimistic finding related to VR's future perspective. Building on the Burdea and Coiffet's (2003) suggestion that one of the three factors determining the feeling of presence in VR next to the immersion and interaction is the imagination, Iachini et al. (2019) researched to explore the relationship between the people's ability for mental imagery (defined as the *capacity to voluntarily generate multisensory images based on information stored in long-term memory, without the corresponding external stimuli (Iachini, 2011)* and perceived presence. Their result confirmed the hypothesis that the ability to generate vivid visual images is positively associated with the capacity to feel present in a virtual world: the higher the vividness of mental images, the stronger the reported sense of presence felt in virtually induced scenarios. Besides imagination, empathy and spatial intelligence have been found to be internal factors that could influence the sense of presence in the user (Wallach et al., 2010, as cited in Paquay et al., 2022).

Presence can be mediated by the choice of senses that are included in a virtual experience. The most common senses stimulated in virtual environments have been sight (through 3D images) and hearing (using computer-generated sounds). To improve the experience, simulations of touch, smell or taste have been considered (Serrano et al., 2016). According to Dinh et al. (1999), as cited in Serrano et al., 2016), the more senses were stimulated by the virtual environment, the greater the experience of presence was created. Presence was particularly induced when hearing and touch were introduced. Adding a physical object that would provide tactile feedback while a virtual hand was exploring a virtual object has been found to increase the sense of presence (Hoffman et al., 1998, as cited in Serrano et al., 2016). In psychotherapy, the virtual environments have been mostly based on visual realism. However, to create more emotional environments, auditory and tactile stimuli have been added to the experience. Adding the scent to the VR experience is shown to increase the presence of participants during an exposure task and removing scents likely results in reducing the presence (Munyan et al., 2016). The association can mediate this effect between smell and strong emotional memories (Emmelkamp, 2005; Munyan et al., 2016).

1.1.1. Measuring presence

To create immersive VR experiences and study interaction in VR, it is crucial to measure presence in a reliably way . Although there is still no a shared consensus on how to measure it (Yan et al., 2020), the most common method for measuring this construct are questionnaires that rely on conscious feedback explicitly requested by the user, which has been shown as sensitive enough to find differences in the presence (Insko, 200, as cited in Schwind, et al., 2019). The most common measure used to investigate the subjective presence is the *Post-immersion questionnaire* (Van Baren & Ijsselsteijn, 2004, as cited in Felton & Jackson, 2021) that asks users to rate their sense of virtual presence, often using Likert-scaled items, following their exposure to a VR environment. In 1992, Witmer and Singer developed the initial version of the *Presence Questionnaire (PQ)*, based on their conceptualization of the four categories of factors that are thought to underlie the concept of presence: control factors, sensory factors, distraction factors, and realism factors. It was developed to measure the degree to which individuals experience presence in a virtual environment and the influence of possible factors on the intensity of this experience (Witmer & Singer, 1998). Structurally, it consists of 32 questions, each on a 1 to 7 scale (Witmer & Singer, 1998). In addition to PQ, they developed the *Immersive Tendencies Questionnaire (ITQ)*, intending to measure the capability or tendency of individuals to be involved or immersed in the virtual environment. The logic behind ITQ was that individuals who tend to become more involved would also have greater immersive tendencies. Both PQ and ITQ rely exclusively on self-report information (Witmer & Singer, 1998).

The Igroup Presence Questionnaire (IPQ), developed by Schubert et al. (2001, as cited in Yan et al., 2021), was based on the embodied cognition framework and identified three factors to measure sense of presence: spatial presence, involvement, and judgment of reality. *The Temple Presence Inventory (TPI)* (Lombard et al., 2000, as cited in Yan et al., 2020), on the other hand, included eight factors to measure the presence: spatial presence, parasocial interaction, passive interpersonal presence, active interpersonal presence, engagement, social richness, social realism, and perceptual realism.

Based on all previous research and questionnaires that already exist, Lessiter et al. (2001., as cited in Yan et al., 2020) developed the *Independent Television Commission-Sense of Presence Inventory (ITC-SOPI)*. Being formatted as a 5-point Likert-type scale, it was theoretically based on four factors: a sense of physical space, engagement, ecological validity, and negative effects. Sense of physical space indicates how individuals are physically involved in a virtual environment, while engagement refers to how individuals are psychologically involved in a virtual environment. Ecological validity measures how close to real a virtual environment is. Negative effects indicate adverse physiological reactions (Yan et al., 2020).

To overcome the limitations of subjective measures, presence can be measured by incorporating physiological and behavioral measures. Behavioral measures rely on an observer or machine recording a user's overt actions or responses to the VR environment (Felton & Jackson, 2021). They are based on the assumption that the sign of a user experiencing a strong sense of virtual presence is when they behave in the virtual world as they would in the physical world (Van Bareen & Ijsselsteijn, 2004, as cited in Felton & Jackson, 2021). While there has been little research into whether behavioral measures are reliable enough (Insko, 2003, as cited in Schwind et al., 2019), there are promising results with physiological measures such as heart rate (Meehan et al., 2002 as cited in Schwind et al., 2019).

1.1.2. The interface used to arrogate virtual reality

The construction and the implementation of a virtual environment are achieved by the presence of both technology's hardware and software. On one side, the hardware units like a central processing unit, monitor, keyboards, mouse, and a joystick are needed to construct a virtual environment. On the other side, media that enables the creation of specific tasks allowed by the software's properties allows an interface and interaction with the user (Gatica-Rojas & Mendez-Rebolledo, 2014). To achieve the real-time simulation offered to the user by the environment, the system of VR requires an output or a visual interface (Head-mounted Display or flat screen), input interfaces for interaction (mouse, joystick, or wired gloves), and tracking devices (Gatica-Rojas & Mendez-Rebolledo, 2014).

Head-mounted displays (HDMs) are devices that are commonly used to mediate immersive VR. They limit any visual contact with the external world, which is replaced with computer-generated images by an internal display. Thanks to the sensors placed in the HDM, the computer-generated image is dynamically adapted to different viewing positions, and the real world shuts out and is not perceived anymore (Liu et al., 2019). Due to their proximity to the eye of the user, the images they display have the highest possible resolution (Gatica-Rojas & Mendez-Rebolledo, 2014). HDMs consist of one monocular or binocular device, and their placement on the user's head allows them to follow the user's movements, making him/her feel integrated into the virtual environment (Monge Pereira et al., 2012, as cited in Gatica-Rojas & Mendez-Rebolledo, 2014). The images obtained through HDM are available to the experimenter who is connected to the computer, so he can see what the user is viewing and fill in the scores achieved during both the current and last sessions to move the user through the virtual environment. The transfer of information between humans and VR must be real-time for users to feel as if they are an integral part of the reality-like virtual experience and perform their actions fluidly and naturally (Liu et al., 2019).

1.2. The application of virtual reality in the field of clinical treatment

As it has been shown as an efficacious technique in different areas from the experimental perspective and was supported by clinical outcomes, VR has been used in medicine (Riva & Wiederhold, 2006, as cited in Gorini & Riva, 2008), aiming to provide adequate training and to make surgical operations successful (Javaid & Haleem, 2020). It helps in achieving this goal by allowing the students and doctors to virtually interact with the human body by virtually interacting with the patient's soft tissue (Bouchard et al., 2017; Birckhead et al., 2019., as cited in Javaid & Haleem, 2020). Surgeons find it helpful because it assists them in operating without any harm, providing the best solution to study the challenging issues and their solutions (Javaid & Haleem, 2019, as cited in Javaid & Haleem, 2020). Javaid and Haleem (2020), in their article summed up the benefits of introducing VR to medical settings: *reduction of surgical time, errors in medical process and training cost; an increase of confidence; improvement of accuracy and communication; improvement of safety, motivation,* and in the end *entertainment of the patient*.

1.2.1. Virtual reality's application in the psychological field

As mentioned earlier, VR has been used in the field of psychology to provide an interaction between the human and the computer, with a high level of control of the interaction with the tool and the enriched experiences provided to the patient (Rothbaum et al., 2000, as cited in Riva, 2002). It allows individuals to act, communicate and become present in the computer-generated environment (Riva et al., 2019).

The above-explained feeling of “being there” experienced during a virtual experience offers a particularly relevant feature for psychology: allowing users to experience a dynamic and social world where they can live and even share specific experiences (Riva & Serino, 2020). Furthermore, the flexibility and the programmability of virtual environments enable the therapist to present a wide variety of controlled stimuli and to measure and monitor a wide variety of responses made by the user (Riva & Gamberini, 2000, as cited in Riva, 2002). One of the broad examples of VR’s application in psychology has been to induce various moods and emotions. For example, it was used to induce positive emotions in patients with metabolic cancer (Banos et al., 2014) and fibromyalgia (Herrero et al., 2014).

In the field of Clinical psychology, VR is mostly used in treatments as a “simulative tool” to recreate ecologically valid scenarios that reproduce feared or critical situations (for example fear of speaking in front of an audience) with precise control over the stimuli delivery according to both therapeutic strategies and patient’s needs (Riva et al., 2019). In this way, VR allows the extending of the boundaries of traditional approaches to treatments (Riva & Serino, 2020).

Two meta-reviews (Riva et al., 2016; 2019) assessing more than 53 systematic reviews and meta-analyses exploring the current use of VR in Clinical psychology support its use in diverse mental disorders (anxiety disorders, eating and weight disorders, pain management) with long-term effects produced the real world. It also has significant applicative potential in other areas like psychosis and addictions (Riva, 2022).

1.2.1.1. *Virtual reality and Anxiety disorders*

One of the most effective treatments for anxiety is exposure therapy, where a person is exposed to specific feared situations or objects that trigger anxiety, and it can be done through actual live exposure, with visualization, imagination, or using VR. In the mid to late 1990s, in the clinical setting, VR started to be added to the *in vivo* exposure-based therapy, providing in-office, controlled exposure therapy to anxious patients, avoiding many of the complications of the *in vivo* exposure: patients are not always willing to expose themselves to the real phobic stimulus or situation; also, *in vivo* exposure can never be fully controlled by the therapist and its intensity can be too strong for the patient (Gorini & Riva, 2008). VRET (VR exposure therapy) has the potential to control, enhance and accelerate the treatment process by offering several advantages over real exposure or imagination techniques (Gorini & Riva, 2008). The interactivity, flexibility, controllability, confidentiality, safety, time-saving, cost savings and repeatability are the defined advantages that make VR, in combination with the traditional cognitive-behavioral therapy, a promising method to increase the likelihood of therapeutic success (Gorini & Riva, 2008). Surveys indicate that many people would prefer to receive VRET over traditional exposure therapy, with one study illustrating that 76% of participants chose VR over in vivo exposure (Garcia-Palacios et al., 2007). Emmelkamp (2005) defined several advantages that VR exposure has over in-vivo exposure: the treatment can be conducted in the therapist's office rather than the therapist and patient having to go outside to do the exposure exercises in the real phobic situation; it provides the possibility of generating more gradual assignments (sequence and intensity of treatment); it is highly cost-effective, and it can be applied on patients who feel too anxious to expose themselves to live exposure. Another advantage of VR is the possibility of treating “residual fears, " given that it can go beyond what a real situation would allow, making overlearning easier to perform (Botella et al., 1998).

Many studies have confirmed the positive impact that VRET had in treating anxiety disorders. Several meta-analyses (Powers & Emmelkamp, 2008; Opris et al., 2011; Carl et al., 2019) confirmed strong treatment effects of VRET for anxiety disorders. The former expands support for using VR for social anxiety disorder, performance anxiety, post-traumatic stress disorder, and panic disorder. The majority of research has focused on VR’s success in the treatment of specific phobias. VR has been presented as a successful tool in treating *flight phobia.* Research conducted by Mühlbergeret al. (2001) revealed that both the virtual exposure flights and relaxation training sessions effectively reduced fear responses in flight phobics. Hodges et al. (1996) did a case study where they tested the effect of virtual flight on the participant's fear of flying. The results indicated that during virtual flight participants experienced many of the classic anxiety symptoms that would be manifested by a person on a real airplane who was afraid of flying. Botella et al. (1998) were the first to report VR's effectiveness in treating *claustrophobia,* where the patient's anxiety for closed spaces decreased after several VR graded exposure sessions. VR has also been shown to reduce anxiety in: *the fear of public speaking* (North et al., 1998); *spider phobia* (Garcia-Palacios et al., 2002); *acrophobia* (Emmelkamp et al., 2002); *fear of driving* (Kaussner et al., 2020); *agoraphobia and panic disorder* (Weschler et al., 2019). The additional support to the success in treating phobias is that virtually-induced phobic stimuli activated the same brain regions as real image stimuli: higher activations of the amygdala and insula were detected both in virtual and real exposure (Peñate et al., 2019).

A common belief among clinicians is that VR may induce more dropouts than other approaches. However, a recent meta-analysis on attrition rates in VR (Benbow & Anderson, 2019) demonstrated that among 1057 participants involved in 46 different studies, only 16% dropped out. These results are similar to the ones conducted for the in vivo exposure. A growing body of literature is now supporting VR for other anxiety disorders, from stress management (Pallavicini et al., 2016; Shah et al., 2015) to generalized anxiety disorder (Repetto et al., 2011). The overview written by Emmelkamp et al. (2020) illustrated that VR has been used successfully in various studies to treat social anxiety disorder.

1.2.1.2. Virtual reality and other psychological disorders

The usefulness of VR expands in the treatment of other DSM-5 categories. Different research papers showed VR could be used successfully in the treatment of posttraumatic stress disorder (PTSD). The meta-analysis by Kothgassner et al. (2019) revealed encouraging findings regarding the VRET's efficacy in reducing PTSD symptoms. However, as the effect is still medium to non-significant when compared to the waitlist and active control group, the authors inferred that VR should be used as an alternative to the traditional therapies, used exclusively in scenarios where the opportunity for in vivo treatment is lacking. The researchers recently developed a VR Iraq to attempt to improve the activation of the traumatic memory during exposure therapy. According to the subjective evaluation of U.S. Army soldiers, 86% of soldiers rated the overall realism of the VR convoy as ranging from adequate to excellent, and 82% reported adequate-to-excellent overall realism of the city environment (Reger et al., 2009), which is a promising result regarding the level of accuracy of presenting scenarios virtually.

It has been used as a safe setting for assessing psychotic symptoms (Riva, 2022). Its first application inside the psychosis spectrum was to explore the psychological processes and mechanisms associated with the onset and maintenance of psychotic symptoms (Valmaggia et al., 2016, as cited in Riva, 2022). Given the possibility of presenting an unlimited number of different hypothetical situations, VR is used for creating specific scenarios to train and develop problem-solving, social, and interpersonal skills (Fernandez-Sotos et al., 2020). It allows researchers to control the levels of paranoid ideation and auditory hallucinations through the manipulation of density of population and avatars, or even the user's height (Veling et al., 2021). More recently, VR has been utilized to improve the effects of cognitive remediation therapy for psychotic disorder, a clinical approach that aims at improving cognitive processes to achieve permanent benefits that could be generalized to daily life functioning (Wykes & Spaulding, 2011, as cited in Riva, 2022).

Some of the VR's features help patients who suffer from autism to master their environments, and they achieve this by adapting to patients' needs: the features can be simplified so that input stimuli are understandable and tolerable by the patients; minimal modification across similar scenes may allow generalization and decrease rigidity; a virtual learning world provides a less harmful environment; it stresses visual response, and it offers individualized treatment; it provides learning with minimal human interaction (Strickland, 1996).

Over the last two decades, VR has offered innovative solutions for reducing food cravings, improving body image, and enhancing emotion regulation skills in eating and weight disorders (Riva et al., 2016). The study conducted by Perpina et al. (1999)focused on the effect of VR on the treatment of body image disturbances, that is considered central in eating disorders. Their results reveal that patients treated in the VR condition showed greater significant improvement than those treated by traditional techniques. Marco et al. (2013) implied at long-term follow-up that the CBT program for eating disorders enhanced by a body-image-specific component using VR techniques was more efficient than CBT alone. Manzoni et al. (2016) found that VR-enhanced CBT proved to be more effective in treating morbid obesity than CBT alone, although CBT is thought to be the golden treatment in this field.

Segawa et al. (2020) suggested through their systematic review that VR provides benefits in assessing and treating substance use disorders and behavioral addictions. When subjects were exposed to opiate cues presented through VR, they experienced increased urges to use (Kuntze et al., 2002, as cited in Bordnick et al., 2008). Also, it has been found that VR is capable of generating significant increases in subjective alcohol craving when drinkers are exposed to virtually induced alcohol cues compared to neutral ones presented through virtual environments (Bordnick et al., 2008). It is important to note that although studies support VR's ability to induce addictive behavior, treatments based exclusively on virtual exposure to addiction-related cues have shown heterogeneous results (Segawa et al., 2020).

The use of VR has been spread to the area of treating cognitive malfunctioning. Relying on several aspects of psychophysics, it offers the possibility of performing activities, tasks, and tests that can adapt to various characteristics and needs of individual patients. Its use in diagnosing and treating cognitive impairment can provide a fully controlled experimental environment for timely observation of memory, emotion, perception, motion control, and other aspects of the user (Tarnanas et al., 2014, as cited in Liu et al., 2019). A characteristic of VR that can be very helpful for Alzheimer's disease applications, is the high interaction level that is possible to achieve in safe virtual environments, where patients may interact from egocentric and allocentric points of view (Weniger et al., 2011, as cited in Garcia-Betances et al., 2015). The meta-analysis conducted by Kim et al. (2019) through analyzing the experimental studies indicated that VR had small-to-medium positive effects on key outcome variables such as physical fitness, cognition, and emotion.

1.3. Advantages of virtual reality in psychological research and treatment

VR has been widespread in psychology because it allows precise control over stimulus and environment, and enables the recording of the accurate performance and behavioral measurements (Annett & Bischof, 2010). Also, besides the already mentioned possibility of presenting environments and situations that would be impossible to present in traditional settings (Gorini & Riva, 2008), it gives an alternative to the research that could be unethical if conducted traditionally (Annett & Bischof, 2010).

There are a lot of advantages that make VR a great and useful tool for exploring and treating a person's mental condition. In their work on exploring the use of VR as the tool for conducting health psychology research, Martigano and Persky (2021) identify the five advantages of VR using the acronym "DREAM" (*data collection*, *realism*, *experimental control*, *adaptability,* and *mobility*). First of all, it makes collecting data easier, by giving precise measurements of physical movements that are taken covertly, automatically, and continuously over time, and capturing subtle indicators of variables participants are unable or unwilling to verbalize. This allows designers to create any scenario to measure participant behavioral response. After that, users' sense of presence makes their behavior ecologically valid without placing participants at risk through dangerous or harmful situations. This allows for the situation not to lose its realism. Furthermore, stimuli being presented in the same format every time enables a high level of experimental control. Then, the possibility to create any situation as needed even if it is rare or impossible for the participant demonstrates its ability to adapt. Finally, once a VR-based experiment is created, it can be directly replicated including hard-to-reach settings and populations and it can ease multi-group collaborations across various research sites using the same software.

It is important to note that using VR devices brings some side effects. Some of the concrete recognized side-effects of exposure to virtual environments are the following: *symptoms of motion sickness; the strain on the ocular system; degraded limb and postural control; the reduced sense of presence; the development of response that is inappropriate for the real world*. Identifying these problems helps scientists develop and improve the tool, and consequently reach better results (Riva, 2002). To investigate symptoms that could be induced while viewing VR imagery through an HMD*, The VR Symptom Questionnaire* was designed and developed. It consists of the 13 symptoms that are used to describe the overall user's experience while indicating difficulties that could occur as a consequence of the exposure to VR. The symptoms are divided into two subgroups: general body symptoms (*general discomfort, fatigue, boredom, drowsiness, headache, dizziness, difficulty concentrating, nausea*) and eye-related symptoms (*tired eyes, sore/aching eyes, eyestrain, blurred vision, difficulty focusing*) (Ames et al., 2005).

2. Relaxation techniques

2.1. General aspects of relaxation

Unlike the biomedical model, which perceives illness as a result of a cellular pathology alone (Virchow, 1858, as cited in Alonso, 2004) and doesn't leave room for the social and psychological dimensions of illness (Engel, 1980 in Wade & Halligan, 2017)**,** the biopsychosocial model allows illness to be seen as a result of interacting mechanisms at the cellular, tissue, organismic, interpersonal and finally environmental levels (Fava & Sonino, 2008). In other words, the biopsychosocial model considers the interaction of biological, social, and psychological factors crucial in understanding the illness (Engel, 1980, as cited in Alonso, 2004). Psychosocial factors may change the course of illness, although their impact may vary depending on the context (Fava & Sonino, 2008).

The very important factor contributing to the process of health and illness is psychosocial stress (Kiecolt-Glaser et al., 2002, as cited in Astin et al., 2008). Stress is defined as an individual's psychophysiological response to any demand perceived to threaten physical, emotional, or psychological health (Varvogli & Darviri, 201, as cited in Shah et al., 2015). Although at low to moderate levels it can be beneficial to the individuals (Shah et al., 2015), prolonged exposure to stress can lead to serious physical health conditions, such as cardiovascular disease, diabetes, cancer, and autoimmune syndrome (Wiegner et al., 2015, as cited in Riches et al., 2021), but also to psychological distress, anxiety, and substance abuse (Thoits, 2010, as cited in Riches et al., 2021). Stress is thought to produce a "stress response", which consists of a set of physiological alterations, among them being the increase in heart rate, blood pressure, and respiration rate

(Dusek & Benson, 2009), produced by the activation of the "fight or flight" response that occurs by the sympathetic branch of the autonomic nervous system when our body is experiencing stress (Selye, 1956, as cited in Dusek & Benson, 2009). Contrary to the stress response, Benson (1982) introduced the physiological state as opposed to the "stress response": "relaxation response", which can be elicited voluntarily and is associated with a dominant activity of the parasympathetic branch of the autonomic nervous system, causing a set of physiological changes opposite of those elicited by the activation of sympathetic branch: decrease in heart rate, blood pressure, respiration rate. Along with the physiological changes, the relaxation response is followed by an increased sense of well-being and the feeling of being physically rested. These psychological changes result from the voluntarily achieved absence of the tension between the body and mind (Esch et al., 2003, as cited in Montero-Marin et al., 2019).

To elicit a relaxation response voluntarily, relaxation techniques are introduced as a part of the therapies that belong to the Mind-Body medicine (Conrad & Roth, 2007, as cited in Blanco et al., 2014). They are used in the prevention and treatment of stress and its consequences (Škarica, 2016). As prolonged exposure to chronic stress is linked with numerous health consequences, relaxation has become an integral part of medical procedures. However, much scientific effort was needed to refute the skeptical view regarding the secular relevance of relaxation techniques, as though history they were perceived as a part of different religious practices. With the change of perspective, the aim of practicing these techniques has changed. While historically they have been used to promote human flourishing, insight, enlightenment, and connection to something larger than oneself, today's use is directed toward achieving mental health benefits and stress relief (Dossett et al., 2020).

Relaxation techniques are an integral component of Cognitive-behavioral therapy, and like any other cognitive-behavioral technique, are underlined by a set of fundamental principles and assumptions (Bond & Dryden, 2002).

Psychologists use relaxation techniques intending to reduce people's levels of stress, improve concentration, reduce anxiety, relieve pain, or help medical illness that is accompanied by psychological symptomatology (Hubbard & Falc, 2015). Relaxation techniques are based on a concept that considers humans' functioning from an integrative perspective, considering diverse inter-related physical, emotional, mental, and spiritual dimensions as a unit. Their general goal is to improve one's emotional, psychological, physical, and physiological well-being (Manzoni et al., 2008, as cited in Montero-Marin et al., 2019) by producing physiological, cognitive, and behavioral changes. The physiological changes elicited by relaxation are uniform and significant decreases in oxygen consumption, carbon dioxide elimination, heart and respiratory rates (Benson, 1982), metabolic rate, brain waves, and blood pressure (Santos-Silva et al., 2020). Considering the perspective of the subjective cognitive experience, relaxation response implies an altered state of consciousness, described as *a peace of mind, feeling at ease with the world,* and a sense of well-being (Benson, 1982).

Subjective factors considered by relaxation were identified in Smith's (Smith, 2007) Psychological relaxation theory, through various subjective experiences reported during physical relaxation states. He proposed four categories of subjective relaxation experience that exist behind basic relaxation states: *basic relaxation,* characterized by perceptions of physical or mental relaxation and feeling of ease and peacefulness; *core mindfulness,* including states of mental focus, heightened awareness, and nonjudgmental acceptance, *positive energy* described as joyful and optimistic, and *transcendence,* characterized by experiences described as "larger and greater than oneself". The strongest benefits from relaxation are found in populations that are especially vulnerable to symptoms of stress, such as terminal patients or elderly people (Santos-Silva et al., 2020). A meta-analysis by Montero-Marin et al. (2019) suggested that there is no evidence that relaxation therapies are less effective than cognitive and behavioral therapy for the treatment of generalized anxiety disorder and panic disorder, at least considering short-time results. Another meta-analysis (Li et al., 2020) revealed that depressed adults who received relaxation interventions experienced greater improvements in depression than controls who didn't receive them. The proposed mechanism that mediates the connection between depression and relaxation is that relaxation techniques can improve exercise durability, relieve symptoms, improve social adaptability, relieve psychological pressure, and consequently relieve depression (Jorm et al., 2008, as cited in Li et al., 2020).

By its ability to induce a relaxation response, exposure to natural environments alone can be associated with mental health benefits (Pearson & Craig, 2014). It has been associated with lower levels of stress (Thompson et al., 2021; in Pearson & Craig, 2014) and reduced overall symptomatology for depression and anxiety (Beyer et al., 2014 in Pearson & Craig, 2014). The term "natural environments" includes the ones that are relatively unchanged or are free from human culture and influences (Johnson et al., 1997, as cited in Mantler & Logan, 2015). They are often rich with vegetation and non-human animal life, and atmospheric components such as light, radiation, charged irons, aromatic chemicals, and microbes. Although numerous pollution factors influence the urban cities, natural areas can be found within urban environments, and are usually parks, gardens, or waterside areas (Mantler & Logan, 2015).

People with more access to green spaces showed better mental and general physical health (Triguero-Mas et al., 2015, as cited in Schutte et al., 2017). Similarly, Passmore and Holder

(2016, as cited in Schutte et al., 2017) concluded that non-clinical participants who attended to nature in their everyday surroundings for two weeks showed more positive affect than those who attended to human-built surroundings. The benefits of natural environments are also proven through physiological measures. Spending time in a natural environment, participating in activities associated with gardening, or even simply viewing scenes of nature have been each associated with more dominant parasympathetic activity and increased heart rate variability, indicating the relaxation response was elicited (Yamane et al., 2004, as cited in Mantler & Logan, 2015). Research that studied the effects of forest therapy revealed that walking through forest settings resulted in lower levels of cortisol, reduced sympathetic tone, and improved blood pressure and heart rate variability, all of them being indicators of reduced level of stress (Takayama et al., 2014, as cited in Mantler and Logan, 2015). These findings were supported by neuroimaging discoveries, with fMRI demonstrating that scenes of natural environments, in comparison with urban ones, increase activity in brain regions associated with positive mental outlook and emotional stability. On the other hand, exposure to urban environments was found to be connected to the increased activity of the amygdala, which is known as the brain's center for processing arousal (Kim et al., 2010).

Despite the proven benefits of the natural environment on mental health, the mechanism behind this process is not clear. Two theories that might explain this phenomenon are Ulrich's Stress recovery theory (SRT) (Ulrich et al., 1991) and the Attentional restoration theory (ART) developed by Kaplan (Mantler & Logan, 2015). The first theory (SRT) is based on the argument that people adapt better to natural environments due to their ancestral experiences with nature. According to this theory, the reason for the decreased stress is a positive emotion resulting from an experience in nature (Mantler & Logan, 2015). The other theory (ART) is based on the effect of *restorativeness,* which is defined as a reduction in cognitive fatigue, decreased negative affect, and decreased sympathetic nervous system activity (Hartig et al., 1991, as cited in Valtchanov et al., 2010). It involves thoughts and perceptions that result in an individual's sense of being away from the ordinary routines of life and their feeling of being connected to alternative surroundings (Hartig et al., 1997, as cited in Schutte et al., 2017). According to the Attentional restoration theory, exposure to urban environments results in cognitive fatigue because people are forced to use their attention to overcome the effects of constant stimulation these environments acquire. In contrast, natural settings do not require mental effort, and they automatically capture attention while simultaneously eliciting feelings of pleasure (Pearson & Craig, 2014), offering physiological, emotional, and attentional restoration more than urban environments (Berto, 2014, as cited in Adhyaru & Kemp, 2022). These two theories are considered complementary to each other, as stress and mental fatigue are believed to be correlated (Mantler & Logan, 2015).

A variety of relaxation techniques are used through diverse approaches and psychotherapy methods (Santos-Silva et al., 2020). Some of them (Progressive Muscle Relaxation, and guided imagery) are used as distraction interventions. These are the emotion-focused interventions that turn people's attention from unpleasant stimuli toward pleasant or interesting ones by manipulating the environment, leading to decreased stress and anxiety (Schneider & Hood, 2007). They are based on Lazarus and Folkman's Stress and coping model, which defines stress as a relationship between a person and an environment that is perceived as threatening. In contrast, the coping responses are defined as thoughts and activities that people use to manage stressful situations. They believe that people turn to emotion-focused coping strategies at times when they realize that there is nothing that could be done to change a threatening situation. Distraction has been used widely in reducing distress symptoms associated with chemotherapy treatments (Chirico et al., 2020; Schneider & Hood, 2007). It is not yet clear if relaxation techniques can be effective as distraction strategies. These techniques require conscious and constant concentration and they require to be practiced before the contact with the unpleasant stimuli, and even with the practice, some patients are not able to allocate attention to unpleasant stimuli (Schneider & Hood, 2007).

A type of distraction intervention that has shown as helping to alleviate distress and treatment-related symptoms is receptive music therapy (MT), which encompasses any intervention in which patients listen to music with the aid of a reproducer under the guidance of the therapist (Atiwannapat et al., 2016; Bruscia, 2018, as cited in Chirico et al., 2019). A meta-analysis conducted by Gramaglia et al. (2019) concluded that there is overall support for the positive effect of music therapy on anxiety, depression, pain, and quality of life.

2.2. Progressive Muscle Relaxation Training (PMRT)

The dominating relaxation technique in literature is Progressive Muscle Relaxation training (PMRT), originally developed by Edmund Jacobson in 1938. PMRT allows individuals to relax while increasing their awareness of personal stress (Chen et al., 2009). It is a stress-reduction intervention that consists of systematically tensing and relaxing various muscle groups from head to feet while focusing on the contrasting sensations of tension and relaxation (Dolbier & Rush, 2012). Jacobson based his idea on the assumption that mental relaxation arises from the physical system, and that it is not possible to have relaxed and tense muscles simultaneously (Škarica, 2016). It uses the principles of neuronal “top-down” and “bottom-up” processing to achieve results (Keptner et al., 2020, as cited in Toussaint et al., 2021). In “top-down” processing, participants use higher cerebral areas like the cerebral cortex and the cerebellum to contract the muscle and gradually release the tension. In “bottom-up” processing, the holding and releasing bodily tension produce proprioceptive stimulation from peripheral muscles that ascends to the brain via the spinal cord and the brainstem (Toussaint et al., 2021). The cognitive-behavioral relaxation model proposes several mechanisms by which PMRT may reduce stress (Smith et al., 1996). One proposed mechanism is tension relief, the positive sensations that correspond to somatic and cognitive arousal reduction (Smith et al., 1996). Tensing and relaxing muscles alleviates physical tension and increases feelings of relaxation (Conrad & Roth, 2007; McCallie et al., 2006, as cited in Dolbier & Rus, 2012). Another potential mechanism is disengagement from unnecessary goal-directed and analytic activity (Smith et., 1996). A third possible mechanism is maintaining focus on simple stimuli. Mentally focusing on following the instructions and the contrast between tension and relaxation leave little time to focus on thoughts connected to stressors (Carlson & Hoyle, 1993, as cited in Dolbier & Rush, 2012). The use of PMRT has been widely spread because of its low cost, simplicity, and effectiveness across a variety of populations. The original Jacobson method required dozens of sessions where the subject was thought to relax 30 different muscle groups, but professionals have abbreviated the original method, due to the cost-effectiveness and time restrictions. Study results show that abbreviated PMRT can produce significant changes in physiological functioning, while original PMRT has produced medium-sized effects in various populations for physical pain and anxiety (Toussaint et al., 2021).

There are numerous physiological and psychological benefits of PMRT such as lower blood pressure, cortisol, heart rate, fatigue, anxiety, and pain, as well as increased perceived control, quality sleep, and energy (Krajewski, Sauerland, & Wieland, 2011; Kwekkeboom et al., 2008;

McCallie et al., 2006; Pawlow & Jones, 2005 as cited in Dolbier & Rush, 2012). Progressive Muscle Relaxation Training (PMRT) can be used to teach patients to practice how to systematically relax their muscles (Lehreh, 1982; Payne, 2000, as cited in Chen et al., 2009). It is primarily used to reduce stress levels. In a study conducted by Pv and Lobo (Pv and Lobo, 2020, as cited in Toussaint et al., 2021), the stress levels of a sample of first-year nursing students were lower after PMRT.

2.2.1. The evidence-based data on the use of PMRT in medical settings

PMRT has been shown to be a successful technique in diverse populations and contexts. As psychological symptoms often follow physical illness, PMRT has been used for treatments of these side effects in various illnesses. It was found to be consistently effective in reducing emotional and physiological side effects of chemotherapy treatment (Burish & Tope, 1992; Holand et al.,1991). Nickel et al. (2006) found out that there was an enhancing effect of relaxation training on lung parameters, as lung function in pregnant women who suffered from asthma was significantly improved after PMRT. It positively reduced depression and anxiety in patients with coronary heart disease (Chanduri et al., 2020, as cited in Toussaint et al., 2021). It has been an effective psychosomatic intervention in treating anxiety, depression, and quality of life in patients with Pulmonary Arterial Hypertension (PAH) (Li et al., 2015). In combination with the music treatment, PMRT produced clinically significant changes in anxiety and dyspnoea along with the physiologic measures in hospitalized COPD (chronic obstructive pulmonary disease) patients (Singh et al., 2009). Similarly, Chegeni et al. (2018) suggested that PMRT can reduce fatigue and improve sleep quality in COPD patients. There is also some evidence that it is effective for inflammatory arthritis, and irritable bowel syndrome (Barrows & Jacobs, 2002). The research on PMRT has expanded and is continuing to grow. Recent research revealed that PMRT could help increase sleep quality and reduce anxiety in patients diagnosed with COVID-19 (Liu et al., 2020). Their results demonstrated that PMRT could be successful in reducing both symptoms. Abbreviated PMRT positively impacted the physiological functioning among college students experiencing high stress levels, as they demonstrated greater increases in relaxation and parasympathetic activity and greater decreases in anxiety and possibly sympathetic activity compared to the control group participants (Dolbier, 2021).

PMRT can be used complementary to other techniques. It has shown important success when used combined with guided imagery. Their combined use was effective in reducing pain and mobility difficulties in women who suffer from osteoarthritis (Beird et al., 2004); it led to reduced stress, anxiety, and higher quality of life in the breast cancer patients (Sinha et al., 2021); it reduced stress, anxiety, and depression in pregnant women (Nasiri et al., 2018). All the evidence concludes that their combined use can be a successful self-management relaxation technique (Beird et al., 2004).

2.2.1.1. The evidence-based data on the use of PMRT in psychological disorders

PMRT is beneficial also in reducing the symptoms of mental disorders. It has been found as an efficacious technique in treating anxiety and depression. The literature highlights its role in reducing anxiety in patients with chronic schizophrenia. In this concrete study, the anxiety levels in the experimental group receiving PMRT improved (Chen et al., 2009). Reducing the arousal before falling asleep, PMRT helps regulate primary insomnia diagnosis (Alexandru et al., 2009).

In the sample of stressed aggressive adolescents, PMRT reduced cortisol concentrations (Nickel et al., 2005). Suhr (1999) hypothesized that training PMRT in people with Alzheimer's Disease would lead to a reduction of psychiatric and behavioral difficulties, but also improve performance on cognitive screening measures. Positive answers led them to conclude that PMRT can effectively manage psychiatric and behavioral disturbance in AD patients with mild to moderate dementia. PMRT was shown to be effective even in reducing social anxiety (Joy et al., 2014).

2.3. Body Scan

The relaxation techniques spectrum continues with the techniques developed from the concept of mindfulness. Mindfulness can be thought of as moment-to-moment, non-judgmental awareness, cultivated by paying attention in a specific way, that is, in the present moment, and as non-reactively, as non-judgmentally, and as open-heartedly possible (Kabat-Zinn, 2015). It has been described as part of the third wave in cognitive-behavioral therapies (Hayes, 2004), and it aims to empower patients to engage in active coping through encouraging awareness of the present, in which, often difficult, thoughts, feelings, and sensations are acknowledged and accepted without judgment (Kabat-Zinn, 1990; Shapiro & Schwartz, 1999, as cited in Ussher et al., 2012).

Based on mindfulness, Jon Kabat-Zinn developed the mindfulness-based stress program (MBSR) which brings together a range of techniques and practices (Dreeben et al., 2013) and was originally developed to facilitate adaptation to mental illness by providing systematic training in mindfulness meditation as a self-regulation approach to stress reduction and emotion management (Bishop, 2002). It aims to teach people to approach stressful situations "mindfully" so they may respond to the situations instead of automatically reacting to them (Bishop, 2002), which allows a larger behavioral spectrum and greater freedom when faced with internal and external stressors (Colgan et al., 2015). Building awareness of the present moment with an attitude of acceptance and curiosity alters the relationship and interaction with the distressing content rather than changing the content itself (Colgan et al., 2015). People practicing MBSR are encouraged to maintain attention to their immediate experience with an attitude of openness, acceptance, curiosity, and compassion (Bishop et al., 2004). It enables nonjudgmental awareness of one's cognitive and somatic experience on a moment-by-moment basis (Kabat-Zinn, 1982), where this decentered stance is believed to disconnect cognitive and affective mental events adaptively (Teasdale et al., 2000 as cited in Sephton, 2007) and may reduce the negative impact of thoughts and sensations associated with chronic pain. As discussed earlier in the chapter, awareness of the present moment and its associated thoughts, emotions, and sensations that are achieved through mindfulness, appear to be prerequisites for achieving maximal health benefits of natural environments. Exposure to nature may not fulfill its full clinical promise if the individual is distracted from mindful awareness (Mantler & Logan, 2015).

Three meditation elements build MBSR: Body Scan, yoga, and meditation. It typically consists of an introductory informational meeting followed by eight, two and a half hours lasting group meetings with an all-day retreat on the weekend of the sixth week. Participants are expected to commit to 45 minutes of home practice, six days of the week for the entire 8-week program (Kabat-Zinn, 1990, as cited in Dreeben et al., 2013). The key component of mindfulness meditation is Body Scan. They are somatically oriented, attention-focusing practices designed to increase interoceptive awareness and acceptance (Dreeben et al., 2013). Its practice enhances the felt sense of being localized within one's physical body and cultivates a subtle distinction between thinking about the body and perceiving the body (Mehling et al., 2008, as cited in Colgan et al., 2015). During its practice, attention is directed sequentially throughout the body intending to cultivate nonjudgmental awareness of physical sensations, cognitions, and emotions (Kabat-Zinn, 1985, as cited in Colgan et al., 2015). It is worth noting that sensations should be simply perceived, rather than being evaluated or thought of (Colgan et al., 2015). The Body Scan is one of the first parts of the MBSR, aiming at reducing stress and increasing quality of life (Bruce & Davies, 2005, as cited in Schultchen et al., 2019). MBSR routinely employs brief Body Scans lasting anything from 5 to 30 minutes (Kabat-Zinn, 1990 as cited in Ussher et al., 2012). In practice, participants begin the Body Scan by sitting or lying in a comfortable position. The instructor (live in class, then on audio recording at home) slowly guides the participants' attention through the various regions of the body (Dreeben et al., 2013).

Mindfulness techniques have been incorporated into many clinical programs and practicing mindfulness has been found to improve the quality of life in patients with a variety of clinical and non-clinical issues (Cropley et al., 2007). To achieve this goal, MBSR has been adapted for various clinical populations, including individuals with eating disorders (Kristeller & Hallett 1999) anxiety (Roemer & Orsillo, 2002), cancer (Speca et al., 2000; Lengacher et al. 2009), chronic pain (Kabat- Zinn et al., 1985) fibromyalgia (Sephton et al. 2007), cardiovascular disease (Tacon et al., 2002), substance abuse (Marlatt, 2002; Breslin et al., 2002). In the treatment of psychiatric populations, Kabat-Zinn et al. (1992) found that an 8-week mindfulness meditation program was effective in significantly lowering the anxiety and panic symptoms of participants, changes that were highly stable (Miller et al., 1995, as cited in Kristeller & Hallett, 1999). It was also reported that individuals with a history of clinical depression who participated in a mindfulness meditation program have reported lower relapse rates than the others (Teasdale et al., 1995, as cited in Kristeller & Hallett, 1999). Although various forms of meditation have similar physiological effects, differences have been observed. In a study conducted by Ditto and colleagues (Ditto et al., 2006), Body Scan meditation elicited a pattern of physiological changes consistent with other forms of meditation. Sauer-Zavala et al. (2013) compared the effectiveness of three different practices used in mindfulness-based interventions: sitting meditation, Body Scan, and mindful yoga condition. Mindful yoga was associated with greater increases in psychological well-being than the other two practices; sitting meditation and mindful yoga were both associated with greater decreases in difficulties with emotion regulation than the Body Scan, and sitting meditation was associated with greater increases in the tendency to take a non-evaluative stance toward observed stimuli than the Body Scan.

2.4. Other relaxation techniques

Autogenic training is a psychophysiological form of autonomic self-regulation (Pickoff, 1984, as cited in Linden, 1994) developed by Schultz in 1932 (Linden, 1994). It is based on autosuggestion, which means that it is generated by a person who wants to achieve a state of relaxation alone (Kanji & Ernst, 2000). The logic behind it is enabling autonomic self-regulation by removing environmental distraction, training imagery that accompanies autonomic self-regulation, and providing a facilitative, structured set of exercises that are easy to learn at remember (Linden, 1994). The original autogenic technique consists of six standard exercises (Kanji & Ernst, 2000), which are based on passive concentration of bodily perceptions (for example, heaviness and warmth of arms, legs, and abdomen; the rhythm of breath; and heartbeat) that are facilitated by self-suggestion (Stetter & Kupper, 2002). A meta-analysis that included a wide range of studies exploring the effects of autogenic training concluded that therapy with autogenic training results in stable medium-to-large clinical main effects. The effects were even larger regarding its nonspecific effects (effects on mood, cognitive performance, quality of life, and physiological variables). In the field of psychological disorders, autogenic training turned out to be effective in anxiety, mild-to-moderate depression, and functional sleep disorders. (Stetter & Kupper, 2002). The combined use of biofeedback and autogenic training has been shown to reduce anxiety, stress, and depressive states in general and clinical populations (Lantyer et al., 2013 as cited in Aritzeta et al., 2017).

Guided imagery is a technique used to generate mental images by the mind's ability to form mental representations of objects, places, or situations (Astin et al., 2002). It is a mental process that considers and translates the senses of the nervous system to cause therapeutic change throughout the body (Horrigan, 2002 as cited in Kuiken, 2004). Its use has been studied in a variety of settings, including cardiac surgery, oncology, stroke rehabilitation, and pain management (Halpin et al., 2002; Klaus et al., 2000; Kolcaba & Fox, 1999; Maguire, 1996; Page, et al., 2001 as cited in Kuiken, 2004).

Deep breathing is a technique based on the notion that the integration of mind and body produces relaxation (Consolo et al., 2008, as cited in Toussaint et al., 2021). This technique requires participants to contract the diaphragm, slowly inhaling and exhaling. It amplifies blood oxygen levels, massages the inner organs in or close to the abdomen, and possibly stimulates the vagus nerve (Gerritsen et al., 2018, as cited in Toussaint et al., 2021). A study that compared the efficacy of deep breathing, PMRT, and guided imagery revealed that all three techniques were effective in promoting both psychological and physiological relaxation states. There weren't differences between techniques regarding the eliciting psychological relaxation states, but physiological states were evoked less robustly by deep breathing than by PMRT and guided imagery (Toussaint et al., 2021).

Relaxation biofeedback training is based on altering one's physiological activity (for example muscle tension, heart rate, blood flow) using visual, auditory (or both) biofeedback. It is a non-invasive training tool that enables individuals to observe their physiological body signals, gain voluntary control of autonomous physiological body signals, and objectively observe the process of relaxation (Mazgelyte et al., 2021).

3. Personalization of relaxing virtual environments

3.1. Virtually-induced relaxation

There are situations when nature is not accessible to people who want to feel its relaxing benefits. Sometimes, people who live in urban areas need to find special time to devote to nature (Browning et al., 2020); people living and working in isolated environments, such as submarines, or space do not have the possibility to experience the benefits of natural scenarios (Anderson et al., 2017); people with disabilities who would like to approach natural settings, but are not able to do so because they struggle to go outdoors (Browning et al., 2020). All mentioned situations lead to the conclusion that there is a growing need for developing technologies that would allow more frequent interactions with the natural world for all of those who have limited access to natural settings (Depledge et al., 2011, as cited in Browning et al., 2020).

One of the ways of improving the relaxation experience and making it more approachable to different individuals is to introduce technology as support to the relaxation. With that aim, it was practiced at first through playing CDs of calming sounds that showed positive effects on stress reduction, by achieving psychological benefits including distraction and relaxation (Beck, 1988; Guzzetta, 1989; Zimmerman et al., 1989, as cited in Villani et al., 2007). Then, as a step further, commercial relaxation DVDs were introduced to increase the effectiveness of relaxation with the integration of visual stimuli (Villani et al., 2007). As a next step further came VR, which enabled relaxing states through an individual's interaction with the computer (Villani et al., 2007).

Due to its ability to create a subjective sense of presence, and consequently can give the sense of transporting a viewer to another place, immersive VR can be a useful tool for creating customized stimulating environments. In the context of relaxation, immersive VR presents computer-generated nature, which differs from the films of real nature that could be presented through basic displays. This computer-generated nature consists of an artist's interpretation of what natural objects, colors, shapes, sounds, physics, motion, and light look like. Also, unlike real nature, computer-generated nature is created with variables defined by the researcher. Taking all these factors into consideration, computer-generated nature is more an interpretation of what nature is, rather than its replication (Valchanov et al., 2009).

The possibility of recreating the beneficial effects of the natural environments by presenting them through immersive VR ability is supported by a growing amount of literature. In general, studies that investigated this subject indicated that relaxation scores are higher when virtual relaxation through HDM was included, concluding that using VR as a tool to promote relaxation is a realizable option (Riches et al., 2021). Serrano et al. (2016) showed that natural virtual environments bring people to higher states of relaxation, and decreased stress, arousal, and anxiety (Serrano et al., 2016). Valtchanov et al. (2010) demonstrated that the computer-generated nature can promote restorative effects, meaning that it can help to achieve decreased stress levels, increased focus, positive affect, decreased negative affect, and decreased sympathetic nervous system activity. Exposure to virtual nature consisting of visual images featuring a forest and stream along with sounds of water and birdsong facilitated recovery from stress (Annerstedt et al., 2013). Similarly, Anderson et al. (2017) found that virtually presented natural scenes induced a greater relaxation response than the control scenes, which were not considered relaxing by the Attention restoration theory. It showed that natural scenes delivered via VR provide relaxation and restoration subjectively and objectively after stressful experiences. Virtual exposure to nature has shown to be a successful tool to induce relaxation in clinicians working in a fast-paced trauma service during the workday, suggesting it could be a good tool for releasing stress produced in a working environment (Adhyaru & Kemp, 2022).

When proposing three approaches to practicing relaxation through VR, Pizzoli et al. (2019) described the first approach as the "relaxing VR", which is thought to utilize mainly "generic" relaxing environments. Users are being exposed to these environments to gain control over the level of the body's physiological activation. Typically, the users are shown content that is generally thought to be associated with pleasant, peaceful, non-arousing sceneries such as islands, parks, gardens, and other open-space, generic nature-based environments. These interventions typically provide users with multimodal stimulation, including visual, auditory, and tactile modalities, to reduce physiological activation and control bodily responses. Although relaxing VR has been perceived as a useful application of VR, its benefits are usually not maintained for long in everyday life, since this virtual experience could hardly be generalized to contexts other than the one preceded through the relaxation (Pizzoli et al., 2019).

The second introduced approach that expands beyond the goal of only achieving relaxation through stimulation was named "engaging VR," and its scope is to influence emotion regulation and give stress management training to the user. This approach does not merely imply a passive visualization, but it requires users to interact with virtual content, permitting the acquisition of specific skills (Pizzoli et al., 2019). This approach is used in psychotherapy when dealing with diverse psychopathological conditions. The stress management training shares similarities with VRET (VR Exposure Therapy), which was earlier described. "Relaxing" and "Engaging" virtual realities can be used conjointly: VRET, for example, is derived from an approach that requires a combination of relaxation and exposure (Pizzoli et al., 2019).

After describing their two main approaches, Pizzoli et al. (2019) proposed a VR relaxation based on personalized content, based on their aim to provide a user-adapted technique. This approach will be further described in further sections.

VR has been shown as a supportive solution for the relaxation practice with psychiatric patients. Traditional stress-reducing interventions may be challenging to these patients, as they require initiative, concentration, sustained attention, and energy, which is all reduced in many psychiatric patients, especially when they are exposed to stressful situations (Millan et al., 2012, as cited in Veling et al., 2021). VR relaxation immediately reduced negative affective states and improved positive affective states in patients who received ambulatory psychiatric treatment. It had a stronger effect on negative affective states than standard relaxation exercises (Veling et al., 2021). These results suggest that immersive virtual exposure to nature is a more powerful tool for immediate improvement of affective states and psychological stress reduction than conventional relaxation exercises (Veling et al., 2021).

Short virtually induced nature experience delivered during the workday was associated with a significant increase in feelings of happiness and relaxation, and significant decreases in feelings of sadness, anger, and anxiety (Adhyhari & Kemp, 2022), meaning it could be introduced as an approach to promote good mental health among employees, who are one of the most vulnerable groups affected by stress.

3.2.1. Integrating a VR relaxing environment and relaxation training

Although their effectiveness in reducing the symptoms of psychophysiological arousal has been proved in literature, the practice of traditional relaxing techniques brings some difficulties. First of all, they are pretty expensive, as they need a teaching environment, material, and a dedicated therapist who would lead the session, which all together increases the costs (Heyse et al., 2019). They require perseverance and focus, which can be difficult to maintain, as exercise can be boring, monotonous, or impractical (Heyse et al., 2020). Furthermore, they are time-consuming (Mullally et al., 2009), which can be challenging in the modern lifestyle that interferes with the possibility of relaxation due to the busy schedules and working hours (Nahar & Gurav, 2018, as cited in Riches et al., 2021). Finally, they are usually unavailable at the moment when stress strikes (Mullally et al., 2009).

By solving these difficulties, VR can bring the benefits of classic relaxation techniques. One of the situations, when VR is used as a support to relaxation, is to help people with low imagery ability to perform imagery-relaxation tasks. Also, it can decrease the cognitive load of relaxation techniques that require simultaneously following instructions and using mental imagery (Pizzoli et al., 2021). Relaxation techniques can be integrated into an immersive virtual world in different ways: as stand-alone narratives, merged, combined with natural sounds, or coordinated with interactive contents within virtual environments (Pizzoli et al., 2019b). Typical VR interventions often combine their narratives with presentations of natural environments (Annerstedt et al., 2013). In a study conducted by Pizzoli et al. (2019b) virtual environments were combined with audio narratives from Body scan and Respiration control to induce relaxation in patients who suffer from breast cancer and results have shown to be successful in both versions.

VR has been used to support mindfulness-based programs to help them achieve more effective results. Different studies that researched the effects of mindfulness programs reported low adherence rates of students' commitment to the studies process (e.g. Pedrelli et al., 2015). These results produced concern and therefore highlighted the need to identify innovative ways to make these interventions more appealing and interesting to this population. With all its properties, VR was introduced to overcome these difficulties. It was concluded that VR exhibits higher acceptability for the practice of mindfulness exercises, with a significant increase in mindfulness state and an improved emotional state after just one VR mindfulness practice session in experienced meditators. The results of the study conducted by Modrego-Alarcon et al. (2021) indicated that Mindfulness-based programs registered higher attendance to sessions and retained significantly more participants when used with VR than MBP alone. However, changes in the efficacy of the treatment weren't recognized (Modrego-Alarcon et al., 2021).

Another situation where VR can be helpful is when Mindfulness-Based Interventions are being conducted on patients with emotional dysregulation sincethese patients can have attention deficits or reduced attentional resources that could interfere with their ability to concentrate. VR helps to enrich their relaxation experience, and consequently achieve better outcomes (Navarro-Haro et al., 2016; Gomez et al., 2017; Flores et al., 2018, as cited in Navarro-Harro et al., 2019). It helps in a way that the sense of presence generated by VR blocks out distractions from the real world, and the illusion of "being there" in the three-dimensionally generated world is in accordance with the essence of mindfulness, which is "to be here" in the present moment. The study conducted by Navarro-Haro et al. (2019) showed that a significantly higher number of participants were retained to the Mindfulness-based intervention when it was used with VR, in comparison to when it was practiced alone. In conclusion, mindfulness practiced through VR might become a good tool to increase treatment adherence and motivation to practice mindfulness (Navarro-Haro et al., 2019).

Considering that use of mind-body therapies to decrease anxiety and help manage pain in children undergoing surgery faces challenges, including access to care, high cost, and provider availability, VR is a helpful tool that helps overcome these obstacles. Introducing VR to deliver the therapies makes therapy more engaging and relevant (Harris & Reid, 2005, as cited in Olbrecht et al., 2021), as it increases accessibility and motivation in pediatric patients compared to methods without VR (Keefe et al., 2012, as cited in Olbrecht et al., 2021). That statement was confirmed with results showing that the use of Guided relaxation-based VR decreased pain intensity, pain unpleasantness, and anxiety in children and adolescents with acute postoperative pain following major surgery, which in the end led to the conclusion that multimodal analgesia by combining immersive VR and relaxation has been found to be effective (Olbrecht et al., 2021).

The sense of "presence" makes VR an excellent form of distraction-based therapy (Carrougher et al., 2009, as cited in Olbrecht et al., 2021), so immersive VR has been used successfully as a distraction intervention aimed to relieve chemotherapy-related anxiety and negative mood states (Chirico et al., 2020), but also for acute procedural, postoperative, and labour pain management (Olbrecht et al., 2021). Chirico et al. (2021) came to the results that demonstrated that patients receiving the intervention through VR significantly reduced their tension, anger, and fatigue levels, with similar results coming from the music therapy group. However, in another study (Schenider, 2007), VR has not been found successful as a distraction intervention, since there was no decrease in patients' distress levels.

3.2. Personalized relaxing virtual environments

When a clear positive correlation between the user's ability to create vivid visual images and the feeling of presence was reported (Iachini et al., 2019), it was highlighted that users felt more spatially present in a virtual environment as mental images they created had personal meaning for them, such as a dear person, a familiar shop, or a country scene. When the subject of mental images was a beloved person, the perceived realism of the virtual experience was at the highest level. This result isn't surprising considering that a sense of presence is highly affected by the emotional response elicited by presenting autobiographical stimuli in VR. In general, the environment that users evaluated as emotional seems to be more engaging, natural, believable, and real to the users than the neutral environments (Banos et al., 2004). Pizzoli et al. (2019) spread this idea into the field of relaxation. They argued that autobiographical contents play an important role in the subjective emotional experience of eliciting a relaxation response, since recalling a previous safe place in a relaxing environment is expected to enhance feelings of security and peace (Holland & Kesinger, 2010; Pizzoli et al., 2019). When Anderson et al. (2017) showed that natural scenes presented through VR induce relaxation responses similar to the one experienced in real nature, it was further concluded that the user's mood and perception of scene quality were affected by their preference of the scene. In other words, VR enables relaxation particularly when it is matched to personal preferences. Personal references were shown to affect the results of subjective measures of relaxation and stress.

While adding olfactory stimuli to virtual environments increases the sense of presence (Munyan et al., 2016), olfactory cues are also strongly associated with autobiographical memories. Smell's capacity to evoke emotional memories is explained by the fact that olfactory cerebral centers are connected with parts of the limbic system known for generating emotion and memory (Smith, 2016). Based on the theoretical background behind the smell's connection to autobiographical stimuli, Pizzoli et al. (2021) attempted to build personalized virtual environments by collecting and using autobiographical scents relevant to users to introduce the olfactory stimuli to virtual environments (Pizzoli et al., 2021). They mention that this approach would be the clinical operationalization of the Proust phenomenon (the name for smell's ability to promptly invoke autobiographical memories). In a personalized smell-evoking setting it would be possible to activate autobiographical memories, even when the user does not deliberately intend to re-experience them. This can help in two ways: at first, the use of autobiographical scents may trigger remote memories while lowering the cognitive load required to evoke memories and experiences (Seigneuric et al., 2010, as cited in Pizzoli et al., 2021), which would permit the allocation of cognitive resources to follow narratives and instructions and perform relaxation exercises; furthermore, the familiarity of a scent is positively related to its perceived pleasantness (Bensadi et al., 2003, as cited in Pizzoli et al., 2021), and consequently, would enhance positive sensations.

Taking all these facts into consideration, in order to improve the relaxing virtual experiences, there is a growing need for their personalization. In order to achieve this, there is a need to collect facts about a user's personality based on the personality models that need to be constructed. Also, these environments should be able to adapt to the user's emotional state at the moment, so they have to be constructed in a way that they would be able to make decisions autonomously. The personalized relaxing environment would therefore not only be different from the perspective of the senses, but it would also contain different relaxation methods, chosen by the user's emotional state (De Jonge, 2018). Adapting to the user's state at the very moment means that these environments would feature integrated systems able to sense and analyze users' states through psychophysiological correlates, self-reported states, and observable behaviors to modify the virtual experience itself. This feature is important because it puts the ability of personalized VR beyond being centered around the user's pre-existing needs, experiences, and memories, but would also adapt to the user's current state changes within the virtual interaction (Pizzoli et al., 2019).

Although the idea behind the concept is set, the biggest challenge is constructing personalized environments that would elicit vivid feelings in individuals. Several models were proposed and they are going to be explained further in the chapter.

3.2.1. "The user-centered" approach to relaxation through personalized virtual environment

Pizzoli et al. (2019) defined their user-centered approach to relaxing in personalized VR by two main characteristics, one relating to the design of the contents of the virtual environment, and the other to the technology to implement. When it comes to the designing the environment, they defined it as the first important step in the preliminary investigation of users' relevant life events, aiming to extract distinctive perceptive features of personal memories and experiences. While Pizzoli et al. (2021) proposed using scent categories to build user-centered virtual environments, this model proposed the preliminary information for making relaxing environments to be precisely about users' relaxing life events. Users would be asked which stimuli they associate with the experience, trying to find out significant perceptive cues effective in memory elicitation

(Holland and Kesinger, 2010, as cited in Pizzoli et al., 2019). The descriptions by users should be accurate, carefully recorded, and should include multisensory details: visual, tactile, auditory, and even olfactory elements, so that the realism of the experience would be lifted (Pizzoli et al., 2019). As the process of building an environment continues, distinctive features of such autobiographical life events and evoking cues would be rendered with symbols, activities, or other virtual environment contents, through a qualitative analysis of user's descriptions. Authors argued that the aim of adopting a personalized VR approach isn't to digitally recreate specific situations but to understand which symbols could be digitally transformed to allow the participant to recall an autobiographical sensation. There are four categories of information that are being taken from the user's autobiographical experience: *perceptual, contextual, content, and specific cues*, which are explained through the concrete following example.

„I'm on the sofa in my grandma's mountain house, in the sitting room. It's quiet, it's winter. No sounds are coming from the outside, I can hear the fireplace. The room is warm and softly illuminated. I'm resting on the sofa, feeling my body warm and heavy. The sofa is soft. I've just stopped playing outside in the snow with my brother. I associate the sound of the fireplace and the shadows of the fire."

Table 1.

An example of extracting relevant information from the autobiographical story to the building of VR.

Perceptual	Contextual	Content	Specific Cue
Visual: softly illuminated	Place: close and warm; sitting room	Speech: silence	Perceptual modality: auditory and visual cue

Audio: fireplace	Situation: resting-state	Relation with the place: known and affective place	Content: fireplace sound shadows of the fire
Tactile: soft	Other people: alone	Story: just stop having a gun with a beloved one	
Intero/proprioceptive: warm and heavy	Weather: winter outside		

Differently from the studies employing unique autobiographical contents and stimuli, in which contents have to be specifically selected for each subject, the personalized VR approach would allow for a broader generalization, reached through the construction of a stimuli library, based on memories' relevant features (Pizzoli et al., 2019).

Table 1

Characteristics of the three main approaches to VR for promoting relaxation or emotion regulation (Pizzoli et al., 2019).

Attributes	**"Relaxing VR"**	**"Engaging VR"**	**Personalized VR**
Psychological or physiological target	Relaxation	Emotion regulation, stress management training	Relaxation, emotion regulation, stress management training, well-being, empowerment
Aim	Transient relaxation	Empower and train users' abilities	Transient relaxation and/or empower and train user's abilities
Contents	Generic scenarios and stimuli (often nature-based)	Specific scenarios and interactive stimuli to promote training	User-centered contents

User's involvement	Passive	Active	Passive or active
Contents and stimuli	Fixed	Based on emotion to induce or ability to train	Adaptive
Technology	VR, psychophysiological correlates	VR, psychophysiological correlates, gaming/interaction	VR, psychophysiological correlates, gaming, Artificial Intelligence

1.1.1. "VRelax" approach to relaxation through personalized virtual environment

In the same year as Pizzoli and colleagues, Heyse et al. (2019) proposed another approach to relaxing in personalized VR, with the same goal to provide a personalized and relaxing virtual environment to the user and allow the virtual experience to adapt in real-time to user's preferences and mood changes. They named it "VRelax". Similar to the former model, it achieves the personalization of the environment through different stages. The first defined step is constructing a model, which would consolidate the data from different sources and hold the needed personality and real time stress data of the user. It uses personalization and adaptation algorithms to change the appearance of the VR environment, in order to match the requirements of the person. Finally, the decisions made by the algorithms are fed to the rendering component, which handles the real-time visualization of the personalized VR environments. In response to the images presented to the user through HDM, real-time stress data can be sampled and fed to the user model. This effectively closes the feedback loop and allows for continuous dynamic adaptations to the VR scene based on real-time user data and background information (Heyse et al., 2019).

Heyse et al. (2020) argued in their recent study that current existing solutions that propose models for personalized relaxing VR are either too tailored for a very particular user-type or very generic, which decreases their effectiveness. Furthermore, their critic considers that these models tend to rely fully on sensor data and subjective user evaluations. While using user data aids to adapt the applications, the variability makes it difficult to create models that could be utilized for a broad range of users. They conclude that for such cases, there is a need for objectively driven models that can fit a wide range of users. They further proposed an advanced personalized and adaptive VR model for relaxation therapy, that would be built objectively. Their model creates a fully adaptive and personalized environment for users by making their personality profiles and following their emotional states. Based on the decision trees, it constructs a personality model of a user to generate an environment. It functions in a way that every outcome of each decision represents a different raw environment. The set of possible environments is fixed and the same for every user, so users with similar personalities could generate the same natural environment. Personality data is gained through a questionnaire. One of the questions asked through the questionnaire is: *Could the presence of water help you relax?* or *What is your favorite season?* However, the construction of the final environment depends on the user's emotional status obtained later in the process through the function of an emotional model. Its main purpose is to estimate the level of relaxation of the user based on the current settings of the environment. Relaxation is estimated from three variables that are believed to influence relaxation response: stress, fear, and arousal.

3.3. VR personalized relaxing environment integrated with relaxing protocol

It was already mentioned that relaxation techniques, like PMRT or Body Scan, are practiced through VR to overcome their high costs and reduced scalability (Heyse et al., 2019), and that their narratives are usually combined with virtual natural scenarios when they are practiced through VR (Annerstedt et al., 2013).

Another problem with traditional relaxation techniques is that they are usually designed universally, for generic patients, so they don't consider the different needs of possible users (Heyse et al., 2019). To overcome that problem, their practice should be conducted through personalized virtual environments. To achieve personalized virtual relaxation, the narrative of these techniques should be combined with personalized adaptive environments, built by models explained earlier in the chapter (pVR, VRelax) (Pizzoli et al., 2019; Heyse et al., 2019). In a recent research Pardini et al. (2022) explored if personalization of Body Scan-guided relaxation supported by virtual environments would influence the user's experience. To enhance standard intervention's effects, they followed a user-centered approach by Pizzoli et al. (2019) described earlier in the chapter. Their findings are promising, as they indicate that participants experienced greater comfort after the personalized VR experience. Several factors that were identified to contribute to pleasantness and preference for the personalized virtual environments were: *the correspondence of the personalized VR with the relaxing context they would choose in reality; the reminiscence; the possibility to choose and control elements in the VR context; the realism of the stimuli.* It is important to note that a standard exposure to a virtual relaxing environment was effective in reducing the levels of anxiety and producing relaxation responses personalization of the environments led to higher subjective states of relaxation. These are the newest findings highlighting the importance of a user-centered approach to virtual relaxation.

However, literature that would research how the success of practice of relaxation techniques (e.g. PMRT, Body Scan) differs when they are integrated with personalized versus standard virtual environments, and how both of these differ from conditions that would imply traditional practice without VR is still limited, and attention to this subjects needs to be further developed in future (Pardini et al., 2022).

3.4. Future perspectives

As the need for personalizing virtual environments has been recognized quite recently and its research is still in its infancy, further development should be considered based on the identified limitations of existing models. Pizzoli et al. (2019) stated that it is still not very clear how to identify participants who would give developers the most meaningful information to start understanding personal experience. Another issue with the existing model is that inadequate or unusable memories that participants sometimes report could affect the quality of sampling (Pizzoli et al., 2019). They further proposed that the adaptation feature of VR could be exploited within the integration of VR and Artificial Intelligence, as their integrative use would permit the development of more natural and realistic virtual environments in which humans and computers would interact naturally (Pizzoli et al., 2019). When discussing further development, Heyse et al. (2020) proposed that it could be useful to incorporate biofeedback into their emotional model. They based their proposal on the argument that the biofeedback could ensure that the estimated emotional state is synchronized with the user's actual state, but also it could make it possible to react to small, sudden changes in the user's state. In the end, it is worth noting that, while there is a lot of evidence showing that virtual nature can induce relaxation responses, there is still a lot of space to develop better models for building personalized virtual environments, and further investigate the efficacy of the use of traditional relaxation techniques combined with them.

3.5. Conclusion

By analyzing the literature regarding the use of personalized virtual environments for relaxation, this dissertation has led to the conclusion that this approach to relaxation techniques has a promising perspective.

After collecting data that proves VR's efficacy in general, and furthermore, in the field of Clinical psychology, it was concluded that its benefits could improve traditional relaxation techniques used for reducing stress in individuals who experience it. Considerable evidence has been collected to prove that their integrated use shows better results than relaxation techniques alone. The significance of virtual relaxation in the clinical context was highlighted in a study conducted by Pizzoli et al. (2019b) where Body Scan practiced through virtual environment successfuly induced relaxation in patients who suffer from breast cancer.

However, another problem has been identified: standard relaxing virtual environments do not consider the different needs of every individual user, as they are designed generically, which has led to the development of an idea to construct virtual environments for relaxation that would be personalized according to the needs of the user. To reach a goal and personalize these environments, different authors (Pizzoli et al., 2019; Heyse et al., 2019) proposed models for constructing personalized relaxing virtual environments that would be constructed according to the user's personality and would be able to adapt to the changes of user's emotional state at the moment.

With all the evidence supporting this approach, further research is needed to provide better insight into the subject, construct better models, and reach better results.

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