Virtual Reality for the Enhancement of Emotion Regulation

Article *in* Clinical Psychology & Psychotherapy · May 2021

DOI: 10.1002/cpp.2618

4 authors:

Desirèe Colombo
University of Valencia

Amanda Díaz-García
University of Zaragoza

Javier Fernández-Álvarez
Catholic University of the Sacred Heart

Cristina Botella
Universitat Jaume I

Colombo Desirée (Orcid ID: 0000-0003-0333-2003)

Virtual Reality for the Enhancement of Emotion Regulation

Desirée Colombo[1*], Amanda Díaz-García[2], Javier Fernandez-Álvarez[3], Cristina Botella[1,4]

[1] *Department of Basic Psychology, Clinic and Psychobiology, Jaume I University, 12071, Spain*

[2] *Department of Psychology and Sociology, Universidad de Zaragoza, 50009, Spain*

[3] *Humane Technology Lab., Università Cattolica del Sacro Cuore, 20123, Italy*

[4] *CIBER Fisiopatología Obesidad y Nutrición (CIBERobn), Instituto Salud Carlos III, 28029, Spain*

Acknowledgements

This work was supported by PSI2014-54172-R (Ministerio de Economía y Competitividad, Spain) and by CIBER of Physiopathology of Obesity and Nutrition CIBERobn, CB06/03 Instituto de Salud Carlos III, Spain.

Conflict of Interest

The authors declare that there are no conflicts of interest.

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1002/cpp.2618

ABSTRACT

In recent decades, a growing body of literature has focused on emotion regulation (ER), which refers to the ability to implement strategies in order to modulate emotional responses and reach desirable goals. To date, impaired ER (i.e., emotion dysregulation) has been identified as a transdiagnostic factor across a wide range of psychopathological conditions, which shows the importance of improving patients' ability to regulate negative and positive emotions in clinical practice. In addition to the increasing evidence showing its efficacy in the treatment of several clinical conditions, virtual reality (VR) has recently emerged as a potentially powerful tool for enhancing ER, thus breaking new ground in the development of cutting-edge transdiagnostic interventions. In the present narrative review, we will provide an overview of the existing evidence about VR-based interventions in the field of ER, emphasizing the promising findings and the barriers that still have to be addressed. To this aim, the available VR-based literature will be analysed in relation to four categories of ER strategies: Situational strategies, attentional strategies, cognitive strategies and response modulation strategies. Furthermore, new emerging fields of research targeting innovative aspects of ER will be highlighted, including the use of VR to promote positive emotions and interpersonal ER skills. Besides, its cost-effectiveness will be discussed, taking into account the costs for both developers (e.g., clinicians and researchers) and end-users. Finally, future directions in this promising field of research will be outlined.

Key Practitioner Message

- Emotion dysregulation is considered an important transdiagnostic factor in a wide range of mental disorders.
- The use of virtual reality has recently emerged as a potentially powerful tool for the enhancement of emotion regulation.
- A growing body of research has shown the efficacy of virtual reality for improving situational, attentional, cognitive and response modulation strategies in several mental disorders.
- Currently, virtual reality-based tools are becoming more accessible, thus opening up new opportunities for clinical practice.

Keywords: Emotion regulation; emotion dysregulation; virtual reality; biofeedback; smartphones; mental health.

1. INTRODUCTION

In the past few decades, emotion regulation (ER) has received increasing attention, becoming one of the most studied constructs in the psychological field (Fernández-Álvarez et al., 2018). ER refers to the set of strategies used to implicitly or explicitly modify an ongoing emotion, either positive or negative, in order to generate adaptive emotional responses and reach desirable goals.

One of the first formal definitions of ER was provided more than twenty years ago in Gross' seminal work: *"(...) ER refers to the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions*" (Gross, 1998b). Based on this definition, a large number of researchers developed new conceptualizations of this construct, for example, by incorporating interpersonal components (Zaki & Craig Williams, 2013) or studying its implicit dimension (Gyurak et al., 2011). Therefore, there is now evidence to suggest that ER is a complex process characterized by physiological underpinnings, behavioural responses, and affective and cognitive correlates (Desirée Colombo, Fernández-Álvarez, Palacios, Cipresso, et al., 2019). In addition, the essential role played by the context where emotions are regulated is becoming increasingly evident, suggesting that situational and momentary factors also shape the regulation of emotions (Aldao & Nolen-Hoeksema, 2012; Desirée Colombo, Fernandez-Alvarez, et al., 2020). In other words, a more articulated conceptualization of ER has been developed, thus questioning the reliability of laboratory experiments and suggesting the need to adopt an ecological approach in order to fully understand this process. In this sense, the use of virtual reality (VR) has recently emerged as an adequate tool to investigate ER in a more ecological manner (Hoffman et al., 2019; Rodríguez et al., 2015), offering new possibilities to explore this construct in realistic environments and controlled settings (Desirée Colombo, Fernández-Álvarez, Palacios, Cipresso, et al., 2019).

Although ER has been extensively explored in healthy populations, a growing number of studies have also focused on the mechanisms underlying impaired ER abilities. In fact, emotion dysregulation has been recognised as a transdiagnostic factor across a wide range of mental disorders (Aldao et al., 2016; Fernandez et al., 2016; Kring, & Sloan, 2009), which points to its key role in clinical practice and in developing transdiagnostic interventions (Barlow et al., 2004; Diaz-Garcia et al., 2021; González-Robles et al., 2020). Broadly speaking, the adoption of a transdiagnostic approach helps to explain the high levels of comorbidity among mental disorders, thus supporting the development of interventions that target processes shared by several psychological conditions, such as ER problems (Harvey et al., 2004; Mansell et al., 2008).

Emotion dysregulation has been conceptualized in many different ways. It has been defined as the failure to identify when to regulate, how to regulate, and which strategies to use (Webb et al., 2012), but also as the result of low emotional awareness, decreased emotional acceptance, and an impaired ability to control impulsive behaviours (Gratz & Roemer, 2004). Furthermore, emotion dysregulation emerges when emotions are not adequately tracked and labelled (i.e., ER failure) or when, despite correctly recognizing the emotional state, an individual fails to define the appropriate goal for regulating emotions (i.e., emotion misregulation) (Gross, 2013). Interestingly, different patterns of emotion dysregulation have been observed depending on the psychopathological condition, revealing difficulties in either strategy selection or strategy implementation (Jazaieri et al., 2013). Strategy selection failures have been observed in patients suffering from social anxiety disorder, who usually report higher levels of suppression and lower levels of reappraisal (Blalock et al., 2016). Similarly, major depressive disorder has been associated with the inability to select the best strategy to regulate ongoing emotions, characterised by a greater tendency to use rumination and less tendency to implement acceptance and positive reappraisal (Van Meter & Youngstrom, 2016). However, ER strategy implementation difficulties have also been found to be related to psychopathology. For instance, depressed patients are not able to use past happy memories to repair sad mood (i.e., positive reminiscence) (Joormann et al., 2007), while the ability to implement cognitive reappraisal effectively is impaired in individuals with high social anxiety (Dryman & Heimberg, 2018). Aldao et al. (2010) conducted a large meta-analysis to explore ER in various mental disorders, including depression, anxiety disorders, eating disorders, and substance-related disorders. This study revealed the significant maladaptive outcomes of certain strategies such as rumination, avoidance, and suppression, which were associated with more severe symptoms, and the adaptiveness of problem solving, acceptance, and reappraisal, which were used less intensely by most patients. In the same vein, a maladaptive use of distraction has been commonly observed in several psychological conditions, such as generalized anxiety disorder, posttraumatic stress disorder, borderline personality disorder, bulimia nervosa, and alcohol dependence (Kring & Sloan, 2009). Recently, the concept of flexibility has been proposed to explain successful ER abilities (Aldao et al., 2015). Cognitive flexibility refers to the flexible use of a wide repertoire of strategies depending on the momentary needs and contextual demands. In other words, rather than distinguishing between adaptive and maladaptive strategies, ER would require a flexible and context-sensitive modulation of emotions in order to achieve long-term personal goals (Barrett et al., 2001; Linehan et al., 1991).

In sum, ER has been shown to play a key role in mental health, and several conceptualizations of emotion dysregulation have been proposed. Regardless of the definition, there is consistent evidence showing the presence of ER difficulties in a wide range of mental disorders, suggesting that emotion dysregulation is an important transdiagnostic factor to target in clinical interventions. Beyond traditional face-to-face treatments, the situational and contextual dimensions of this construct are making clinicians and researchers increasingly aware of the importance of treating emotion dysregulation from a more ecological perspective, thus calling for the development of innovative approaches (Desirée Colombo, Fernández-Álvarez, Palacios, Cipresso, et al., 2019).

The incorporation of VR into clinical practice began more than 20 years ago (Botella et al., 1998; Cipresso et al., 2018; North et al., 1997; Rothbaum et al., 1995). Although the first applications were mainly non-immersive environments presented on a screen, technological advancements made it possible to experience the “sense of being” in a different world just by wearing a head-mounted display (HMD) to simulate depth perception and provide sensorial stimulation (Freeman et al., 2017), producing an experience that is extremely close to reality (Baños et al., 2004). VR-based interventions have been successfully employed in the treatment of a wide range of mental conditions (Botella et al., 2004; Riva, 2005), such as anxiety disorders (Carl et al., 2019; Fernández-Álvarez, Colombo, et al., 2019), post-traumatic stress disorder (Baños et al., 2009), phobias (Botella et al., 2017; Parsons & Rizzo, 2008; Suso-Ribera et al., 2019) and depression (Zeng et al., 2018). Analogously, the use of VR recently emerged as a potentially powerful tool for the treatment of ER (Desirée Colombo, Fernández-Álvarez, Palacios, Cipresso, et al., 2019). In fact, the immersion in realistic and personally significant virtual environments (Botella et al., 2004; Jallais & Gilet, 2010; Riva et al., 2007; Strack et al., 1985; Zhang et al., 2014) has been shown to effectively induce positive and/or negative emotions, thus allowing to create a controlled setting in which to train ER (Baños et al., 2006). Furthermore, the use of VR-based tools makes it possible to target ER with a more ecological approach (Hoffman et al., 2019; Rodríguez et al., 2015). On the one hand, patients have the chance to be immersed in a virtual environment and experience a situation with their own eyes, which might significantly differ from traditional procedures based on the use of imagination and memory. On the other hand, clinicians and/or researchers are able to manipulate the environment and customize the setting based on the needs of each individual.

In the present narrative review, we will provide an overview of the evidence about VR-based interventions to enhance ER, in relation to both negative and positive emotions, taking into account interventions that implicitly or explicitly target ER skills. Likewise, we will examine the cost-effectiveness of VR-based interventions, highlighting both advantages and disadvantages, and we will shed light on potential future directions in this promising field of research.

2. WHAT IS THE EVIDENCE?

Traditionally, ER has been conceptualized by considering the process that leads to the generation of an emotion, which includes the deployment of antecedent-focused and response-focused strategies (Gross, 1998a, 2015a). Drawing on the four steps of the emotion generation process (i.e., situation, attention, appraisal, response), four categories of strategies have been identified (Gross et al., 2019): 1) Situational strategies, which involve influencing the generation of an emotion by selecting or modifying an emotion-eliciting situation; 2) attentional strategies, which focus attention on specific features of a situation that can modify the associated emotional response; 3) cognitive strategies, which refer to changing the interpretation and meaning of a stimulus in order to modify its emotional impact; and 5) response modulation strategies, which refer to attempts to influence an emotional response once it has been elicited.

Table 1: Overview of the fields of application of VR-based interventions for the enhancement of emotion regulation strategies.

SITUATIONAL STRATEGIES	● Exposure ● Behavioural activation
ATTENTIONAL STRATEGIES	● Mindfulness ● Distraction ● Relaxation
COGNITIVE STRATEGIES	● Cognitive reappraisal
RESPONSE MODULATION STRATEGIES	● Stress inoculation ● Impulse control

To organize the increasing research on VR-based interventions for improving ER, the model shown above was followed (see **Table 1**). It should be noted that many of the developed VR interventions have been designed to target more than one strategy, which makes it difficult to simplify the available literature into this simple schema. Although not exhaustive, we attempted to provide a clear overview of the current evidence by discussing each VR-based intervention according to the main strategy targeted. The model proposed in this review is designed to offer a basic framework for researchers and clinicians who are interested in understanding the role of ER in VR treatments.

2.1 Situational strategies

Exposure

So far, VR has been extensively used as a tool to foster traditional exposure therapy protocols. Anxiety disorders, such as agoraphobia, specific phobias, and social anxiety disorder, are characterized by the presence of excessive and maladaptive experiences of fear and anxiety when facing specific situations or stimuli, which in turn produces avoidance behaviours (Barlow, 1988). Rather than merely being a maintenance factor, the tendency to avoid potentially threatening situations has been shown to further intensify anxious response patterns and keep patients from implementing adaptive strategies (Salters-Pedneault et al., 2004). When confronting feared stimuli, exposure therapy, therefore, helps individuals to better regulate their emotions by reducing avoidance behaviours.

The cornerstones of VR-based exposure therapy consist of creating realistic and personally relevant environments (Botella, Villa, et al., 2004) that significantly elicit emotional reactions (Baños et al., 2008; Riva et al., 2007), experiencing the sense of "being there" (i.e., presence) (Riva, 2009), and interacting with a virtual scenario (Rizzo et al., 1997). In addition, compared to in vivo exposure, the use of VR offers the opportunity to manipulate a feared stimulus (e.g., different features and different contexts) and provide exposure to multiple contexts, which has been found to be more effective for reducing renewal rates than extinction in a single context (Shiban et al., 2013, 2015). In addition to immersive VR, the use of augmented reality (AR) also represents an important alternative to traditional exposure therapy, making it possible to introduce virtual elements into reality (i.e., feared stimuli) and bring relevant and salient information to the scene (Botella et al., 2010, 2016; Wrzesien et al., 2013). Unlike VR immersive systems, AR does not substitute the real world. Instead, a perfect combination of real and virtual images is achieved that allows users to maintain the sense of presence in the real world (Botella et al., 2005). Together, VR and AR systems have been shown to provide a valid alternative to in vivo exposure to induce specific emotions and expose patients to feared stimuli in a safe, gradual, and controlled way. In other words, VR-based systems offer the possibility to select and modify the emotionally eliciting situation that a patient is asked to confront.

In this regard, several studies have demonstrated the effectiveness of virtual exposure therapy in both adults and children (Bretón-López et al., 2017; López Soler et al., 2011) for the treatment of anxiety disorders (e.g., agoraphobia, specific phobia, and social anxiety; see Wechsler et al., 2019), stress-related disorders (Botella et al., 2015), and to a lesser extent, eating disorders and addictive behaviours (Maples-Keller et al., 2017). In addition, VR has been found to be effective for the treatment of persecutory delusions in psychosis (Freeman et al., 2016; Gega et al., 2013), showing the generalizability of clinical improvements to real life (Morina et al., 2015) and good stability of the results over time (Opriş et al., 2012). Furthermore, attrition rates for VR are similar to those for face-to-face interventions (Benbow & Anderson, 2019), and deterioration rates are not higher than in other active treatments (Fernández-Álvarez, Rozental, et al., 2019), thus suggesting that VR is an adequate candidate to decrease avoidance behaviours and improve ER skills. Moreover, self-led and automated VR-based exposure therapy protocols (i.e., without the presence of a therapist) administered through smartphones have also been found to be effective in the treatment of several anxiety disorders, such as public speaking anxiety and acrophobia (Freeman et al., 2018; Lindner et al., 2019), thus opening up new opportunities to disseminate evidence-based treatments for ER outside traditional face-to-face settings.

Behavioural activation

Recently, VR has also been applied in the field of behavioural activation, a strategy that has been shown to be effective for the treatment of depression (Ekers et al., 2014). The aim of behavioural activation interventions is to increase patients' engagement in adaptive activities and decrease engagement in situations that could enhance and/or maintain depressive symptoms. These goals are pursued by either encouraging patients to join daily adaptive activities or by inhibiting processes that hinder their participation (e.g., avoidance) (Dimidjian et al., 2011).

Along these lines, Paul et al. (2020) developed a VR-based intervention to promote behavioural activation in patients suffering from depression. To do so, 360° videos reproducing different activities (e.g., travels, nature, animals) were integrated into a broader protocol of behavioural activation and administered to a patient suffering from MDD. The possibility of virtually experiencing pleasant activities was hypothesized to motivate behavioural activation and increase the patient's engagement in daily activities. Between each session, the participant was instructed to watch four virtual scenarios that reflected personally enjoyable activities. Preliminary results from this case study demonstrated the feasibility and acceptability of the intervention, which is now being tested in a broader sample of patients suffering from major depressive disorder. Moreover, significantly reduced depressive symptoms were observed, which suggests the great potential of this VR tool to support situation selection.

2.2 Attentional strategies

Mindfulness

Mindfulness is an antecedent-focused strategy (Gross, 2015a) defined as the attempt to be fully present, aware, and focused on the present moment. Mindfulness has been shown to be a highly adaptive strategy, predicting enhanced levels of daily autonomy (Brown & Ryan, 2003) and more intense and frequent positive emotions (Brown & Ryan, 2003). Accordingly, mindfulness-based interventions have shown promising results for the treatment of anxiety disorders, major depressive disorder, and adjustment disorders (Sundquist et al., 2017). In line with these encouraging findings, VR has also been used to foster the use of mindfulness skills.

VR-based mindfulness training has been found to significantly reduce both physiological and self-reported anxiety levels (Tarrant et al., 2018). Navarro-Haro et al. (2019) compared a traditional mindfulness-based intervention to the same intervention combined with VR-based mindfulness training in patients suffering from generalized anxiety disorder. To do so, a virtual natural scenario was created where patients were asked to navigate while listening to audios teaching mindfulness skills. Although both groups showed significant clinical improvements (e.g., reduced symptoms, decreased emotion dysregulation, enhanced mindfulness skills), adherence was significantly higher among participants in the VR condition. Interestingly, the efficacy of this VR-based mindfulness intervention was also investigated in a patient suffering from borderline personality disorder (Navarro-Haro et al., 2016), confirming its acceptability and clinical efficacy. Cikajlo et al. (2016) developed a VR mobile application to practice real-time mindfulness skills in a virtual environment. The VR app was used to provide group mindfulness therapy as part of an 8-week mindfulness-based stress reduction course for patients with anxiety and stress-related symptoms. Although only slight improvements were observed in mindfulness skills, patients were satisfied and pleased with the intervention, thus suggesting that engagement is an important feature of VR treatments. Finally, although not directly designed to target ER, some interesting results were also observed by Cebolla et al. (2019). Using *the machine to be another* (Bertrand et al., 2014; De Oliveira et al., 2016), the authors developed a VR-based self-compassion intervention in which participants could virtually see themselves from a third-person perspective while listening to self-compassion audios (Cebolla et al., 2019). Two weeks after the treatment, participants who received the VR-based self-compassion treatment showed increased awareness and attention to the present for mental events and bodily sensations, thus showing the usefulness of VR to enhance and facilitate the learning of mindfulness skills.

Distraction

One type of attentional deployment strategy that has received increasing attention in the field of VR is distraction, which refers to the attempt to move attention away from an emotion-eliciting stimulus by focusing on external (e.g., neutral or positive details of the stimulus) or internal (e.g., neutral or positive mental representations) aspects of a situation.

Moreover, VR has been extensively used as a distraction technique for pain management in paediatric populations (Eijlers et al., 2019): that is, to immerse children in a virtual environment and distract them from the views and sounds of a hospital room (Hoffman et al., 2004). VR-based distraction tools have been shown to reduce cognitive and affective components of pain by focusing attention on the interaction with the virtual environment, which in turn decreases the attentional resources available to process painful stimuli (Hoffman, Patterson, et al., 2000). Thus far, VR has been successfully used as a distraction tool in paediatric populations in different medical contexts, such as wound care (Hoffman, Doctor, et al., 2000), venepuncture (Atzori, Hoffman, et al., 2018), or dental procedures (Atzori, Grotto, et al., 2018). Similarly, VR has also been used to increase physical exercise in overweight children (Baños et al., 2016; Guixeres et al., 2013) who are assumed to avoid workouts because of the associated bodily sensations. For this purpose, the authors asked a group of overweight children to run on a treadmill while observing their avatar racing in a virtual environment projected on a display, synchronized to participants' running parameters. In addition to showing higher enjoyment rates, children who were doing physical exercise in VR were more likely to shift their attention to the virtual environment and focus less on internal bodily sensations than children who were running on a traditional treadmill. Finally, important insights also come from the study by Wiederhold et al. (2014), who demonstrated the efficacy of delivering VR distraction sessions through low-hand devices (i.e., smartphones) in patients suffering from chronic pain. Although not as effective as the use of a head-mounted display, the authors demonstrated that patients who received VR distraction sessions through a smartphone reported reduced levels of pain and anxiety.

Relaxation

A growing body of studies have shown the efficacy of attentional strategies such as focusing on relaxing music (Linnemann et al., 2015) or videos of natural environments (Bielinis et al., 2020; Freeman et al., 2004; Wang et al., 2020) for reducing stress levels and increasing momentary well-being. In this regard, VR represents a powerful tool to further foster these strategies because it can provide users with the possibility of experiencing, from a first-person perspective, a virtual world that integrates pleasant, peaceful, and non-arousing audio and visual stimuli. Accordingly, VR-based interventions have been developed that put users in a virtual peaceful condition in order to practice relaxation techniques and lower their physiological arousal (Pizzoli et al., 2019). Supporting this approach, there is strong evidence showing the effects of non-immersive and immersive virtual environments for stress recovery on both physiological and self-reported measures (Anderson et al., 2017; Annerstedt et al., 2013; Baños et al., 2004).

In this direction, Baños et al. (2004) designed a mood induction procedure based on a VR scenario to elicit relaxation and three further emotional states (sadness, joy, anxiety). Using an open immersive display and a wireless pad, participants were asked to walk through a virtual park (The Park of Well-Being) whose light parameters could be changed to induce a specific emotional state (e.g., the environment turned grey and cloudy to induce sadness). Furthermore, Velten statements, music, movies, autobiographical recalls, narratives, and pictures inside the environment could be manipulated depending on the emotion to be elicited. Despite being non-immersive, the environment was shown to produce an increasing subjective sense of presence throughout the virtual experience (Baños et al., 2005). Furthermore, results showed the efficacy of the virtual environment in inducing a state of relaxation (Baños et al., 2004) and changing the induced mood to the opposite emotion (Baños et al., 2006). Another interesting study in this field is Relaxation Island, an immersive virtual scenario where participants can freely navigate while listening to relaxing narratives based on progressive muscular relaxation, autogenic training, and deep breathing techniques (Villani & Riva, 2008). After two sessions, a sample of 60 undergraduate students showed reduced anxiety symptoms, decreased sadness levels, and higher relaxation rates. Consistent with these encouraging results, Villani et al. (2012) created a VR stress management protocol based on a virtual wilderness park where participants could practice progressive muscular relaxation and guided imagery. Confirming previous findings, the authors demonstrated the efficacy of the VR-based intervention for improving emotional well-being in individuals with high levels of stress. Although not immersive, the studies by Serrano et al. (2013, 2016) are also worth mentioning because of the attempt to foster relaxation through sensory stimulation in a virtual environment. To achieve this aim, the House of Relaxation was developed, a computer-based VR environment to induce relaxation through visual, auditory, tactile, and olfactory stimuli. Although not statistically significant, participants whose sense of touch was stimulated showed higher relaxation and sense of presence than participants in the VR and VR + olfactory conditions, thus suggesting that sensory stimulation is a potential tool to further boost VR-based relaxation interventions. In relation to young populations, an illustrative example of a non-immersive system to train relaxation techniques is the GameTeen System (GT-System), an interactive VR serious game platform for the assessment and enhancement of breathing and relaxation strategies in adolescents (Alcañiz et al., 2014; Rodriguez et al., 2015). This computer-based system includes two main components: A game to induce frustration and two mini games to train ER skills. A preliminary study revealed significantly lower frustration levels in almost all the participants after playing the ER games, thus highlighting the effectiveness of the system for regulating negative emotions (Rodriguez et al., 2015)..

In addition to enhancing relaxation skills in healthy or subclinical samples, some studies have also explored the efficacy of VR-based relaxation interventions in clinical populations. In a recent study, a group of patients diagnosed with MDD or bipolar disorder were encouraged to practice different relaxation techniques on a peaceful virtual beach (Shah et al., 2015). At the end of the treatment, patients reported lower stress levels and depressive and anxiety symptoms and greater perceived relaxation. Similarly, a VR self-management relaxation protocol with immersive 360° nature videos was recently developed and tested in a sample of patients suffering from anxiety, psychotic, depressive, or bipolar disorders (Veling et al., 2020). Compared to a standard relaxation procedure, VR led to a significantly greater reduction in negative affect such as momentary anxiety and sadness. These findings are particularly relevant because they further confirm the efficacy of delivering VR-based interventions through low-hand devices such as smartphones.

2.3 Cognitive strategies

Cognitive reappraisal

Cognitive reappraisal refers to the process of rethinking the meaning and interpretation of a stimulus in order to change its emotional impact (Gross, 2015b), that is, reducing the intensity of negative emotions (Gross & John, 2003; Richardson, 2017) and increasing positive ones (Quoidbach et al., 2015). Growing evidence has highlighted its adaptiveness, showing that less use of this strategy is a transdiagnostic feature across several psychopathological conditions (Cludius et al., 2020) and associated with higher levels of depression, anxiety, and stress (Eftekhari et al., 2009).

However, thus far, only a few interventions have been developed to explicitly train cognitive reappraisal skills by means of VR. The SPARX programme is a computerised cognitive behavioural therapy (CBT) intervention for adolescents that targets cognitive distortions and other ER skills (e.g., relaxation, problem solving, social abilities) (Fleming et al., 2012). Based on the concept of gamification, the intervention involves a virtual character that interacts and guides young users throughout the intervention, as well as a "game world" in which adolescents can learn how to cope with negative thoughts or feelings while playing mini games with a personalized avatar. Although ER skill improvements throughout the intervention were not directly explored, the results from a randomized control trial showed the efficacy of the program in reducing depressive symptoms. Furthermore, the use of personalized avatars (i.e., avatars that are physically similar to the participant) has been shown to be more effective for inducing intense emotional states (Wrzesien et al., 2015), thus being suggested as a crucial element to foster VR-based interventions for ER (Blascovich et al., 2002; Herrera et al., 2020).

Although exposure therapy has traditionally been conceptualized as an intervention that targets avoidance behaviours (Barlow, 1988), cognitive skills such as cognitive reappraisal are also involved. Anxiety disorders are characterized by the presence of cognitive distortions and biases in the way information related to a threatening situation is processed (Kaczkurkin & Foa, 2015). Thus, exposure therapy aims to change fear memories (i.e., information about fear stimuli, responses, and meaning) by providing novel incompatible information that challenges distorted interpretations and facilitates emotional processing (Maples-Keller et al., 2017).

Accordingly, mechanisms such as negative beliefs, extinction, and inhibitory learning have been important targets of exposure treatments (Craske et al., 2008; Foa & Kozak, 1986). In this direction, Wilson et al. (2018) found that participants with considerable contamination concerns showed increased approach behaviours (i.e., reduced avoidance) when exposure to potentially contaminated objects was provided along with instructions to reappraise the emotional stimulus/situation. In another study exploring dental phobia, high-reappraisal individuals were found to be more efficacious in regulating emotional responses when exposed to threatening stimuli (Hermann et al., 2013). Therefore, cognitive reappraisal is proposed as an important strategy to enhance exposure therapy's efficacy. Furthermore, Botella et al. (2014) found that patients with fear of flying were likely to prefer VR exposure therapy along with cognitive restructuring, compared to VR exposure alone, which was perceived as less effective and more aversive.

In line with this evidence, some attempts have been made to explicitly promote cognitive restructuring in VR-based exposure therapies. The program "Engaging Media for Mental Health Application" (EMMA) is a flexible VR system that makes it possible to shape and customize a virtual environment in order to generate personally significant emotional reactions. Unlike traditional VR exposure treatments that aim to recreate a traumatic situation with high realism, EMMA has been tested for the treatment of post-traumatic stress disorder due to its ability to evoke traumatic situations through the use of symbols, thus focusing more on the meaning and interpretation of a trauma (Baños et al., 2009, 2011; Botella, García-Palacios, et al., 2010; Guillén et al., 2018). Although CBT alone was found to be as effective as CBT plus virtual reality, participants in the EMMA condition showed greater improvements in terms of depression, relaxation intensity, social interference, and motivation towards the treatment. Based on the same conceptual framework, EMMA has also been tested in combination with a structured CBT manualized program in a patient who reported complicated grief, and, more specifically, it has been used to target intrusive and irrational thoughts (Botella et al., 2008). Results revealed a significant decrease in depressive symptoms and negative affect, as well as lower rates of fear, avoidance, belief in irrational thoughts, and avoidance of intrusive thoughts after the intervention. Another representative example of the importance of cognitive restructuring in exposure therapy comes from the field of psychosis, where several studies have attempted to combine CBT with VR-based exposure. Gega et al. (2013) developed a protocol in which the exposure to anxiety-provoking situations through VR was integrated with a CBT intervention that helps patients to identify distorted beliefs and develop alternative ways of thinking about the situation. Hence, VR is not only a tool to provide exposure, but also a way to implement and provide training in cognitive reappraisal skills. Recently, further attempts in this direction consisted of the gameChange and THRIVE trials, specifically designed to provide VR cognitive treatment to patients with psychosis (Freeman, Lister, et al., 2019; Freeman, Yu, et al., 2019). For this purpose, an automated VR intervention was developed, in which patients are exposed to virtual anxiety-provoking social situations while being guided in practicing cognitive techniques. According to the authors, the "*treatment is not designed as exposure therapy (participants are not asked to remain in situations until anxiety reduces)", *but rather, as a way for patients to "*test their fear expectations around other people in order to relearn safety*".

2.4 Response modulation strategies

Stress inoculation

Within the category of response modulation, VR has been widely adopted in the field of stress inoculation training. The fundamentals underlying this type of intervention involve gradual and repeated exposure to stressful situations in order to shape the associated emotional reaction and decrease the emotional impact of stressors on an individual's affective state (i.e., "mental readiness") (Meichenbaum & Deffenbacher, 1988). In line with the advantages discussed in the paragraph about exposure therapy, VR has been shown to be an adequate tool for use in this type of intervention because of the possibility of eliciting stress and progressively modifying the associated emotional response in ecological and controlled settings (Serino et al., 2014).

Interestingly, most of the available studies have been implemented in military samples. In Stetz et al. 's study (2007), a stress inoculation training was administered to a group of soldiers and compared to a VR-enhanced version of the same intervention, which included the possibility of practicing coping skills in Iraq and Afghan VR combat virtual scenarios. Compared to the control condition, participants in the VR training group showed reduced stress levels and increased stress resilience. In similar studies, the use of VR-based stress inoculation training, combined with graphical feedback of respiratory patterns to practice breathing techniques, was found to be more effective than traditional military training for reducing tension and stress (Maciolek et al., 2013a; Maciolek et al., 2013b), although only in the short term (Ilnicki et al., 2012).

Impulse control

Impulse control is another key component of response modulation strategies. Indeed, successful ER also involves cognitive control processes, that is, the ability to efficiently inhibit impulsive responses during emotional situations, which in turn allows the person to implement adequate ER strategies or switch to alternative ones depending on the emotional context (Pruessner et al., 2020).

Adolescence is often characterized by the emergence of risky behaviours (e.g., risky sexual behaviours or substance abuse), which in turn have been associated with reduced ER skills (Hessler & Katz, 2010). Interestingly, there is evidence suggesting that risk decisions are not motivated by the analysis of facts, but rather by difficulties in accessing and implementing adaptive strategies when experiencing intense emotional situations (Steinberg, 2007). Accordingly, some specific ER interventions developed for adolescents focus on implementing adaptive strategies during intense emotional situations in order to reduce risky behaviours (Houck et al., 2016). In fact, VR is a valid tool to expose patients to high-risk situations in a controlled way and explore and teach self-regulation strategies (Kniffin et al., 2014). Related to the latter, an illustrative example was developed by Hadley et al. (2018). In a randomized pilot trial, a brief ER and risk reduction intervention was combined with either role-plays or a VR-based intervention to prevent risk behaviours in adolescents. The authors developed four virtual scenarios in which adolescents were exposed to potentially risky situations to elicit negative emotional reactions. Participants were asked to negotiate safe behaviours (e.g., refusing substances, purchasing condoms) by using the ER strategies learned during face-to-face sessions (e.g., distancing, emotional expression, reappraisal). According to the results, participants in the VR condition reported higher adherence to the protocol. Compared to the role-play group, adolescents in the VR condition also showed higher ER skills, such as less difficulty in accessing ER strategies and higher emotional self-efficacy, at the 3-month follow-up.

Another important field of research involving self-control strategies consists of the use of VR for the treatment of substance use disorders. Patients with addictions have been shown to associate specific contextual cues with the rewarding effects of a substance (e.g., nicotine, alcohol, drugs), which in turn triggers its use. In this regard, VR is a compelling approach for the treatment of craving, which can be achieved by exposing patients to distressful situations in order to extinguish this learned association (i.e., cue exposure therapy) (Segawa et al., 2020).

VR-based cue exposure therapy has been extensively used to quit smoking, revealing that the gradual exposure to salient cues using VR can reduce cue-induced craving and craving levels (Lee et al., 2004; Pericot-Valverde et al., 2014), despite being associated with higher relapse rates than traditional CBT protocols (Pericot-Valverde et al., 2019). Similar results have been obtained for the treatment of alcohol addiction, revealing that VR-based conditioning through exposure to high-risk and aversive situations can reduce craving levels in pathological drinkers (Choi & Lee, 2015; Lee et al., 2009; Son et al., 2015). In addition to addictions, a similar theoretical framework has been applied with patients suffering from eating disorders, who tend to show intense anxiogenic reactions when exposed to food stimuli (Clus et al., 2018). Accordingly, the use of VR to induce food craving has been shown to be effective (Ferrer-García et al., 2015; Ferrer-García et al., 2013), producing a high sense of presence and intense emotional reactions in participants (Gorini et al., 2010; Perpiñá et al., 2013). In the case of binge-eating disorder, for instance, VR cue exposure therapy has been suggested as a valid approach to induce food craving and extinguish the associated conditioned responses (Ferrer-García et al., 2017; Pla-Sanjuanelo et al., 2015). Finally, VR has also been explored in relation to obsessive compulsive disorders and, more specifically, to expose patients to anxiety-provoking situations. Although in its infancy, the results so far have highlighted VR's potential as a tool to provide exposure response prevention and help patients to develop new associations when facing perceived threatening situations (Belloch et al., 2014; Laforest et al., 2016).

Finally, the serious game PlayMancer was developed with the aim of improving self-control skills in patients with impulsive behaviours, who are typically characterized by dysfunctional ER processes (Fernández-Aranda et al., 2012). The virtual scenario consists of several islands, each of which provides users with different activities and games to improve self-control skills (e.g., impulse control, managing adverse and frustrating situations, relaxation techniques). Interestingly, the video game also includes innovative features such as continuous physiological monitoring and facial expression recognition, which allows the system to automatically trigger specific games depending on the user's momentary state (e.g., relaxing activities when high frustration is detected). Preliminary findings in patients suffering from gambling disorder and bulimia nervosa are promising and show significant clinical improvements in impulsivity, novelty seeking, and anger expression (Giner-Bartolomé et al., 2015; Tárrega et al., 2015).

3. FURTHER EMERGING FIELDS OF RESEARCH

Although the growing evidence supports VR as a tool to improve ER in different samples and by enhancing different skills, some aspects of this construct have been explored less. In the following sections, we will discuss some of the gaps in the current literature, highlighting preliminary evidence of VR applied to other promising fields of research.

3.1 Regulation of positive emotions: Positive interventions

As discussed in the previous sections, for a long time, most of the ER research focused on how to improve the regulation of negative emotional states. This is coherent with the general trend in psychopathology research, which was typically more interested in the downregulation of negative emotions. However, the upregulation of positive emotion also needs attention. The elaboration of a new integrative research domain called Positive Psychology represented an important change from the perspective that had been dominant for many decades. Positive Psychology emphasizes the importance of exploring positive human experiences and functioning and identifying factors that increase people's resilience and happiness (Seligman & Csikszentmihalyi, 2000). The development of this new theoretical framework also affected the use of Information and Communication Technologies (ICTs) in the field of clinical psychology. In 2011, Sander introduced the concept of Positive Computing to refer to ''*the study and development of information and communication technology that is consciously designed to support people's psychological flourishing in a way that honors individuals' and communities' different ideas about the good life*" (Sander, 2011). Hence, a new approach called Positive Technology was proposed, whose aim is to "*manipulate and enhance the features of our personal experience with the goal of increasing wellness, and generating strengths and resilience in individuals, organizations, and society*" (Botella et al., 2012; Riva et al., 2012). Accordingly, a growing body of literature has begun to focus on the use of VR as a tool to enhance positive affect and the regulation of positive emotional states.

Positive ER refers to the attempt to create, maintain, and enhance positive emotions by using savouring strategies (Bryant, 2003; Quoidbach et al., 2015). It has been shown to have beneficial effects on mental health, including greater happiness, higher positive affect, and enhanced well-being (Colombo, Pavani, et al., 2020; Jose et al., 2012; Quoidbach et al., 2010). Additionally, poor use of savouring has been linked to reduced emotional well-being (Li et al., 2017; Wood et al., 2003), and a dysfunctional regulation of positive affect has been recognised as an important feature of emotional disorders (Carl et al., 2013, 2014), suggesting the importance of targeting the regulation of positive emotional states to enhance mental health.

The Park of Well-Being (Baños et al., 2004) is a clear example of the way VR has been applied to increase positive emotional states (i.e., relaxation and joy) through the manipulation of music, movies, autobiographical recalls, narratives, and pictures inside a virtual environment. Rather than a mere emotional induction procedure, this VR scenario has also been integrated into a broader program of positive psychology called the "EARTH of well-being" (Baños et al., 2014). In addition to the virtual park, the protocol includes a personal diary to record positive events and recall positive memories, as well as two further VR scenarios of natural landscapes (Walk Through Nature) designed to enhance relaxation and joy (Baños et al., 2012) through positive reminiscence, savouring, and slow breathing techniques. Several studies have demonstrated the efficacy of this integrated VR protocol for increasing positive mood in both clinical and non-clinical populations (Baños et al., 2014; Botella et al., 2016; Espinoza et al., 2016). The combined use of the Park of Well-Being and Walk Through Nature virtual scenarios to induce positive emotional states was also tested in hospitalized patients with metastatic cancer (Baños et al., 2013). After four sessions, patients showed increased positive emotions and decreased negative emotions, and they perceived the intervention as useful for teaching skills such as distraction and relaxation. In another study, the EMMA VR- based system was adopted to induce positive emotions and promote motivation, self-efficacy, and behaviour activation in a sample of patients suffering from fibromyalgia syndrome (Botella et al., 2013; Herrero et al., 2014). The protocol involved both group and face-to-face traditional sessions and the exposure to a virtual beach with positively valenced music, sounds, images, and narratives designed by clinicians with expertise in CBT treatments. Preliminary findings indicated the efficacy of the intervention, highlighting enhanced mood state, positive emotions, motivation, and self-efficacy. Similarly, the use of VR was recently tested as a tool to expose depressed patients to positively valenced reinforcing stimuli (Chen et al., 2021). The 13-session protocol consisted of VR positive induction and imaginal recounting (i.e., recalling positively valenced elements and emotions experienced in the virtual environments, as well as retrieving an autobiographical memory associated with the VR experience), and it significantly decreased patients' levels of anhedonia, depression, anxiety, and negative affect, although the mechanisms of change underlying this improvement are still not clear. Finally, a VR-based positive autobiographical memory training for depression was recently developed using *Google Earth VR,* an app that makes it possible to travel to different places around the world from a first-person perspective (Fernandez-Álvarez et al., 2020). Positive reminiscence is a widely recognized strategy to enhance current levels of positive emotions (Bryant et al., 2005; Quoidbach et al., 2010) by re-experiencing beliefs, emotions, thoughts, and desires from past positive memories (Klein, 2015). Consistent with the evidence showing that depressed patients tend to retrieve more negative memories than positive ones (Gaddy & Ingram, 2014; Matt et al., 1992) and underestimate the positivity of past positive experiences (Colombo et al., 2020), the goal of this VR-based intervention was to foster the retrieval of positive memories (i.e., positive reminiscence). To do so, patients were repeatedly immersed in the virtual environment where a positive event occurred, thus being provided with a spatial reference for recalling positive episodes from the past. Promising results were observed in a single case experimental design with 18 MDD patients, with increased positive affect, daily savouring, and reminiscence observed in almost all the participants (Fernandez-Álvarez et al., 2020).

It should be pointed out that most of the studies discussed in this section did not assess ER skills directly. In other words, although all the interventions were found to significantly enhance positive emotions and other related constructs, whether these findings are due to improved skills in regulating positive emotional states is still unclear.

3.2 Physiological regulation of emotions: Biofeedback techniques

When discussing the use of VR to enhance ER skills, biofeedback techniques are also worth mentioning. Through physiological monitoring (e.g., heart rate, brain activity, or breathing), a large amount of data can be obtained. At the same time, visual, auditory, or tactile feedback representing physiological patterns can be provided to patients (i.e., biofeedback) in order to improve the physiological regulation of emotions (Mohr et al., 2017; Snippe et al., 2016). So far, most of the attention has been placed on heart rate variability (HRV) and, more specifically, the high frequencies of HRV, which are directly linked to Respiratory Sinus Arrhythmia and considered a physiological indicator of emotion dysregulation (Appelhans & Luecken, 2006; Beauchaine & Bell, 2018). In this direction, some studies have integrated biofeedback techniques with VR to train ER.

In addition to the serious game PlayMancer described in previous sections (Fernández-Aranda et al., 2012), another illustrative example is DEEP, a VR video game that uses respiratory-based biofeedback to help young individuals cope with subclinical stress and anxiety symptoms (Weerdmeester et al., 2017). The results revealed significantly lower arousal levels in almost all the participants after using DEEP, thus emphasizing the effectiveness of this biofeedback video game in regulating emotions. Broadly speaking, this remarkably versatile tool (i.e., game-based biofeedback) has shown promising results for ER and the treatment of stress and anxiety (Lobel et al., 2016), with some authors advocating its potential as an alternative delivery model for evidence-based treatments (Schoneveld et al., 2018). In another study, Gaggioli et al. (2014) developed “Interreality”, a new technological paradigm for the management and prevention of psychological stress. This paradigm combines virtual scenarios with real-time monitoring and improvement, using advanced technologies such as wearable biosensors to provide the heart rate or HRV biofeedback. In their study, the sample was composed of individuals who were highly exposed to psychological stress in their jobs (i.e., teachers and nurses). Participants were randomly assigned to the experimental group, which received a 5-week treatment based on the Interreality paradigm; to a control group, which received a 5-week traditional stress management training based on CBT; or to a wait-list group. Compared to a wait-list condition, both treatments (CBT and Interreality) significantly reduced perceived stress and significantly increased coping skills. However, only participants who received Interreality reported a significantly greater reduction in chronic trait anxiety and a significantly greater increase in emotion-related coping skills, compared to participants in the CBT condition. Similar results were observed by Rockstroh et al. (2019), who demonstrated the effectiveness of a VR-based biofeedback training to increase short-term HRV and enhance motivation for the treatment. Recently, the usability of a mobile application to provide HRV biofeedback training through virtual environments was also tested, leading the way in designing innovative self-help and low-hand tools for use in daily life (Fernandez-Alvarez et al., 2019).

Together, these results are particularly relevant because they suggest that the use of VR with real-time monitoring using biosensors is clinically efficacious and even provides better outcomes than traditionally accepted gold standard CBT in the management of psychological stress.

3.3 Interpersonal emotion regulation

Most of the literature has focused on intrapersonal ER, emphasizing how people regulate ongoing emotions using different strategies at an individual level. However, another category of ER was recently proposed that refers to using others to regulate one’s emotions (i.e., interpersonal ER) (Hofmann et al., 2016). The VR-based literature in this direction is still in its infancy, although promising results have been pointed out.

In the past decade, VR has been defined as the “ultimate empathy machine” (Milk, 2015) because it has the potential to make people experience situations from different perspectives and points of view. Although the available studies in this field are still limited, and definitive conclusions cannot be drawn, a recent meta-analysis pointed to significant changes in perspective-taking measures after VR exposure, but no significant improvements in terms of empathy (Ventura et al., 2020). In this regard, VR-based perspective-taking tasks have been shown to be a powerful tool to foster short- and long-term empathy and pro-social behaviours towards outgroup members, especially for individuals with low levels of empathy prior to the intervention (Ahn et al., 2013; van Loon et al., 2018). Herrera et al. (2018), for example, asked participants to virtually embody a homeless person from a first-person perspective and imagine what it would be like to be in that situation. Compared to a traditional perspective-taking task based on imagery, participants in the VR condition were more likely to sign a petition supporting the homeless, thus showing more prosocial behaviours. Other studies have shown that the virtual embodiment of white people in dark-skinned bodies can reduce implicit racial bias (Banakou et al., 2016; Maister et al., 2013; Peck et al., 2013), whereas self-identification with virtual bodies can improve self-criticism and self-compassion in both healthy (Falconer et al., 2014) and depressed individuals (Falconer et al., 2016). Moreover, putting offenders in the virtual body of a victim of domestic abuse improves socio-perceptual processes such as emotion recognition (Seinfeld et al., 2018), which might be explained by the neurobiological changes in the activity of the Default Mode Network observed in people experiencing a violent situation from a first-person perspective through VR (Seinfeld et al., 2021). Interesting findings also come from the immersive VR intervention developed by Bailey et al. (2019), based on an animated media character to train inhibitory control and social compliance in children. In their study, the authors showed that children in the VR condition, compared to a TV condition (i.e., experiencing the same environment on a TV display), showed higher social compliance, whereas no differences were observed in terms of emotional and physical distress. Interestingly, children in the VR condition also reported enhanced sharing behaviours, thus suggesting that VR is a potential tool to strengthen social affiliation behaviours in young populations. Finally, there is strong evidence supporting the use of VR to improve social functioning in patients suffering from psychosis (Rus-Calafell et al., 2018; Valmaggia, 2017), such as conversation skills, assertiveness skills, emotion expression skills, and job interview skills (Ku et al., 2007; Park et al., 2011; Smith et al., 2015). Together, these results highlight the potential of VR to improve, in addition to intrapersonal ER, interpersonal strategies such as empathy, compassion, social skills, and perspective taking.

4. COST-EFFECTIVENESS OF VIRTUAL REALITY

As briefly summarized in the previous sections, increasing research has shown the efficacy and effectiveness of VR for the enhancement and treatment of ER. Nevertheless, in the past few decades, VR has hardly been implemented in clinical settings due to the high costs of devices and software development. As VR becomes more accessible, new interesting directions are starting to emerge, which might help to bridge the gap between research and clinical practice in the near future.

Recently, mobile VR interventions have started to emerge thanks to the proliferation of off-the-shelf hardware. Today, there are a number of new options that are not only wireless and low-cost, but also easy and intuitive to use. Gear VR, OculusGo, or Google Cardboards are some of the cheapest options on the market that can support some of the existing developments in virtual environments for use by people in daily life or by clinicians in clinical practice. These low-cost head-mounted displays make it possible to access VR environments without complex systems or expensive laptops, just by owning a normal smartphone. In this regard, considerable research has already been published on using mobile VR, confirming its efficacy (Donker et al., 2019; Kim et al., 2017; Lindner et al., 2019; Miloff et al., 2019) and highlighting the potential of this tool to reach people in need who otherwise would not receive any treatment. Compared to the past, evidence-based VR treatments can now be more easily dispensed at very low cost for end-users.

Regarding software development, advances in recent years have shown that accessible platforms for VR development have started to become widespread, with a significant impact on both research and commercial products. Unity3D is one of these platforms. Along with the growth of VR, companies, start-ups, and freelance programmers have emerged in this context to help tackle the technical aspects of VR technology implementation. Nevertheless, it is important to mention that the initial cost of developing a VR environment might be quite high and require the involvement of a multidisciplinary team of programmers and human-computer interaction experts. In addition to having considerable psychological knowledge, technical skills are also required to develop VR interventions, which psychologists usually do not have.

Although VR development platforms are now evolving to languages that are more accessible to the non-specialist population, they are still a long way from achieving the status of easy-to-use plug-and-play interfaces. When a multidisciplinary collaboration is too costly, there are many user-friendly options that can help to address technical and economic barriers. For instance, the emergence of affordable and readily available 360° stereoscopic video cameras and open-source VR apps is creating a new design space that can be quite beneficial for clinical purposes. Less expensive than old VR systems, these cameras make it possible to record VR videos that can be transferred to systems such as Gear VR or Google Cardboard. Recently, some initial studies have been carried out using 360° stereoscopic video cameras, with encouraging results for fear of public speaking (Stupar-Rutenfrans et al., 2017), fear of heights (Hong et al., 2017), or providing behavioural activation (Paul et al., 2020). Despite being complex and interactive, the use of 360° videos might be an easily accessible way to distribute VR interventions in the field of ER.

4. FUTURE DIRECTIONS

In this narrative review, we have provided an overview of the available evidence about VR-based interventions for ER, taking into consideration the different fields of the applications explored. It is again important to note that this is not intended to be an exhaustive review because a systematic methodology was not followed; instead, it is an opportunity to examine VR-based interventions from an emotion regulation perspective. So far, several frameworks have been proposed to explain emotion dysregulation (e.g., Koole, 2009; Parkinson & Totterdell, 1999; Webb et al., 2012). Although we acknowledge the potential conceptual limitations of adopting a specific strategy-based framework (Berking & Wupperman, 2012), in the present review we synthesized the available studies based on Gross' model (Gross et al., 2019), which is one of the most widely used frameworks for organizing ER processes.

Today, VR is producing an important technological revolution in the treatment of several psychopathological conditions (Freeman et al., 2017). Regarding the specific case of ER, the studies discussed in this narrative review suggest that more evidence is needed before drawing definitive conclusions about the adoption of VR for the enhancement of ER skills in both healthy and clinical populations. Nevertheless, the findings from both non-immersive and immersive VR-based literature are encouraging, showing significant clinical improvements associated with the proposed interventions. The available evidence emphasizes the importance of concepts such as gaming, gamification, and persuasive technology for the development of

VR-based treatments targeting ER (Fleming et al., 2016; Li et al., 2011), as reflected by the high acceptability and adherence rates to the protocols. Because ER is a well-known protective factor in mental health (Troy & Mauss, 2011), the adoption of VR to strengthen and improve regulatory skills might lead to the development of transdiagnostic interventions, as well as innovative approaches in the field of prevention. To achieve this aim, more efforts are needed to disentangle the mechanisms of change underlying these interventions. Indeed, most of the available studies mainly evaluated the efficacy of the proposed protocol by considering symptom reduction and/or mood improvement, disregarding the potential clinical change in the ER skills targeted by the intervention. This is especially evident in the literature exploring positive interventions, where most of the studies aimed to improve positive affective states, but without addressing and/or exploring any specific strategy.

One of the most interesting and promising aspects emerging from this review is the use of low-hand devices such as smartphones to provide VR-based interventions. One future challenge revolves around the development of VR mobile apps for use in daily life, which would increase the dissemination of evidence-based interventions and reach more people in need. In line with the observed significant association between VR-based interventions and engagement, the use of approaches based on gamification should play a key role in app development, in order to potentially increase not only adherence, but also the efficacy of the intervention (Fleming et al., 2016). Moreover, future research should also focus on integrating VR with other technological solutions (Desirée Colombo, Fernández-Álvarez, Palacios, Cipresso, et al., 2019). The development of VR-based biofeedback protocols, for instance, is a clear example of the integration of technologies to concurrently capture different dimensions of ER processes (i.e., physiological and cognitive aspects) and train one's control over physiological arousal. However, further possibilities based on a more integrative approach could be explored in the near future. Ecological Momentary Assessment (EMA) could be combined with VR-based interventions in order to elucidate how the treatment impacts the deployment of ER strategies in daily life and the potential changes in overall daily functioning associated with the newly acquired skills. Furthermore, big data and deep learning should be incorporated when combining VR with data gathered through wearable biosensors or EMA, in order to personalize interventions depending on the specific characteristics of the users. The development of complex systems based on the continuous monitoring of patients' physiological parameters and/or self-reported states would make it possible to trigger real-time interventions (Ecological Momentary Interventions) (Desirée Colombo, Fernández-Álvarez, Palacios, Patané, et al., 2019), where customized VR-based activities could be suggested based on the specific momentary needs detected by the system.

Despite the advantages highlighted in the present review, the integration of VR with traditional therapeutic procedures should be more precisely understood. It is imperative to accurately understand when VR interventions can be used, when self-help VR interventions are appropriate, when additional therapeutic face-to-face support is needed, or when the use of technologies should be ruled out. An innovative potential advancement would be the incorporation of holograms, which should be incorporated into the broad field of ER. Holograms would make it possible to have in-person therapists, but without being materially there. In addition, ethical implications should be considered (Botella et al., 2009). One of the issues highlighted by the literature is cybersickness (i.e., the experience of nausea, fatigue, headache while navigating in a virtual environment) (Davis et al., 2014). Although this adverse side effect affects a very small percentage of patients and can easily be solved by stopping the experience, it should be considered an ethical requirement to take into account when using VR in clinical contexts. Another important consideration has to do with the use of VR when treating children, adolescents, or elderly patients, as well as patients with severe clinical conditions. Although some evidence suggests that VR does not cause specific negative outcomes or side effects in these populations, researchers and clinicians should proceed cautiously when using VR in these samples (Botella et al., 2009). Furthermore, some problems related to technology addiction, such as internet gaming disorder (recently included in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders; DSM-5) (Petry et al., 2014), should always be kept in mind when developing a treatment plan that is at least partially based on the use of technologies. Developing immersive experiences in VR is not a trivial task, and the elaboration of detailed guidelines to facilitate the creation of new environments is paramount. Overcoming these barriers will further simplify the revolution that new technologies are producing in the science of behaviour (Insel, 2017) while changing the way we conceptualize and treat emotion dysregulation problems.

REFERENCES

Ahn, S. J., Le, A. M. T., & Bailenson, J. (2013). The Effect of Embodied Experiences on Self-Other Merging, Attitude, and Helping Behavior. *Media Psychology*, *16*(1), 7–38. https://doi.org/10.1080/15213269.2012.755877

Alcañiz, M., Rodríguez, A., Rey, B., & Parra, E. (2014). Using serious games to train adaptive emotional regulation strategies. *International Conference on Social Computing and Social Media*, 541–549. https://doi.org/10.1007/978-3-319-07632-4_51

Aldao, A., Gee, D. G., De Los Reyes, A., & Seager, I. (2016). Emotion regulation as a transdiagnostic factor in the development of internalizing and externalizing psychopathology: Current and future directions. *Development and Psychopathology*, *28*(4), 927–946. https://doi.org/10.1017/S0954579416000638

Aldao, A., & Nolen-Hoeksema, S. (2012). The influence of context on the implementation of adaptive emotion regulation strategies. *Behaviour Research and Therapy*, *50*(7), 493–501. https://doi.org/10.1016/j.brat.2012.04.004

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, *30*(2), 217–237. https://doi.org/10.1016/j.cpr.2009.11.004

Aldao, A., Sheppes, G., & Gross, J. J. (2015). Emotion Regulation Flexibility. *Cognitive Therapy and Research*, *39*(3), 263–278. https://doi.org/10.1007/s10608-014-9662-4

Anderson, A. P., Mayer, M. D., Fellows, A. M., Cowan, D. R., Hegel, M. T., & Buckey, J. C. (2017). Relaxation with immersive natural scenes presented using virtual reality. *Aerospace Medicine and Human Performance*, *88*(6), 520–526. https://doi.org/10.3357/AMHP.4747.2017

Annerstedt, M., Jönsson, P., Wallergård, M., Johansson, G., Karlson, B., Grahn, P., Hansen, Å. M., & Währborg, P. (2013). Inducing physiological stress recovery with sounds of nature in a virtual reality forest - Results from a pilot study. *Physiology and Behavior*, *118*, 240–250. https://doi.org/10.1016/j.physbeh.2013.05.023

Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review of General Psychology*, *10*(3), 229–240. https://doi.org/10.1037/1089-2680.10.3.229

Atzori, B., Grotto, R. L., Giugni, A., Calabrò, M., Alhalabi, W., & Hoffman, H. G. (2018). Virtual reality analgesia for pediatric dental patients. *Frontiers in Psychology*, *9*, 2265. https://doi.org/10.3389/fpsyg.2018.02265

Atzori, B., Hoffman, H. G., Vagnoli, L., Patterson, D. R., Alhalabi, W., Messeri, A., & Grotto, R. L. (2018). Virtual reality analgesia during venipuncture in pediatric patients with onco-hematological diseases. *Frontiers in Psychology*, *9*, 2508.

https://doi.org/10.3389/fpsyg.2018.02508

Bailey, J. O., Bailenson, J. N., Obradović, J., & Aguiar, N. R. (2019). Virtual reality's effect on children's inhibitory control, social compliance, and sharing. *Journal of Applied Developmental Psychology*, *64*, 101052. https://doi.org/10.1016/j.appdev.2019.101052

Banakou, D., Hanumanthu, P. D., & Slater, M. (2016). Virtual embodiment of white people in a black virtual body leads to a sustained reduction in their implicit racial bias. *Frontiers in Human Neuroscience*, *10*, 601. https://doi.org/10.3389/fnhum.2016.00601

Baños, R. M., Botella, C., Alcañiz, M., Liaño, V., Guerrero, B., & Rey, B. (2004). Immersion and emotion: Their impact on the sense of presence. *Cyberpsychology and Behavior*, *7*(6), 734–741. https://doi.org/10.1089/cpb.2004.7.734

Baños, R. M., Botella, C., Guerrero, B., Liaño, V., Alcañiz, M., & Rey, B. (2005). The third pole of the sense of presence: Comparing virtual and imagery spaces. *PsychNology Journal*, *3*(1), 90–100.

Baños, R. M., Botella, C., Guillen, V., García-Palacios, A., Quero, S., Bretón-López, J., & Alcañiz, M. (2009). An adaptive display to treat stress-related disorders: EMMA's world. *British Journal of Guidance and Counselling*, *37*(3), 347–356. https://doi.org/10.1080/03069880902957064

Baños, R. M., Botella, C., Liaño, V., Guerrero, B., Rey, B., & Alcañiz, M. (2004). Sense of Presence in Emotional Virtual Environments. *Presence: Teleoperators and Virtual Environments*, 156–159.

Baños, R. M., Botella, C., Rubió, I., Quero, S., García-Palacios, A., & Alcañiz, M. (2008). Presence and emotions in virtual environments: The influence of stereoscopy. *Cyberpsychology and Behavior*, *11*(1), 1–8. https://doi.org/10.1089/cpb.2007.9936

Baños, R. M., Escobar, P., Cebolla, A., Guixeres, J., Alvarez Pitti, J., Lisón, J. F., & Botella, C. (2016). Using virtual reality to distract overweight children from bodily sensations during exercise. *Cyberpsychology, Behavior, and Social Networking*, *19*(2), 115–119. https://doi.org/10.1089/cyber.2015.0283

Baños, R. M., Espinoza, M., García-Palacios, A., Cervera, J. M., Esquerdo, G., Barrajón, E., & Botella, C. (2013). A positive psychological intervention using virtual reality for patients with advanced cancer in a hospital setting: A pilot study to assess feasibility. *Supportive Care in Cancer*, *21*(1), 263–270. https://doi.org/10.1007/s00520-012-1520-x

Baños, R. M., Etchemendy, E., Castilla, D., García-Palacios, A., Quero, S., & Botella, C. (2012). Positive mood induction procedures for virtual environments designed for elderly people. *Interacting with Computers*, *24*(3), 131–138. https://doi.org/10.1016/j.intcom.2012.04.002

Baños, R. M., Etchemendy, E., Farfallini, L., García-Palacios, A., Quero, S., & Botella, C. (2014). EARTH of Well-Being System: A pilot study of an Information and Communication Technology-based positive psychology intervention. *Journal of Positive Psychology*, *9*(6), 482–488. https://doi.org/10.1080/17439760.2014.927906

Baños, R. M., Guillen, V., Quero, S., García-Palacios, A., Alcaniz, M., & Botella, C. (2011). A virtual reality system for the treatment of stress-related disorders: A preliminary analysis of efficacy compared to a standard cognitive behavioral program. *International Journal of Human Computer Studies*, *69*(9), 602–613. https://doi.org/10.1016/j.ijhcs.2011.06.002

Baños, R. M., Liaño, V., Botella, C., Alcañiz, M., Guerrero, B., & Rey, B. (2006). Changing induced moods via virtual reality. *International Conference on Persuasive Technology.*, 7–15. https://doi.org/10.1007/11755494_3

Barlow, D H. (1988). *Anxiety and its disorders: The nature and treatment of anxiety and panic*. Guilford Press.

Barlow, David H., Allen, L. B., & Choate, M. L. (2004). Toward a unified treatment for emotional disorders. *Behavior Therapy*, *35*(2), 205–230. https://doi.org/10.1016/S0005-7894(04)80036-4

Barrett, L. F., Gross, J., Christensen, T. C., & Benvenuto, M. (2001). Knowing what you're feeling and knowing what to do about it: Mapping the relation between emotion differentiation and emotion regulation. *Cognition and Emotion*, *15*(6), 713–724. https://doi.org/10.1080/02699930143000239

Beauchaine, T. P., & Bell, Z. E. (2018). Respiratory Sinus Arrhythmia as a Transdiagnostic Biomarker of Emotion Dysregulation. In *The Oxford Handbook of Emotion Dysregulation* (pp. 1–26). https://doi.org/10.1093/oxfordhb/9780190689285.013.12

Belloch, A., Cabedo, E., Carrió, C., Lozano-Quilis, J. A., Gil-Gómez, J. A., & Gil-Gómez, H. (2014). Virtual reality exposure for OCD: Is it feasible? *Revista de Psicopatologia y Psicologia Clinica*, *19*(1), 37–44. https://doi.org/10.5944/rppc.vol.19.num.1.2014.12981

Benbow, A. A., & Anderson, P. L. (2019). A meta-analytic examination of attrition in virtual reality exposure therapy for anxiety disorders. *Journal of Anxiety Disorders*, *61*(1), 18–27. https://doi.org/10.1016/j.janxdis.2018.06.006

Berking, M., & Wupperman, P. (2012). Emotion regulation and mental health: Recent findings, current challenges, and future directions. *Current Opinion in Psychiatry*, *25*(2), 128–134. https://doi.org/10.1097/YCO.0b013e3283503669

Bertrand, P., González Franco, D., Pointeau, A., & Cherene, C. (2014). The Machine to be Another - Embodied Telepresence using human performers. *8th International Conference on Tangible, Embedded and Embodied Interaction*, *17*(14), 5109.

Bielinis, E., Simkin, J., Puttonen, P., & Tyrväinen, L. (2020). Effect of viewing video representation of the urban environment and forest environment on mood and level of procrastination. *International Journal of Environmental Research and Public Health*, *17*(14), 5109. https://doi.org/10.3390/ijerph17145109

Blalock, D. V., Kashdan, T. B., & Farmer, A. S. (2016). Trait and Daily Emotion Regulation in Social Anxiety Disorder. *Cognitive Therapy and Research*, *40*(3), 416–425. https://doi.org/10.1007/s10608-015-9739-8

Blascovich, J., Loomis, J., Beall, A. C., Swinth, K. R., Hoyt, C. L., & Bailenson, J. N. (2002). Immersive virtual environment technology as a methodological tool for social psychology. *Psychological Inquiry*, *13*(2), 103–124. https://doi.org/10.1207/S15327965PLI1302_01

Botella, C., Baños, R. M., Etchemendy, E., García-Palacios, A., & Alcañiz, M. (2016). Psychological countermeasures in manned space missions: “EARTH” system for the Mars-500 project. *Computers in Human Behavior*, *55*, 898–908. https://doi.org/10.1016/j.chb.2015.10.010

Botella, C., Baños, R. M., Perpiñá, C., Villa, H., Alcañiz, M., & Rey, A. (1998). Virtual reality treatment of claustrophobia: A case report. *Behaviour Research and Therapy*, *36*(2), 239–246. https://doi.org/10.1016/S0005-7967(97)10006-7

Botella, C., Bretón-López, J., Quero, S., Baños, R., & García-Palacios, A. (2010). Treating Cockroach Phobia With Augmented Reality. *Behavior Therapy*, *41*(3), 401–413. https://doi.org/10.1016/j.beth.2009.07.002

Botella, C., Bretón-LÓPEZ, J., Serrano, B., García-Palacios, A., Quero, S., & Baños, R.

(2014). Treatment of flying phobia using virtual reality exposure with or without cognitive restructuring: Participants' preferences. *Revista de Psicopatologia y Psicologia Clinica*, *19*(3), 157–169. https://doi.org/10.5944/rppc.vol.19.num.3.2014.13898

Botella, C., Fernández-Álvarez, J., Guillen, V., Garcia-Palacios, A., Banos, R., Fernández-Álvarez, J., Guillén, V., García-Palacios, A., & Baños, R. (2017). Recent Progress in Virtual Reality Exposure Therapy for Phobias: A Systematic Review. *Current Psychiatry Reports*, *19*(7), 42. https://doi.org/10.1007/s11920-017-0788-4

Botella, C., Garcia-Palacios, A., Baños, R. M., & Quero, S. (2009). Cybertherapy: Advantages, limitations, and ethical issues. *PsychNology Journal*, *7*(1), 77–100.

Botella, C., García-Palacios, A., Guillen, V., Baños, R. M., Quero, S., & Alcaniz, M. (2010). An adaptive display for the treatment of diverse trauma PTSD victims. *Cyberpsychology, Behavior, and Social Networking*, *13*(1), 67–71. https://doi.org/10.1089/cyber.2009.0353

Botella, C., Garcia-Palacios, A., Vizcaíno, Y., Herrero, R., Baños, R. M., & Belmonte, M. A. (2013). Virtual reality in the treatment of fibromyalgia: A pilot study. *Cyberpsychology, Behavior, and Social Networking*, *16*(3), 215–223. https://doi.org/10.1089/cyber.2012.1572

Botella, C., Juan, M. C., Baños, R. M., Alcañiz, M., Guillén, V., & Rey, B. (2005). Mixing realities? An application of augmented reality for the treatment of cockroach phobia. *Cyberpsychology and Behavior*, *8*(2), 162–171. https://doi.org/10.1089/cpb.2005.8.162

Botella, C., Osma, J., Palacios, A. G., Guillen, V., & Banos, R. (2008). Treatment of complicated grief using virtual reality: A case report. *Death Studies*, *32*(7), 674–692. https://doi.org/10.1080/07481180802231319

Botella, C., Pérez-Ara, M. Á., Bretón-López, J., Quero, S., García-Palacios, A., & Baños, R. M. (2016). In Vivo versus augmented reality exposure in the treatment of small animal phobia: A randomized controlled trial. *PLoS ONE*, *11*(2), e0148237. https://doi.org/10.1371/journal.pone.0148237

Botella, C., Quero, S., Baños, R. M., Perpiña, C., García Palacios, A., & Riva, G. (2004). Virtual reality and psychotherapy. *Studies in Health Technology and Informatics*, *99*, 37–52. https://doi.org/10.3233/978-1-60750-943-1-37

Botella, C., Riva, G., Gaggioli, A., Wiederhold, B. K., Alcaniz, M., & Baños, R. M. (2012). The Present and Future of Positive Technologies. *Cyberpsychology, Behavior, and Social Networking*, *15*(2), 78–84. https://doi.org/10.1089/cyber.2011.0140

Botella, C., Serrano, B., Baños, R. M., & Garcia-Palacios, A. (2015). Virtual reality exposure-based therapy for the treatment of post-traumatic stress disorder: A review of its efficacy, the adequacy of the treatment protocol, and its acceptability. *Neuropsychiatric Disease and Treatment*, *11*, 2533. https://doi.org/10.2147/NDT.S89542

Botella, C., Villa, H., García-Palacios, A., Baños, R. M., Perpiñá, C., & Alcañiz, M. (2004). Clinically significant virtual environments for the treatment of panic disorder and agoraphobia. *Cyberpsychology & Behavior : The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society*, *7*(5), 527–535. https://doi.org/10.1089/cpb.2004.7.527

Bretón-López, J., Mira, A., Castilla, D., Garcia-Palacios, A., & Botella, C. (2017). Revisión de aplicaciones de las tecnologías de la información y la comunicación en psicología clínica y de la salud en infancia y adolescencia. *Revista de Psicología Clínica Con Niños y Adolescentes*, *4*(3), 11–16.

Brown, K. W., & Ryan, R. M. (2003). The Benefits of Being Present: Mindfulness and Its Role in Psychological Well-Being. *Journal of Personality and Social Psychology*, *84*(4), 822. https://doi.org/10.1037/0022-3514.84.4.822

Bryant, F. B. (2003). Savoring Beliefs Inventory (SBI): A scale for measuring beliefs about savouring. *Journal of Mental Health*, *12*(2), 175–196. https://doi.org/10.1080/0963823031000103489

Bryant, F. B., Smart, C. M., & King, S. P. (2005). Using the past to enhance the present: Boosting happiness through positive reminiscence. *Journal of Happiness Studies*, *6*(3), 227–260. https://doi.org/10.1007/s10902-005-3889-4

Carl, E., Stein, A. T., Levihn-Coon, A., Pogue, J. R., Rothbaum, B., Emmelkamp, P., Asmundson, G. J. G., Carlbring, P., & Powers, M. B. (2019). Virtual reality exposure therapy for anxiety and related disorders: A meta-analysis of randomized controlled trials. *Journal of Anxiety Disorders*, *61*, 27–36. https://doi.org/10.1016/j.janxdis.2018.08.003

Carl, J. R., Fairholme, C. P., Gallagher, M. W., Thompson-Hollands, J., & Barlow, D. H.

(2014). The effects of anxiety and depressive symptoms on daily positive emotion regulation. *Journal of Psychopathology and Behavioral Assessment*, *36*(2), 224–236. https://doi.org/10.1007/s10862-013-9387-9

Carl, J. R., Soskin, D. P., Kerns, C., & Barlow, D. H. (2013). Positive emotion regulation in emotional disorders: A theoretical review. *Clinical Psychology Review*, *33*(3), 343–360. https://doi.org/10.1016/j.cpr.2013.01.003

Cebolla, A., Herrero, R., Ventura, S., Miragall, M., Bellosta-Batalla, M., Llorens, R., & Baños, R. M. (2019). Putting oneself in the body of others: A pilot study on the efficacy of an embodied virtual reality system to generate self-compassion. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.01521

Chen, K., Barnes-Horowitz, N., Treanor, M., Sun, M., Young, K. S., & Craske, M. G. (2021). Virtual Reality Reward Training for Anhedonia: A Pilot Study. *Frontiers in Psychology*, *11*, 3748. https://doi.org/10.3389/fpsyg.2020.613617

Choi, Y. J., & Lee, J. H. (2015). The effect of virtual covert sensitization on reducing alcohol craving in heavy social drinkers. *Virtual Reality*, *19*(2), 111–117. https://doi.org/10.1007/s10055-015-0264-6

Cikajlo, I., Čižman-Štaba, U., Vrhovac, S., Larkin, F., & Roddy, M. (2016). Recovr: Realising collaborative virtual reality for wellbeing and self-healing. *Proceedings of the 3rd IASTED International Conference on Telehealth and Assistive Technology, TAT 2016*. https://doi.org/10.2316/P.2016.846-008

Cipresso, P., Giglioli, I. A. C., Raya, M. A., & Riva, G. (2018). The past, present, and future of virtual and augmented reality research: A network and cluster analysis of the literature. *Frontiers in Psychology*, *9*, 2086. https://doi.org/10.3389/fpsyg.2018.02086

Cludius, B., Mennin, D., & Ehring, T. (2020). Emotion regulation as a transdiagnostic process. *Emotion*, *20*(1), 37. https://doi.org/10.1037/emo0000646

Clus, D., Larsen, M. E., Lemey, C., & Berrouiguet, S. (2018). The use of virtual reality in patients with eating disorders: Systematic review. *Journal of Medical Internet Research*, *20*(4), e157. https://doi.org/10.2196/jmir.7898

Colombo, D., Pavani, J. B., Fernández-Álvarez, J., Garcia-Palacios, A., & Botella, C. (2020). Savoring the present: The reciprocal influence between positive emotions and positive emotion regulation in everyday life. *In Preparation*.

Colombo, Desirée, Fernández-Álvarez, J., Palacios, A. G., Cipresso, P., Botella, C., & Riva, G. (2019). New technologies for the understanding, assessment, and intervention of emotion regulation. *Frontiers in Psychology*, *10*, 1261. https://doi.org/10.3389/fpsyg.2019.01261

Colombo, Desirée, Fernández-Álvarez, J., Palacios, A. G., Patané, A., Semonella, M., Cipresso, P., Kwiatkowska, M., Riva, G., & Botella, C. (2019). Current State and Future Directions of Technology- Based Ecological Momentary Assessment and Intervention for Major Depressive Disorder: A Systematic Review. *Journal of Clinical Medicine*, *8*(4), 465.

Colombo, Desirée, Fernandez-Alvarez, J., Suso-Ribera, C., Cipresso, P., Valev, H., Leufkens, T., Sas, C., Garcia-Palacios, A., Riva, G., & Botella, C. (2020). The need for change: Understanding emotion regulation antecedents and consequences using ecological momentary assessment. *Emotion*, *20*(1), 30–36.

Colombo, Desirée, Suso-Ribera, C., Fernández Álvarez, J., Cipresso, P., Garcia-Palacios, A., Riva, G., & Botella, C. (2020). Affect recall bias: Being resilient by distorting reality. *Cognitive Therapy and Research*, 1–13.

Craske, M. G., Kircanski, K., Zelikowsky, M., Mystkowski, J., Chowdhury, N., & Baker, A. (2008). Optimizing inhibitory learning during exposure therapy. *Behaviour Research and Therapy*, *46*(1), 5–27. https://doi.org/10.1016/j.brat.2007.10.003

Davis, S., Nesbitt, K., & Nalivaiko, E. (2014). Systematic review of cybersickness. *ACM International Conference Proceeding Series*, 1–9. https://doi.org/10.1145/2677758.2677780

De Oliveira, E. C., Bertrand, P., Lesur, M. E. R., Palomo, P., Demarzo, M., Cebolla, A., Banos, R., & Tori, R. (2016). Virtual Body Swap: A New Feasible Tool to Be Explored in Health and Education. *XVIII Symposium on Virtual and Augmented Reality (SVR)*, 81–89. https://doi.org/10.1109/SVR.2016.23

Díaz-García, A., Gonzalez-Robles, A., Garcia-Palacios, A., Fernandez-Álvarez, J., Castilla, D., Breton-Lopez, J., Baños, R. M., Quero, S., & Botella, C. (2021). Negative and Positive Affect Regulation in a Transdiagnostic Internet-Based Protocol for Emotional Disorders: Randomized Controlled Trial. *Journal of Medical Internet Research*, *23*(2), e21335.

Dimidjian, S., Barrera, M., Martell, C., Muñoz, R. F., & Lewinsohn, P. M. (2011). The origins and current status of behavioral activation treatments for depression. *Annual Review of Clinical Psychology*, *7*, 1–38. https://doi.org/10.1146/annurev-clinpsy-032210-104535

Donker, T., Cornelisz, I., Van Klaveren, C., Van Straten, A., Carlbring, P., Cuijpers, P., & Van Gelder, J. L. (2019). Effectiveness of Self-guided App-Based Virtual Reality Cognitive Behavior Therapy for Acrophobia: A Randomized Clinical Trial. *JAMA Psychiatry*, *76*(7), 682–690. https://doi.org/10.1001/jamapsychiatry.2019.0219

Dryman, M. T., & Heimberg, R. G. (2018). Emotion regulation in social anxiety and depression: a systematic review of expressive suppression and cognitive reappraisal. *Clinical Psychology Review*, *65*, 17–42. https://doi.org/10.1016/j.cpr.2018.07.004

Eftekhari, A., Zoellner, L. A., & Vigil, S. A. (2009). Patterns of emotion regulation and psychopathology. *Anxiety, Stress and Coping*, *22*(5), 571–586. https://doi.org/10.1080/10615800802179860

Eijlers, R., Utens, E. M. W. J., Staals, L. M., De Nijs, P. F. A., Berghmans, J. M., Wijnen, R. M. H., Hillegers, M. H. J., Dierckx, B., & Legerstee, J. S. (2019). Systematic Review and Meta-analysis of Virtual Reality in Pediatrics: Effects on Pain and Anxiety. *Anesthesia and Analgesia*, *129*(5), 1344. https://doi.org/10.1213/ANE.0000000000004165

Ekers, D., Webster, L., Van Straten, A., Cuijpers, P., Richards, D., & Gilbody, S. (2014). Behavioural activation for depression; An update of meta-analysis of effectiveness and sub group analysis. *PLoS ONE*, *9*(6). https://doi.org/10.1371/journal.pone.0100100

Espinoza, M., Etchemendy, E., Farfallini, L., Botella, C., & Baños, R. M. (2015). A positive technology system for the promotion of well-being: From the lab to the hospital setting. *International Symposium on Pervasive Computing Paradigms for Mental Health.*, 209–219. https://doi.org/10.1007/978-3-319-32270-4_21

Falconer, C. J., Rovira, A., King, J. A., Gilbert, P., Antley, A., Fearon, P., Ralph, N., Slater, M., & Brewin, C. R. (2016). Embodying self-compassion within virtual reality and its effects on patients with depression. *BJPsych Open*, *2*(1), 74–80. https://doi.org/10.1192/bjpo.bp.115.002147

Falconer, C. J., Slater, M., Rovira, A., King, J. A., Gilbert, P., Antley, A., & Brewin, C. R. (2014). Embodying compassion: A virtual reality paradigm for overcoming excessive self-criticism. *PLoS ONE*, *9*(11). https://doi.org/10.1371/journal.pone.0111933

Fernández-Álvarez, J., Cipresso, P., Colombo, D., Botella, C., & Riva, G. (2018). Reading between the lines: A computational bibliometric analysis on emotion regulation. *International Symposium on Pervasive Computing Paradigms for Mental Health*, 119–128.

Fernández-Álvarez, J., Colombo, D., Botella, C., García-Palacios, A., & Riva, G. (2019). Virtual reality for anxiety and stress-related disorders: A SWOT analysis. In *Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST* (Vol. 288). https://doi.org/10.1007/978-3-030-25872-6_4

Fernandez-Álvarez, J., Colombo, D., Suso-Ribera, C., Chirico, A., Serino, S., Di Lernia, D., Garcia-Palacios, A., Riva, G., & Botella, C. (2020). Using Virtual Reality to target Positive Autobiographical Memory in Individulas with Moderate to Moderately Severe Depressive Symptoms: A Single Case Experimental Design. *In Preparation*.

Fernández-Álvarez, J., Rozental, A., Carlbring, P., Colombo, D., Riva, G., Anderson, P. L., Baños, R. M., Benbow, A. A., Bouchard, S., Bretón-López, J. M., Cárdenas, G., Difede, J. A., Emmelkamp, P., García-Palacios, A., Guillén, V., Hoffman, H., Kampann, I., Moldovan, R., Mühlberger, A., … Botella, C. (2019). Deterioration rates in Virtual Reality Therapy: An individual patient data level meta-analysis. *Journal of Anxiety Disorders*, *61*(1), 3–17. https://doi.org/10.1016/j.janxdis.2018.06.005

Fernández-Aranda, F., Jiménez-Murcia, S., Santamaría, J. J., Gunnard, K., Soto, A., Kalapanidas, E., Bults, R. G. A., Davarakis, C., Ganchev, T., Granero, R., Konstantas, D., Kostoulas, T. P., Lam, T., Lucas, M., Masuet-Aumatell, C., Moussa, M. H., Nielsen, J., & Penelo, E. (2012). Video games as a complementary therapy tool in mental disorders: PlayMancer, a European multicentre study. *Journal of Mental Health*, *21*(4), 364–374. https://doi.org/10.3109/09638237.2012.664302

Fernandez, K. C., Jazaieri, H., & Gross, J. J. (2016). Emotion Regulation: A Transdiagnostic Perspective on a New RDoC Domain. *Cognitive Therapy and Research*, *40*(3), 426–440. https://doi.org/10.1007/s10608-016-9772-2

Ferrer-García, M., Gutiérrez-Maldonado, J., Pla-Sanjuanelo, J., Vilalta-Abella, F., Riva, G., Clerici, M., Ribas-Sabaté, J., Andreu-Gracia, A., Fernandez-Aranda, F., Forcano, L., Riesco, N., Sánchez, I., Escandón-Nagel, N., Gomez-Tricio, O., Tena, V., & Dakanalis, A. (2017). A Randomised Controlled Comparison of Second-Level Treatment

Approaches for Treatment-Resistant Adults with Bulimia Nervosa and Binge Eating Disorder: Assessing the Benefits of Virtual Reality Cue Exposure Therapy. *European Eating Disorders Review*, *25*(6), 479–490. https://doi.org/10.1002/erv.2538

Ferrer-García, M., Gutiérrez-Maldonado, J., & Pla, J. (2013). Cue-elicited anxiety and craving for food using virtual reality scenarios. *Annual Review of CyberTherapy and Telemedicine*, *191*, 105–109. https://doi.org/10.3233/978-1-61499-282-0-105

Ferrer-García, M., Gutierrez-Maldonado, J., Treasure, J., & Vilalta-Abella, F. (2015). Craving for Food in Virtual Reality Scenarios in Non-Clinical Sample: Analysis of its Relationship with Body Mass Index and Eating Disorder Symptoms. *European Eating Disorders Review*, *23*(5), 371–378. https://doi.org/10.1002/erv.2375

Fleming, T., de Beurs, D., Khazaal, Y., Gaggioli, A., Riva, G., Botella, C., Baños, R. M., Aschieri, F., Bavin, L. M., Kleiboer, A., Merry, S., Lau, H. M., & Riper, H. (2016). Maximizing the impact of E-Therapy and Serious Gaming: Time for a paradigm shift. *Frontiers in Psychiatry*, *7*, 65. https://doi.org/10.3389/fpsyt.2016.00065

Fleming, T., Dixon, R., Frampton, C., & Merry, S. (2012). A pragmatic randomized controlled trial of computerized CBT (SPARX) for symptoms of depression among adolescents excluded from mainstream education. *Behavioural and Cognitive Psychotherapy*, *40*(5), 529. https://doi.org/10.1017/S1352465811000695

Foa, E. B., & Kozak, M. J. (1986). Emotional Processing of Fear. Exposure to Corrective Information. *Psychological Bulletin*, *99*(1), 20. https://doi.org/10.1037/0033-2909.99.1.20

Freeman, D., Bradley, J., Antley, A., Bourke, E., DeWeever, N., Evans, N., Černis, E., Sheaves, B., Waite, F., Dunn, G., Slater, M., & Clark, D. M. (2016). Virtual reality in the treatment of persecutory delusions: Randomised controlled experimental study testing how to reduce delusional conviction. *British Journal of Psychiatry*, *209*(1), 62–67. https://doi.org/10.1192/bjp.bp.115.176438

Freeman, D., Haselton, P., Freeman, J., Spanlang, B., Kishore, S., Albery, E., Denne, M., Brown, P., Slater, M., & Nickless, A. (2018). Automated psychological therapy using immersive virtual reality for treatment of fear of heights: a single-blind, parallel-group, randomised controlled trial. *The Lancet Psychiatry*, *5*(8), 625–632. https://doi.org/10.1016/S2215-0366(18)30226-8

Freeman, D., Lister, R., Waite, F., Yu, L. M., Slater, M., Dunn, G., & Clark, D. (2019).

Automated psychological therapy using virtual reality (VR) for patients with persecutory delusions: Study protocol for a single-blind parallel-group randomised controlled trial (THRIVE). *Trials*, *20*(1), 1–8. https://doi.org/10.1186/s13063-019-3198-6

Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B., & Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological Medicine*, *47*(14), 2393–2400. https://doi.org/10.1017/S003329171700040X

Freeman, D., Yu, L. M., Kabir, T., Martin, J., Craven, M., Leal, J., Lambe, S., Brown, S., Morrison, A., Chapman, K., Dudley, R., O'Regan, E., Rovira, A., Goodsell, A., Rosebrock, L., Bergin, A., Cryer, T. L., Robotham, D., Andleeb, H., … Waite, F. (2019). Automated virtual reality (VR) cognitive therapy for patients with psychosis: Study protocol for a single-blind parallel group randomised controlled trial (gameChange). *BMJ Open*, *9*(8), e031606. https://doi.org/10.1136/bmjopen-2019-031606

Freeman, J., Lessiter, J., & Keogh, E. (2004). Relaxation Island: virtual, and really relaxing. *Proceedings of 7th International Workshop on Presence*, 67–72.

Gaddy, M. A., & Ingram, R. E. (2014). A meta-analytic review of mood-congruent implicit memory in depressed mood. *Clinical Psychology Review*, *34*(5), 402–416. https://doi.org/10.1016/j.cpr.2014.06.001

Gaggioli, A., Pallavicini, F., Morganti, L., Serino, S., Scaratti, C., Briguglio, M., Crifaci, G., Vetrano, N., Giulintano, A., Bernava, G., Tartarisco, G., Pioggia, G., Raspelli, S., Cipresso, P., Vigna, C., Grassi, A., Baruffi, M., Wiederhold, B., & Riva, G. (2014). Experiential virtual scenarios with real-time monitoring (interreality) for the management of psychological stress: A block randomized controlled trial. *Journal of Medical Internet Research*, *16*(7), e167. https://doi.org/10.2196/jmir.3235

Gega, L., White, R., Clarke, T., Turner, R., & Fowler, D. (2013). Virtual environments using video capture for social phobia with psychosis. *Cyberpsychology, Behavior, and Social Networking*, *16*(6), 473–479. https://doi.org/10.1089/cyber.2013.1510

Giner-Bartolomé, C., Fagundo, A. B., Sánchez, I., Jiménez-Murcia, S., Santamaría, J. J., Ladouceur, R., Menchón, J. M., & Fernández-Aranda, F. (2015). Can an intervention based on a serious videogame prior to cognitive behavioral therapy be helpful in bulimia nervosa? A clinical case study. *Frontiers in Psychology*, *6*, 982.

https://doi.org/10.3389/fpsyg.2015.00982

González-Robles, A., Díaz-García, A., García-Palacios, A., Roca, P., Ramos-Quiroga, J. A., & Botella, C. (2020). Effectiveness of a transdiagnostic guided internet-delivered protocol for emotional disorders versus treatment as usual in specialized care: Randomized controlled trial. *Journal of Medical Internet Research*, *22*(7), e18220. https://doi.org/10.2196/18220

Gorini, A., Griez, E., Petrova, A., & Riva, G. (2010). Assessment of the emotional responses produced by exposure to real food, virtual food and photographs of food in patients affected by eating disorders. *Annals of General Psychiatry*, *9*(1), 1–10. https://doi.org/10.1186/1744-859X-9-30

Gratz, K. L., & Roemer, L. (2004). Multidimensional Assessment of Emotion Regulation and Dysregulation: Development, Factor Structure, and Initial Validation of the Difficulties in Emotion Regulation Scale. *Journal of Psychopathology and Behavioral Assessment*, *26*(1), 41–54. https://doi.org/10.1023/B:JOBA.0000007455.08539.94

Gross, J. J. (1998a). Antecedent- and Response-Focused Emotion Regulation: Divergent Consequences for Experience, Expression, and Physiology. *Journal of Personality and Social Psychology*, *74*(1), 224. https://doi.org/10.1037/0022-3514.74.1.224

Gross, J. J. (1998b). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, *2*(3), 271–299. https://doi.org/10.1037/1089-2680.2.3.271

Gross, J. J. (2013). Emotion regulation: Taking stock and moving forward. *Emotion*, *13*(3), 359. https://doi.org/10.1037/a0032135

Gross, J. J. (2015a). Emotion Regulation: Current Status and Future Prospects. *Psychological Inquiry*, *26*(1), 1–26. https://doi.org/10.1080/1047840X.2014.940781

Gross, J. J. (2015b). The Extended Process Model of Emotion Regulation: Elaborations, Applications, and Future Directions. *Psychological Inquiry*, *26*(1), 130–137. https://doi.org/10.1080/1047840X.2015.989751

Gross, J. J., & John, O. P. (2003). Individual Differences in Two Emotion Regulation Processes: Implications for Affect, Relationships, and Well-Being. *Journal of Personality and Social Psychology*, *85*(2), 348. https://doi.org/10.1037/0022-3514.85.2.348

Gross, J. J., Uusberg, H., & Uusberg, Andero. (2019). Mental illness and well-being: an affect regulation perspective. *World Psychiatry*, *18*(2), 130–139. https://doi.org/10.1002/wps.20618

Guillén, V., Baños, R. M., & Botella, C. (2018). Users' opinion about a virtual reality system as an adjunct to psychological treatment for stress-related disorders: A quantitative and qualitative mixed-methods study. *Frontiers in Psychology*, *9*, 1038. https://doi.org/10.3389/fpsyg.2018.01038

Guixeres, J., Saiz, J., Alcañiz, M., Cebolla, A., Escobar, P., Baños, R., Botella, C., Lison, J. F., Alvarez, J., Cantero, L., & Lurbe, E. (2013). Effects of virtual reality during exercise in children. *Journal of Universal Computer Science*, *19*(9), 1199–1218.

Gyurak, A., Gross, J. J., & Etkin, A. (2011). Explicit and implicit emotion regulation: a dual-process framework. *Cognition & Emotion*, *25*(3), 400–412. https://doi.org/10.1080/02699931.2010.544160

Hadley, W., Houck, C., Brown, L. K., Spitalnick, J. S., Ferrer, M., & Barker, D. (2018). Moving beyond role-play: evaluating the use of virtual reality to teach emotion regulation for the prevention of adolescent risk behavior within a randomized pilot trial. *Journal of Pediatric Psychology*, *44*(4), 425–435.

Harvey, A. G., Watkins, E., Mansell, W., & Shafran, R. (2004). *Cognitive behavioural processes across psychological disorders: A transdiagnostic approach to research and treatment*. Oxford University Press.

Hermann, A., Leutgeb, V., Scharmüller, W., Vaitl, D., Schienle, A., & Stark, R. (2013). Individual differences in cognitive reappraisal usage modulate the time course of brain activation during symptom provocation in specific phobia. *Biology of Mood & Anxiety Disorders*, *3*(1), 1–11. https://doi.org/10.1186/2045-5380-3-16

Herrera, F., Bailenson, J., Weisz, E., Ogle, E., & Zak, J. (2018). Building long-term empathy: A large-scale comparison of traditional and virtual reality perspective-taking. *PLoS ONE*, *13*(10), e0204494. https://doi.org/10.1371/journal.pone.0204494

Herrera, F., Oh, S. Y., & Bailenson, J. N. (2020). Effect of behavioral realism on social interactions inside collaborative virtual environments. *Presence: Teleoperators and Virtual Environments*, *27*(2), 163–182. https://doi.org/10.1162/PRES_a_00324

Herrero, R., García-Palacios, A., Castilla, D., Molinari, G., & Botella, C. (2014). Virtual reality for the induction of positive emotions in the treatment of fibromyalgia: A pilot study over acceptability, satisfaction, and the effect of virtual reality on mood. *Cyberpsychology, Behavior, and Social Networking*, *17*(6), 379–384. https://doi.org/10.1089/cyber.2014.0052

Hessler, D. M., & Katz, L. F. (2010). Brief report: Associations between emotional competence and adolescent risky behavior. *Journal of Adolescence*, *33*(1), 241–246. https://doi.org/10.1016/j.adolescence.2009.04.007

Hoffman, H. G., Doctor, J. N., Patterson, D. R., Carrougher, G. J., & Furness, T. A. (2000). Virtual reality as an adjunctive pain control during burn wound care in adolescent patients. *Pain*, *85*(1–2), 305–309. https://doi.org/10.1016/S0304-3959(99)00275-4

Hoffman, H. G., Meyer, W. J., Drever, S. A., Soltani, M., Atzori, B., Herrero, R., Alhalabi, W., Richards, T. L., Sharar, S. R., Jensen, M. P., & Patterson, D. R. (2019). Virtual Reality Distraction to Help Control Acute Pain during Medical Procedures. In *Virtual Reality for Psychological and Neurocognitive Interventions* (pp. 195–208). Springer. https://doi.org/10.1007/978-1-4939-9482-3_8

Hoffman, H. G., Patterson, D. R., & Carrougher, G. J. (2000). Use of virtual reality for adjunctive treatment of adult burn pain during physical therapy: A controlled study. *Clinical Journal of Pain*, *16*(3), 244–250. https://doi.org/10.1097/00002508-200009000-00010

Hoffman, H. G., Sharar, S. R., Coda, B., Everett, J. J., Ciol, M., Richards, T., & Patterson, D. R. (2004). Manipulating presence influences the magnitude of virtual reality analgesia. *Pain*, *111*(1–2), 162–168. https://doi.org/10.1016/j.pain.2004.06.013

Hofmann, S. G., Carpenter, J. K., & Curtiss, J. (2016). Interpersonal Emotion Regulation Questionnaire (IERQ): Scale Development and Psychometric Characteristics. *Cognitive Therapy and Research*, *40*(3), 341–356. https://doi.org/10.1007/s10608-016-9756-2

Hong, Y.-J., Kim, H. E., Jung, Y. H., Kyeong, S., & Kim, J.-J. (2017). Usefulness of the Mobile Virtual Reality Self-Training for Overcoming a Fear of Heights. *Cyberpsychology, Behavior, and Social Networking*, *20*(12), 753–761. https://doi.org/10.1089/cyber.2017.0085

Houck, C. D., Hadley, W., Barker, D., Brown, L. K., Hancock, E., & Almy, B. (2016). An Emotion Regulation Intervention to Reduce Risk Behaviors Among at-Risk Early Adolescents. *Prevention Science*, *17*(1), 71–82. https://doi.org/10.1007/s11121-015-0597-0

Ilnicki, S., Wiederhold, B. K., Maciolek, J., Kosinska, L., Szymanska, S., Zbyszewski, M., Siatkowska, A., Opalko-Piotrkiewicz, E., Ilnicki, P., Filarowska, M., Glibowska, A., Borzetka, D., Pleskacz, K., & Murawski, P. (2012). Effectiveness evaluation for short-term group pre-deployment VR computer- assisted stress inoculation training provided to polish ISAF soldiers. *Annual Review of CyberTherapy and Telemedicine*, 113.

Insel, T. R. (2017). Digital phenotyping: Technology for a new science of behavior. *JAMA*, *318*(13), 1215–1216. https://doi.org/10.1001/jama.2017.11295

Jallais, C., & Gilet, A.-L. (2010). Inducing changes in arousal and valence: comparison of two mood induction procedures. *Behavior Research Methods*, *42*(1), 318–325. https://doi.org/10.3758/BRM.42.1.318

Jazaieri, H., Urry, H., & Gross, J. (2013). Affective Disturbance and Psychopathology: An Emotion Regulation Perspective. *Journal of Experimental Psychopathology*, *4*(5), 584–599. https://doi.org/10.5127/jep.030312

Joormann, J., Siemer, M., & Gotlib, I. H. (2007). Mood Regulation in Depression: Differential Effects of Distraction and Recall of Happy Memories on Sad Mood. *Journal of Abnormal Psychology*, *116*(3), 484. https://doi.org/10.1037/0021-843X.116.3.484

Jose, P. E., Lim, B. T., & Bryant, F. B. (2012). Does savoring increase happiness? A daily diary study. *Journal of Positive Psychology*, *7*(3), 176–187. https://doi.org/10.1080/17439760.2012.671345

Justynamaciolek, M., Ilnicki, S., Wiederhold, B. K., Kosinska, L., Szymanska, S., Zbyszewski, M., Opalko-Piotrkiewicz, E., Siatkowska, A., Glibowska, A., Borzetka, D., Ilnicki, P., Filarowska, M., Pleskacz, K., & Murawski, P. (2013). The Influence of Pre-Deployment VR Computer-Assisted Stress Inoculation Training on the Anxiety Level in the Polish ISAF Soldiers. In *New tools to enhance posttraumatic stress disorder diagnosis and treatment* (p. 161).

Kaczkurkin, A. N., & Foa, E. B. (2015). Cognitive-behavioral therapy for anxiety disorders: An update on the empirical evidence. *Dialogues in Clinical Neuroscience*, *17*(3), 337. https://doi.org/10.31887/dcns.2015.17.3/akaczkurkin

Kim, H. E., Hong, Y. J., Kim, M. K., Jung, Y. H., Kyeong, S., & Kim, J. J. (2017). Effectiveness of self-training using the mobile-based virtual reality program in patients with social anxiety disorder. *Computers in Human Behavior*, *73*, 614–619. https://doi.org/10.1016/j.chb.2017.04.017

Klein, S. B. (2015). What memory is. *Wiley Interdisciplinary Reviews: Cognitive Science*, *6*(1), 1–38. https://doi.org/10.1002/wcs.1333

Kniffin, T. C., Carlson, C. R., Ellzey, A., Eisenlohr-Moul, T., Beck, K. B., McDonald, R., & Jouriles, E. N. (2014). Using Virtual Reality to Explore Self-Regulation in High-Risk Settings. *Trauma, Violence, and Abuse*, *15*(4), 310–321. https://doi.org/10.1177/1524838014521501

Koole, S. L. (2009). The psychology of emotion regulation: An integrative review. *Cognition & Emotion*, *23*(1), 4–41. https://doi.org/10.1080/02699930802619031

Kring, A. M., & Sloan, D. M. (2009). *Emotion regulation and psychpathology: A transdiagnostic approach to etiology and treatment*. Guilford Press.

Ku, J., Han, K., Hyung, R. L., Hee, J. J., Kwang, U. K., Sung, H. P., Jae, J. K., Chan, H. K., In, Y. K., & Kim, S. I. (2007). VR-based conversation training program for patients with schizophrenia: A preliminary clinical trial. *Cyberpsychology and Behavior*, *10*(4), 567–574. https://doi.org/10.1089/cpb.2007.9989

Laforest, M., Bouchard, S., Crétu, A. M., & Mesly, O. (2016). Inducing an anxiety response using a contaminated virtual environment: Validation of a therapeutic tool for obsessive-compulsive disorder. *Frontiers in ICT*, *3*, 18. https://doi.org/10.3389/fict.2016.00018

Lee, J., Lim, Y., Graham, S. J., Kim, G., Wiederhold, B. K., Wiederhold, M. D., Kim, I. Y., & Kim, S. I. (2004). Nicotine craving and cue exposure therapy by using virtual environments. *Cyberpsychology and Behavior*, *7*(6), 705–713. https://doi.org/10.1089/cpb.2004.7.705

Lee, S. H., Han, D. H., Oh, S., Lyoo, I. K., Lee, Y. S., Renshaw, P. F., & Lukas, S. E. (2009). Quantitative electroencephalographic (qEEG) correlates of craving during virtual reality therapy in alcohol-dependent patients. *Pharmacology Biochemistry and Behavior*, *91*(3), 393–397. https://doi.org/10.1016/j.pbb.2008.08.014

Li, W. H., Chung, J. O., & Ho, E. K. (2011). The effectiveness of therapeutic play, using virtual reality computer games, in promoting the psychological well-being of children hospitalised with cancer. *Journal of Clinical Nursing*, *20*(15–16), 2135–2143. https://doi.org/10.1111/j.1365-2702.2011.03733.x

Li, Y. I., Starr, L. R., & Hershenberg, R. (2017). Responses to Positive Affect in Daily Life: Positive Rumination and Dampening Moderate the Association Between Daily Events and Depressive Symptoms. *Journal of Psychopathology and Behavioral Assessment*, *39*(3), 412–425. https://doi.org/10.1007/s10862-017-9593-y

Lindner, P., Miloff, A., Fagernäs, S., Andersen, J., Sigeman, M., Andersson, G., Furmark, T., & Carlbring, P. (2019). Therapist-led and self-led one-session virtual reality exposure therapy for public speaking anxiety with consumer hardware and software: A randomized controlled trial. *Journal of Anxiety Disorders*, *61*, 45–54. https://doi.org/10.1016/j.janxdis.2018.07.003

Linehan, M. M., Armstrong, H. E., Suarez, A., Allmon, D., & Heard, H. L. (1991). Cognitive-Behavioral Treatment of Chronically Parasuicidal Borderline Patients. *Archives of General Psychiatry*, *48*(12), 1060–1064. https://doi.org/10.1001/archpsyc.1991.01810360024003

Linnemann, A., Ditzen, B., Strahler, J., Doerr, J. M., & Nater, U. M. (2015). Music listening as a means of stress reduction in daily life. *Psychoneuroendocrinology*, *60*, 82–90. https://doi.org/10.1016/j.psyneuen.2015.06.008

Lobel, A., Gotsis, M., Reynolds, E., Annetta, M., Engels, R. C. M. E., & Granic, I. (2016). Designing and Utilizing Biofeedback Games for Emotion Regulation. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '16*, 1945–1951. https://doi.org/10.1145/2851581.2892521

López Soler, C., Castro, M., Alcántara, M., & Botella, C. (2011). Sistema de realidad virtual EMMA-Infancia en el tratamiento psicológico de un menor con estrés postraumático. *Revista de Psicopatología y Psicología Clínica*, *16*(3), 189–206.

Maciolek, J., Ilnicki, S., Wiederhold, B. K., Kosinska, L., Szymanska, S., Zbyszewski, M., Opalko-Piotrkiewicz, E., Siatkowska, A., Glibowska, A., Borzetka, D., Ilnicki, P., Filarowska, M., Pleskacz, K., & Murawski, P. (2013). VR Stress Inoculation Training Results for Polish ISAF Soldiers - A Study of 4 Cases. *New Tools to Enhance Posttraumatic Stress Disorder Diagnosis and Treatment: Invisible Wounds of War*, *108*, 149–160.

Maister, L., Sebanz, N., Knoblich, G., & Tsakiris, M. (2013). Experiencing ownership over a dark-skinned body reduces implicit racial bias. *Cognition*, *128*(2), 170–178. https://doi.org/10.1016/j.cognition.2013.04.002

Mansell, W., Harvey, A., Watkins, E. R., & Shafran, R. (2008). Cognitive Behavioral Processes Across Psychological Disorders: A Review of the Utility and Validity of the

Transdiagnostic Approach. *International Journal of Cognitive Therapy*, *1*(3), 181–191. https://doi.org/10.1680/ijct.2008.1.3.181

Maples-Keller, J. L., Bunnell, B. E., Kim, S. J., & Rothbaum, B. O. (2017). The use of virtual reality technology in the treatment of anxiety and other psychiatric disorders. *Harvard Review of Psychiatry*, *25*(3), 103–113. https://doi.org/10.1097/HRP.0000000000000138

Matt, G. E., Vázquez, C., & Campbell, W. K. (1992). Mood-congruent recall of affectively toned stimuli: A meta-analytic review. *Clinical Psychology Review*, *12*(2), 227–255. https://doi.org/10.1016/0272-7358(92)90116-P

Meichenbaum, D. H., & Deffenbacher, J. L. (1988). Stress Inoculation Training. *The Counseling Psychologist*, *16*, 69–90. https://doi.org/10.1177/0011000088161005

Migoya-Borja, M., Delgado-Gómez, D., Carmona-Camacho, R., Porras-Segovia, A., López-Moriñigo, J. D., Sánchez-Alonso, M., Albarracín García, L., Guerra, N., Barrigón, M. L., Alegría, M., & Baca-García, E. (2020). Feasibility of a Virtual Reality-Based Psychoeducational Tool (VRight) for Depressive Patients. *Cyberpsychology, Behavior, and Social Networking*, *23*(4), 246–252. https://doi.org/10.1089/cyber.2019.0497

Milk, C. (2015). *How virtual reality can create the ultimate empathy machine*. TED.Com.

Miloff, A., Lindner, P., Dafgård, P., Deak, S., Garke, M., Hamilton, W., Heinsoo, J., Kristoffersson, G., Rafi, J., Sindemark, K., Sjölund, J., Zenger, M., Reuterskiöld, L., Andersson, G., & Carlbring, P. (2019). Automated virtual reality exposure therapy for spider phobia vs. in-vivo one-session treatment: A randomized non-inferiority trial. *Behaviour Research and Therapy*, *118*, 130–140. https://doi.org/10.1016/j.brat.2019.04.004

Mohr, D. C., Zhang, M., & Schueller, S. M. (2017). Personal Sensing: Understanding Mental Health Using Ubiquitous Sensors and Machine Learning. *Annual Review of Clinical Psychology*, *13*(1), 23–47. https://doi.org/10.1146/annurev-clinpsy-032816-044949

Morina, N., Ijntema, H., Meyerbröker, K., & Emmelkamp, P. M. G. (2015). Can virtual reality exposure therapy gains be generalized to real-life? A meta-analysis of studies applying behavioral assessments. *Behaviour Research and Therapy*, *74*, 18–24. https://doi.org/10.1016/j.brat.2015.08.010

Navarro-Haro, Maria V., Hoffman, H. G., Garcia-Palacios, A., Sampaio, M., Alhalabi, W., Hall, K., & Linehan, M. (2016). The use of virtual reality to facilitate mindfulness skills training in dialectical behavioral therapy for borderline personality disorder: A case study. *Frontiers in Psychology*, *7*, 1573. https://doi.org/10.3389/fpsyg.2016.01573

Navarro-Haro, María V., Modrego-Alarcón, M., Hoffman, H. G., López-Montoyo, A., Navarro-Gil, M., Montero-Marin, J., García-Palacios, A., Borao, L., & García-Campayo, J. (2019). Evaluation of a mindfulness-based intervention with and without virtual reality dialectical behavior therapy® mindfulness skills training for the treatment of generalized anxiety disorder in primary care: A pilot study. *Frontiers in Psychology*, *10*, 55. https://doi.org/10.3389/fpsyg.2019.00055

North, M. M., North, S. M., & Coble, J. R. (1997). Virtual reality therapy: An effective treatment for psychological disorders. *Studies in Health Technology and Informatics*, 59–70. https://doi.org/10.3233/978-1-60750-888-5-59

Opriş, D., Pintea, S., García-Palacios, A., Botella, C., Szamosközi, Ş., & David, D. (2012). Virtual reality exposure therapy in anxiety disorders: A quantitative meta-analysis. *Depression and Anxiety*, *29*(2), 85–93. https://doi.org/10.1002/da.20910

Park, K. M., Ku, J., Choi, S. H., Jang, H. J., Park, J. Y., Kim, S. I., & Kim, J. J. (2011). A virtual reality application in role-plays of social skills training for schizophrenia: A randomized, controlled trial. *Psychiatry Research*, *189*(2), 166–172. https://doi.org/10.1016/j.psychres.2011.04.003

Parkinson, B., & Totterdell, P. (1999). Classifying affect-regulation strategies. *Cognition and Emotion*, *13*(3), 277–303. https://doi.org/10.1080/026999399379285

Parsons, T. D., & Rizzo, A. A. (2008). Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry*, *39*(3), 250–261. https://doi.org/10.1016/j.jbtep.2007.07.007

Paul, M., Bullock, K., & Bailenson, J. (2020). Case Report: Virtual Reality Behavioral Activation as an Intervention for Major Depressive Disorder. *JMIR Mental Health*, *7*(11). https://doi.org/10.2196/24331

Peck, T. C., Seinfeld, S., Aglioti, S. M., & Slater, M. (2013). Putting yourself in the skin of a black avatar reduces implicit racial bias. *Consciousness and Cognition*, *22*(3), 779–787. https://doi.org/10.1016/j.concog.2013.04.016

Pericot-Valverde, I., Secades-Villa, R., & Gutiérrez-Maldonado, J. (2019). A randomized clinical trial of cue exposure treatment through virtual reality for smoking cessation.

Journal of Substance Abuse Treatment, *96*, 26–32. https://doi.org/10.1016/j.jsat.2018.10.003

Pericot-Valverde, I., Secades-Villa, R., Gutiérrez-Maldonado, J., & García-Rodríguez, O. (2014). Effects of systematic cue exposure through virtual reality on cigarette craving. *Nicotine and Tobacco Research*, *16*(11), 1470–1477. https://doi.org/10.1093/ntr/ntu104

Perpiñá, C., Roncero, M., Fernández-Aranda, F., Jiménez-Murcia, S., Forcano, L., & Sánchez, I. (2013). Clinical validation of a virtual environment for normalizing eating patterns in eating disorders. *Comprehensive Psychiatry*, *54*(6), 680–686. https://doi.org/10.1016/j.comppsych.2013.01.007

Petry, N. M., Rehbein, F., Gentile, D. A., Lemmens, J. S., Rumpf, H. J., Mößle, T., Bischof, G., Tao, R., Fung, D. S. S., Borges, G., Auriacombe, M., González Ibáñez, A., Tam, P., & O'Brien, C. P. (2014). An international consensus for assessing internet gaming disorder using the new DSM-5 approach. *Addiction*, *109*(9), 1399–1406. https://doi.org/10.1111/add.12457

Pizzoli, S. F. M., Mazzocco, K., Triberti, S., Monzani, D., Raya, M. L. A., & Pravettoni, G. (2019). User-centered virtual reality for promoting relaxation: An innovative approach. *Frontiers in Psychology*, *10*, 479. https://doi.org/10.3389/fpsyg.2019.00479

Pla-Sanjuanelo, J., Ferrer-García, M., Gutiérrez-Maldonado, J., Riva, G., Andreu-Gracia, A., Dakanalis, A., Fernandez-Aranda, F., Forcano, L., Ribas-Sabaté, J., Riesco, N., Rus-Calafell, M., Sánchez, I., & Sanchez-Planell, L. (2015). Identifying specific cues and contexts related to bingeing behavior for the development of effective virtual environments. *Appetite*, *87*, 81–89. https://doi.org/10.1016/j.appet.2014.12.098

Pruessner, L., Barnow, S., Holt, D. V., Joormann, J., & Schulze, K. (2020). A cognitive control framework for understanding emotion regulation flexibility. *Emotion (Washington, D.C.)*, *20*(1), 21. https://doi.org/10.1037/emo0000658

Quoidbach, J., Berry, E. V., Hansenne, M., & Mikolajczak, M. (2010). Positive emotion regulation and well-being: Comparing the impact of eight savoring and dampening strategies. *Personality and Individual Differences*, *49*(5), 368–373. https://doi.org/10.1016/j.paid.2010.03.048

Quoidbach, J., Mikolajczak, M., & Gross, J. J. (2015). Positive interventions: An emotion regulation perspective. *Psychological Bulletin*, *141*(3), 655. https://doi.org/10.1037/a0038648

Richardson, C. M. E. (2017). Emotion regulation in the context of daily stress: Impact on daily affect. *Personality and Individual Differences*, *112*, 150–156. https://doi.org/10.1016/j.paid.2017.02.058

Riva, G. (2005). Virtual reality in psychotherapy: Review. *Cyberpsychology and Behavior*, *8*(3), 220–230. https://doi.org/10.1089/cpb.2005.8.220

Riva, G. (2009). Virtual reality: An experiential tool for clinical psychology. *British Journal of Guidance and Counselling*, *37*(3), 337–345. https://doi.org/10.1080/03069880902957056

Riva, G., Baños, R. M., Botella, C., Wiederhold, B. K., & Gaggioli, A. (2012). Positive Technology: Using Interactive Technologies to Promote Positive Functioning. *Cyberpsychology, Behavior, and Social Networking*, *15*(2), 69–77. https://doi.org/10.1089/cyber.2011.0139

Riva, G., Mantovani, F., Capideville, C. S., Preziosa, A., Morganti, F., Villani, D., Gaggioli, A., Botella, C., & Alcañiz, M. (2007). Affective Interactions Using Virtual Reality: The Link between Presence and Emotions. *CyberPsychology & Behavior*, *10*(1), 45–56. https://doi.org/10.1089/cpb.2006.9993

Rizzo, A. A., Buckwalter, J. G., & Neumann, U. (1997). Virtual reality and cognitive rehabilitation: A brief review of the future. *Journal of Head Trauma Rehabilitation*, *12*(6), 1–15. https://doi.org/10.1097/00001199-199712000-00002

Rockstroh, C., Blum, J., & Göritz, A. S. (2019). Virtual reality in the application of heart rate variability biofeedback. *International Journal of Human Computer Studies*, *130*, 209–220. https://doi.org/10.1016/j.ijhcs.2019.06.011

Rodríguez, A., Rey, B., Clemente, M., Wrzesien, M., & Alcañiz, M. (2015). Assessing brain activations associated with emotional regulation during virtual reality mood induction procedures. *Expert Systems with Applications*, *42*(3), 1699–1709. https://doi.org/10.1016/j.eswa.2014.10.006

Rodriguez, A., Rey, B., Vara, M. D., Wrzesien, M., Alcaniz, M., Banos, R. M., & Perez-Lopez, D. (2015). A VR-based serious game for studying emotional regulation in adolescents. *IEEE Computer Graphics and Applications*, *35*(1), 65–73. https://doi.org/10.1109/MCG.2015.8

Rothbaum, B. O., Hodges, L. F., Kooper, R., Opdyke, D., Williford, J. S., & North, M.

(1995). Virtual reality graded exposure in the treatment of acrophobia: A case report. *Behavior Therapy*, *26*(3), 547–554. https://doi.org/10.1016/S0005-7894(05)80100-5

Rus-Calafell, M., Garety, P., Sason, E., Craig, T. J. K., & Valmaggia, L. R. (2018). Virtual reality in the assessment and treatment of psychosis: A systematic review of its utility, acceptability and effectiveness. *Psychological Medicine*, *48*(3), 362. https://doi.org/10.1017/S0033291717001945

Salters-Pedneault, K., Tull, M. T., & Roemer, L. (2004). The role of avoidance of emotional material in the anxiety disorders. *Applied and Preventive Psychology*, *11*(2), 95–114. https://doi.org/10.1016/j.appsy.2004.09.001

Sander, T. (2011). Positive computing. In *Positive Psychology as Social Change* (pp. 309–326). Springer. https://doi.org/10.1007/978-90-481-9938-9_17

Schoneveld, E. A., Lichtwarck-Aschoff, A., & Granic, I. (2018). Preventing Childhood Anxiety Disorders: Is an Applied Game as Effective as a Cognitive Behavioral Therapy-Based Program? *Prevention Science*, *19*(2), 220–232. https://doi.org/10.1007/s11121-017-0843-8

Segawa, T., Baudry, T., Bourla, A., Blanc, J. V., Peretti, C. S., Mouchabac, S., & Ferreri, F. (2020). Virtual Reality (VR) in Assessment and Treatment of Addictive Disorders: A Systematic Review. *Frontiers in Neuroscience*, *13*, 1409. https://doi.org/10.3389/fnins.2019.01409

Seinfeld, S., Arroyo-Palacios, J., Iruretagoyena, G., Hortensius, R., Zapata, L. E., Borland, D., de Gelder, B., Slater, M., & Sanchez-Vives, M. V. (2018). Offenders become the victim in virtual reality: impact of changing perspective in domestic violence. *Scientific Reports*, *8*(1), 1–11. https://doi.org/10.1038/s41598-018-19987-7

Seinfeld, S., Zhan, M., Poyo-Solanas, M., Barsuola, G., Vaessen, M., Slater, M., Sanchez-Vives, M. V., & de Gelder, B. (2021). Being the victim of virtual abuse changes default mode network responses to emotional expressions. *Cortex*, *135*, 268–284. https://doi.org/10.1016/j.cortex.2020.11.018

Seligman, M. E., & Csikszentmihalyi, M. (2000). Positive psychology. An introduction. *The American Psychologist*. https://doi.org/10.1037/0003-066X.55.1.5

Serino, S., Triberti, S., Villani, D., Cipresso, P., Gaggioli, A., & Riva, G. (2014). Toward a validation of cyber-interventions for stress disorders based on stress inoculation training:

A systematic review. *Virtual Reality*, *18*(1), 73–87. https://doi.org/10.1007/s10055-013-0237-6

Serrano, B., Baños, R. M., & Botella, C. (2016). Virtual reality and stimulation of touch and smell for inducing relaxation: A randomized controlled trial. *Computers in Human Behavior*, *55*, 1–8. https://doi.org/10.1016/j.chb.2015.08.007

Serrano, B., Botella, C., Baños, R. M., & Alcañiz, M. (2013). Using virtual reality and mood-induction procedures to test products with consumers of ceramic tiles. *Computers in Human Behavior*, *29*(3), 648–653. https://doi.org/10.1016/j.chb.2012.10.024

Shah, L. B. I., Torres, S., Kannusamy, P., Chng, C. M. L., He, H. G., & Klainin-Yobas, P. (2015). Efficacy of the virtual reality-based stress management program on stress-related variables in people with mood disorders: The feasibility study. *Archives of Psychiatric Nursing*, *29*(1), 6–13. https://doi.org/10.1016/j.apnu.2014.09.003

Shiban, Y., Pauli, P., & Mühlberger, A. (2013). Effect of multiple context exposure on renewal in spider phobia. *Behaviour Research and Therapy*, *51*(2), 68–74. https://doi.org/10.1016/j.brat.2012.10.007

Shiban, Y., Schelhorn, I., Pauli, P., & Mühlberger, A. (2015). Effect of combined multiple contexts and multiple stimuli exposure in spider phobia: A randomized clinical trial in virtual reality. *Behaviour Research and Therapy*, *71*, 45–53. https://doi.org/10.1016/j.brat.2015.05.014

Smith, M. J., Fleming, M. F., Wright, M. A., Roberts, A. G., Humm, L. B., Olsen, D., & Bell, M. D. (2015). Virtual reality job interview training and 6-month employment outcomes for individuals with schizophrenia seeking employment. *Schizophrenia Research*, *166*(1–3), 86–91. https://doi.org/10.1016/j.schres.2015.05.022

Snippe, E., Simons, C. J. P., Hartmann, J. A., Menne-Lothmann, C., Kramer, I., Booij, S. H., Viechtbauer, W., Delespaul, P., Myin-Germeys, I., & Wichers, M. (2016). Change in daily life behaviors and depression: Within-person and between-person associations. *Health Psychology*, *35*(5), 433–441. https://doi.org/10.1037/hea0000312

Son, J. H., Lee, S. H., Seok, J. W., Kee, B. S., Lee, H. W., Kim, H. J., Lee, T. K., & Han, D. H. (2015). Virtual reality therapy for the treatment of alcohol dependence: A preliminary investigation with positron emission tomography/computerized tomography. *Journal of Studies on Alcohol and Drugs*, *76*(4), 620–627. https://doi.org/10.15288/jsad.2015.76.620

Steinberg, L. (2007). Risk taking in adolescence: New perspectives from brain and behavioral science. *Current Directions in Psychological Science*, *16*(2), 55–59. https://doi.org/10.1111/j.1467-8721.2007.00475.x

Stetz, Melba., Long, Chris., Schober, William., Cardillo, Carlos., Wildzunas, R. . (2007). Stress Assessment and Management while Medics Take Care of the VR Wounded. *Annual Review of CyberTherapy and Telemedicine*, *5*, 165–171.

Strack, F., Schwarz, N., & Gschneidinger, E. (1985). Happiness and Reminiscing: The Role of Time Perspective, Affect, and Mode of Thinking. *Journal of Personality and Social Psychology*, *49*(6), 1460–1469. https://doi.org/10.1037/0022-3514.49.6.1460

Stupar-Rutenfrans, S., Ketelaars, L. E. H., & van Gisbergen, M. S. (2017). Beat the Fear of Public Speaking: Mobile 360° Video Virtual Reality Exposure Training in Home Environment Reduces Public Speaking Anxiety. *Cyberpsychology, Behavior, and Social Networking*, *20*(10), 624–633. https://doi.org/10.1089/cyber.2017.0174

Sundquist, J., Palmér, K., Johansson, L. M., & Sundquist, K. (2017). The effect of mindfulness group therapy on a broad range of psychiatric symptoms: A randomised controlled trial in primary health care. *European Psychiatry*, *43*, 19–27. https://doi.org/10.1016/j.eurpsy.2017.01.328

Suso-Ribera, C., Fernández-Álvarez, J., García-Palacios, A., Hoffman, H. G., Bretón-López, J., Baños, R. M., Quero, S., & Botella, C. (2019). Virtual Reality, Augmented Reality, and in Vivo Exposure Therapy: A Preliminary Comparison of Treatment Efficacy in Small Animal Phobia. *Cyberpsychology, Behavior, and Social Networking*, *22*(1), 31–38. https://doi.org/10.1089/cyber.2017.0672

Tarrant, J., Viczko, J., & Cope, H. (2018). Virtual reality for anxiety reduction demonstrated by quantitative EEG: A pilot study. *Frontiers in Psychology*, *9*, 1280. https://doi.org/10.3389/fpsyg.2018.01280

Tárrega, S., Castro-Carreras, L., Fernández-Aranda, F., Granero, R., Giner-Bartolomé, C., Aymamí, N., Gómez-Peña, M., Santamaría, J. J., Forcano, L., Steward, T., Menchón, J. M., & Jiménez-Murcia, S. (2015). A serious videogame as an additional therapy tool for training emotional regulation and impulsivity control in severe gambling disorder. *Frontiers in Psychology*, *6*, 1721. https://doi.org/10.3389/fpsyg.2015.01721

Troy, A. S., & Mauss, I. B. (2011). Resilience in the face of stress: Emotion regulation as a protective factor. *Resilience and Mental Health: Challenges Across the Lifespan*, *1*(2), 30–44. https://doi.org/10.1017/CBO9780511994791.004

Valmaggia, L. (2017). The use of virtual reality in psychosis research and treatment. *World Psychiatry*, *16*(3), 246. https://doi.org/10.1002/wps.20443

van Loon, A., Bailenson, J., Zaki, J., Bostick, J., & Willer, R. (2018). Virtual reality perspective-taking increases cognitive empathy for specific others. *PLoS ONE*, *13*(8), e0202442. https://doi.org/10.1371/journal.pone.0202442

Van Meter, A. R., & Youngstrom, E. A. (2016). Distinct Roles of Emotion Reactivity and Regulation in Depressive and Manic Symptoms Among Euthymic Patients. *Cognitive Therapy and Research*, *40*(3), 262–274. https://doi.org/10.1007/s10608-015-9738-9

Veling, W., Lestestuiver, B., Jongma, M., Hoenders, R., & van Driel, C. (2020). Virtual Reality Relaxation for Patients With a Psychiatric Disorder: Crossover Randomized Controlled Trial. *Journal of Medical Internet Research*, *23*(1), e17233.

Ventura, S., Badenes-Ribera, L., Herrero, R., Cebolla, A., Galiana, L., & Banõs, R. (2020). Virtual Reality as a Medium to Elicit Empathy: A Meta-Analysis. *Cyberpsychology, Behavior, and Social Networking*, *23*(10), 667–676. https://doi.org/10.1089/cyber.2019.0681

Villani, D., & Riva, G. (2008). Presence and relaxation: A preliminary controlled study. *PsychNology Journal*, *6*(1).

Villani, D., & Riva, G. (2012). Does interactive media enhance the management of stress? Suggestions from a controlled study. *Cyberpsychology, Behavior, and Social Networking*, *15*(1), 24–30. https://doi.org/10.1089/cyber.2011.0141

Wang, Y., Jiang, M., Huang, Y., Sheng, Z., Huang, X., Lin, W., Chen, Q., Li, X., Luo, Z., & Lv, B. (2020). Physiological and psychological effects of watching videos of different durations showing urban bamboo forests with varied structures. *International Journal of Environmental Research and Public Health*, *17*(10), 3434. https://doi.org/10.3390/ijerph17103434

Webb, T. L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin*, *138*(4), 775–808. https://doi.org/10.1037/a0027600

Wechsler, T. F., Mühlberger, A., & Kümpers, F. (2019). Inferiority or even superiority of virtual reality exposure therapy in phobias? A systematic review and quantitative meta-analysis on randomized controlled trials specifically comparing the efficacy of virtual reality exposure to gold standard in vivo exp. *Frontiers in Psychology*, *10*, 1758. https://doi.org/10.3389/fpsyg.2019.01758

Weerdmeester, J., Van Rooij, M., Harris, O., Smit, N., Engels, R. C. M. E., & Granic, I. (2017). Exploring the role of self-efficacy in biofeedback video games. *CHI PLAY 2017 Extended Abstracts - Extended Abstracts Publication of the Annual Symposium on Computer-Human Interaction in Play*, 453–461. https://doi.org/10.1145/3130859.3131299

Wiederhold, B. K., Gao, K., Kong, L., & Wiederhold, M. D. (2014). Mobile devices as adjunctive pain management tools. *Cyberpsychology, Behavior, and Social Networking*, *17*(6), 385–389. https://doi.org/10.1089/cyber.2014.0202

Wilson, A. C., Aldao, A., & Cheavens, J. (2018). Appraising reappraisal: Exploring its role in the context of behavioral exposure for contamination fears. *Journal of Clinical Psychology*, *74*(9), 1583–1593. https://doi.org/10.1002/jclp.22613

Wood, J. V., Heimpel, S. A., & Michela, J. L. (2003). Savoring Versus Dampening: Self-Esteem Differences in Regulating Positive Affect. *Journal of Personality and Social Psychology*, *85*(3), 566. https://doi.org/10.1037/0022-3514.85.3.566

Wrzesien, M., Alcañiz, M., Botella, C., Burkhardt, J. M., Bretón-López, J., Ortega, M., & Brotons, D. B. (2013). The therapeutic lamp: Treating small-animal phobias. In *IEEE Computer Graphics and Applications* (Vol. 33, Issue 1, pp. 80–86). https://doi.org/10.1109/MCG.2013.12

Wrzesien, M., Rodríguez, A., Rey, B., Alcañiz, M., Baños, R. M., & Vara, M. D. (2015). How the physical similarity of avatars can influence the learning of emotion regulation strategies in teenagers. *Computers in Human Behavior*, *43*, 101–111. https://doi.org/10.1016/j.chb.2014.09.024

Zaki, J., & Craig Williams, W. (2013). Interpersonal emotion regulation. *Emotion*, *13*(5), 803–810. https://doi.org/10.1037/a0033839

Zeng, N., Pope, Z., Lee, J., & Gao, Z. (2018). Virtual Reality Exercise for Anxiety and Depression: A Preliminary Review of Current Research in an Emerging Field. *Journal of Clinical Medicine*, *7*(3), 42. https://doi.org/10.3390/jcm7030042

Zhang, X., Yu, H. W., & Barrett, L. F. (2014). How does this make you feel? A comparison of four affect induction procedures. *Frontiers in Psychology*, *5*, 689. https://doi.org/10.3389/fpsyg.2014.00689