Virtual Reality for Anxiety and Stress-Related Disorders: A SWOT Analysis

Javier Fernández-Alvarez[1(✉)], Desirée Colombo[2], Cristina Botella[2,3],
Azucena García-Palacios[2,3], and Giuseppe Riva[1,4]

[1] Department of Psychology of the Catholic University,
Largo Gemelli 1, 20100 Milan, Italy
{javier.fernandezkirszman, giuseppe.riva}@unicatt.it
[2] Department of Basic Psychology, Clinic and Psychobiology,
Universitat Jaume I, Castellón, Spain
{dcolombo, botella, azucena}@uji.es
[3] CIBER Fisiopatología Obesidad y Nutrición, Instituto Salud Carlos III,
Madrid, Spain
[4] Applied Technology for Neuro-Psychology Lab at IRCCS Istituto
Auxologico Italiano, Milan, Italy
{p.cipresso, g.riva}@auxologico.it

Abstract. Virtual Reality (VR) Therapy has emerged in the 90s as an appealing way of delivering exposure treatment. Throughout these years, ample evidence has been published. Although there is an agreed consensus regarding its efficacy, currently a quick shift in the field is being experienced, especially due to the advent of off-the-shelf technology that is greatly facilitating its dissemination. In this context, theoretical discussions of the field appear as an important action in order to take stock of the mounting evidence that has been produced and the main challenges for the coming future. To stimulate the discussion in a burgeoning field, a SWOT analysis is proposed, which may help to map the field of VR therapy for anxiety and stress-related disorders. Overall, it is undoubted that VR appears as a well-established technology for the treatment of ASRD and the main challenges are in line with the possibility of hurdling the same obstacles that the whole field of clinical psychology and psychotherapy has to deal with: How to bridge the gap between research and clinical practice.

Keywords: Virtual reality therapy · Anxiety disorders · SWOT analysis

1 Introduction

Anxiety and stress-related disorders (ASRD) are among the most prevalent mental disorders [1]. Having an ASRD is sometimes perceived as a minor psychopathological manifestation. However, not only suffering from an ASRD can be devastating by itself, but also it may constitute the correlate of a chronic, serious and disabling mental or physical dysfunction. A clear indicator in this regard is the high comorbidity of ASRD with a vast array of other disorders [2].

Despite the well-established efficacy of a range of psychological treatments [3], a large amount of people does not receive adequate treatment or remains untreated [4, 5]. In this context, the development of new therapeutic strategies can be part of the

solution [6]. Particularly, Information and Communication Technologies (ICTs) may hurdle some of the existing obstacles, such as the dissemination and implementation of the already existing treatments [7].

Virtual Reality (VR) is one of the technological advancements that has been developed more than two decades ago and since then has shown a spark of interest in the scientific community. Initially, it emerged as an alternative for the delivery of in vivo exposure. Although applying exposure to anxiety disorders is one of the few undisputable procedures in clinical psychology research [8], a number of studies have shown that both therapists [9–11] and patients [12, 13] are reluctant to undergoing in vivo exposure. In that sense, the possibility of creating virtual environments capable of provoking analogue emotional reactions to real stimuli arouse as an appealing strategy for the whole spectrum of ASRD. Therefore, the term coined for applying exposure by means of VR has been Virtual Reality Exposure Therapy (VRET).

In these 25 years, the field of VR for ASRD has experienced profound changes, in line with the logical evolution of clinical psychology as a field and VR as a technology in the society in general. With the goal of describing the salient aspects of the present and future of the field, this study aims to conduct a SWOT analysis. Although this is not the first study of this kind for VR, more than 15 years have gone by since that article and the state-of-the-art and future challenges are very different. Besides, it is interesting to compare that study with the current one in order to establish the extent to which the field of VR has changed.

2   Methods

For previous studies, we had carried out several systematic searches of the literature [14, 15], so a direct contact with the current literature in the field was already performed. An update of the literature search was conducted in order to include the latest studies that have been published recently. This study involves people from two of the main laboratories working with VR, as recently stated in a bibliometric analysis of research on VR [16].

The decision of doing a SWOT analysis was based on the fact that this approach has shown to be effective at mapping the general picture of a particular field. Usually used in organizational settings, it has also been sometimes implemented for clinical research, for example for describing the field of negative effects in clinical psychology [17]. This type of study may promote new unexplored avenues of future research as well as alerting the scientific community with regard to the aspects that need to be carefully addressed.

Despite this paper is focused on ASRD, general aspects of virtual reality therapy, regardless of the specificity for these clinical conditions, will be taken into consideration.

3   Strengths and Weaknesses of VR for Anxiety Disorders

The therapeutic strengths of VR are extensively agreed in the literature. On the one hand, the controllability of the stimuli can be of paramount importance for the delivery of exposure. Although the presupposed mechanism of exposure was initially thought to be habituation, nowadays evidence supports that the operating principle is the inhibitory learning [18]. Thus, the necessity to violate confirming biases associated with the feared stimuli rather than exposing the individual to the feared stimuli in a hierarchical way. In any case, VR offers a secure modality that in vivo exposure does not guarantee. The most illustrative example is constituted by the extensive research to treat PTSD in veterans of war given the possibility of recreating the same contextual information [19].

In this sense, the strongest aspect of VR for ASRD revolves around the fact that in these 25 years dozens of clinical trials have been carried out and nowadays there is a large body of evidence that supports its equal efficacy to in vivo exposure. Interestingly, improvements are observed not only in self-report measures [20], but also in behavioural [21] and physiological measures [22, 23]. Besides, evidence suggests that VR is more accepted than in vivo exposure [12], and its attrition and deterioration rates are comparable to face-to-face interventions [15, 24].

One aspect of paramount importance is that increasing attention is being paid to the quality, standards and guidelines to carry out VR clinical trials [25, 26]. However, this is part of a weakness detected by experts in VR for healthcare, who identified that most of the clinical trials until 2013 were of dubious quality. Throughout these years, indeed, the weaknesses of research on VR have consistently been identified, including the aforementioned problems in clinical trials' designs (e.g. small sample sizes [27] or problems with the randomization of participants [26]), the scarcity of process-focused research studies [28] or the lack of implementation of VR in naturalistic settings.

From the three described problems, it could be stated that research quality has considerably improved, including publications in the best clinical journals with powered samples [29–33]; the research on process-focused research has seen a slow but still important progress; and the implementation of VR in clinical settings is definitely the most serious shortcoming.

With regard to process-focused research, some signs of progress have been achieved in therapeutic alliance (TA). Although none clinical study had the primary aim of exploring TA, there are some theoretical discussion on the topic [34–37]. Besides, three RCTs [38–40] and one pilot study [41] included TA as a secondary outcome measure. Currently, the results indicate that TA in VR treatments is similar to face-to-face approaches. That is, there is a consistent positive association between TA and outcome. A spark of interest was also shown in the predictors of outcome. In total, four studies explored the role of expectations as a predictor of outcome in VRET [42–45], indicating that it constitutes a relevant non technical aspect that plays a relevant role in VRET. Likewise, some studies were conducted to look into the levels of engagement as a key process in VR outcomes, with mixed findings [46, 47].

Last but not least, the first studies to shed light upon the mechanisms of change in VR are starting to appear, in line with the advent of the process-based CBT movement that Stefan Hofmann and Steven Hayes have recently promoted [48]. As an example,

Norr and colleagues [49] performed moderator analyses to explore the characteristics of the patients who improved the most for prolonged exposure versus VR exposure. Their results indicate that being young, not to take antidepressants and having greater PTSD hyperarousal symptoms predicted a greater reduction in PTSD symptoms undergoing VR exposure. In another study, mediational analyses revealed that the reduction of posttraumatic symptoms leads to the change of depressive symptoms and not the other way around [50]. Likewise, Maples-Keller and colleagues [44] investigated the role of reexperiencing symptoms in VRET for PTSD, showing its importance in line with Emotional Processing Theory. Finally, a further research line explored the role of cognitive mechanisms in spider phobia VRET. In line with the conceptualization of exposure in cognitive behaviour models, both the phobic stimuli and self-efficacy have proven to be predictors of change in two different studies [51, 52].

Apart from cutting edge research, another well-established advantage of VR as a clinical tool revolves around the possibility of providing patients with contextually relevant stimuli. This feature is gaining more importance with the proliferation of personalized systems [53] as well as user-friendly software that allow to create virtual environment with almost none programming skills. In terms of hardware, head-mounted displays are significantly decreasing their price, which permits to acquire VR devices for very affordable prices [54].

Precisely in terms of hardware, it is interesting the results of a recent systematic review which synthesized the VR equipment used by all the existing trials in the field [55]. The authors found that among the 82 included studies, a great proportion utilized the eMagin z800 and then many different devices were only rarely implemented. The most salient aspect shared by all these devices share is that all are stationary. Among the commonly sold HMDs sold on the market, none was used in these studies. It must be stated, however, that in the latest studies published during the last couple of years, researchers are starting to use off-the-shelf devices in line with the abovementioned decrease of the prices [56].

As previously stated, the lack of implementation of VR in clinical settings is the most critical aspect that should be mentioned. On the one hand this can be explained by the overall problems that literature has detected in order to bridge the gap between research and practice [57], and the difficulties to translate basic science to applied contexts [58]. Besides, in the case of VR, even when prices are significantly decreasing, therapists might not see the reason to justify a still high expenditure [54].

4 Opportunities and Threats that Foresee the Future Challenges in the Field

As described before, VR has mainly been studied as a replacement of exposure. However, we consider that there are numerous opportunities for the future of VR in the field of ASRD given the capabilities of this interactive and immersive technology. Four potential ways in which VR can really go beyond exposure:

(a) VR as an embodied tool. Such an approach considers that the body plays an instrumental role in the processing of cognition. Apart from merely reproducing

certain stimuli of the real world, VR can interact with the real world modifying it [59]. In particular, VR has shown to be effective at fooling the body matrix, which in turn is essential in the regulation of the psychological and physiological processes of individuals. Specifically, a technique called "body swapping", which permits to promote changes in the body memory, may be useful in order to work on body image distortions that sometimes are present in individuals suffering from ASRD [60]. Likewise, this technique can be helpful for social anxiety disorder, in which body image plays an important role [60] and bodily aspects may be relevant targets to deactivate safety behaviours. Furthermore, an interventional study, based on this paradigm, has shown that assigning a dissimilar avatar to social anxiety individuals helped them to reduce the levels of anxiety, which highlights the relevance of self-representation in this condition [61].

(b) Integration of VR with psychophysiology is opening new avenues, in particular, to intervene in the self-regulation of specific processes that have shown to be predictive of a range of disorders, including anxiety. Specifically, a physiological process that is impaired in ASRD is Heart Rate Variability (HRV) [62]. Although HRV biofeedback has shown to be effective for ASRD [63], the integration of VR environments may enhance the engagement and thus the effectiveness of biofeedback training. Existing examples are already available. For example, Repetto tested a virtual reality mobile based biofeedback [64] or Lorenzetti and colleagues implemented a real-time functional magnetic resonance imaging neurofeedback protocol with the aim of enhancing emotional states in healthy subjects [65]. Another technology that may be integrated with VR and is gaining interest is eye-tracking. Extensive research has shown the presence of perceptual and attentional biases in anxiety disorders, and preliminary research using VR suggests that it is an effective way of delivering attentional bias modification [66].

(c) VR for the training of psychological strategies of affect and emotion regulation. For example, autobiographical memory training could be achieved through VR environments that permit to stimulate the evocation of specific memories. Some initial evidence in this regard was achieved by Baños and colleagues [67] who used a system that used symbolic information for the re-elaboration of traumatic events in PTSD patients. The utilization of non-symbolic information (i.e. bringing the person to real place where the events took place) has not been researched yet but constitutes a promising avenue to explore. Likewise, 360 degrees videos may be utilized for the training of specific situations that are dysfunctional. For example, in the case of social anxiety disorders, training how to interact with people in stressful situations may be important to train assertiveness. Besides, certain emotion regulation strategies that are causing problems may be also trained, such as cognitive reappraisal in order to decrease rumination or fostering acceptance instead of dealing with experiential avoidance.

(d) One of the weaknesses of VR that could be transformed into strength in the near future is the utilization of VR as an assessment tool. Clinically, the possibility of providing a patient with multiple scenarios can be of tremendous help in order to make accurate diagnoses. Especially, in order to determine the extent to which personality is compromised in the context of an anxiety disorder [68]. In this line

the existing associations between multisensory integration (process that has extensively been research in VR), attachment and personality (disorders) constitutes a very promising line to further explore. Although there are some existing examples in the literature, this is a research line that can be greatly expanded.

Among the threats, in line with all ICTs, it must be mentioned the time that research needs to demonstrate efficacious procedures. Currently, the classic validation design of any treatment supposes a series of steps that culminate in conducting a randomized controlled trial as the gold standard criteria of quality [69]. Should all the recommended steps be taken; the whole process is a matter of years until the final results are available. Given that technological developments, including VR, are ever changing, much faster testing procedures are required. Two highly recommended approaches are qualitative research and single case experimental design, which luckily is re-emerging as a very powerful research design, especially when testing new treatment approaches [70].

Another aspect that needs particular attention in order to not become a weakness is how embodied conversational agents (ECA) are incorporated in therapeutic interventions, practices that are defined by human interaction. There is no doubt that ECAs will grow exponentially in the next years, in line with the overall explosion of artificial intelligence. Indeed, there are already examples of development and pilot studies starting to implement ECAs in the context of anxiety disorders [71]. The first examples of self-led interventions are showing very promising results, and if personalized the possibility of increasing the personalization of the virtual stimuli depending on the individual necessity and preference, would greatly strengthen VR as a clinical tool.

First and foremost, there is an ethical concern regarding the extent to which the interventions will be open for the massive public and how regulation and monitoring of users will be done. In this sense, works like the one conducted by Freeman and colleagues [31] are promising examples given the high quality of the clinical trial. Besides, it is of utmost relevance to establish when people do need human support [72] given that in many cases it should be needed additional therapeutic content in order to achieve full recovery. However, in terms of regulation and ethical concerns, it is not only important to ensure the effectiveness but also the privacy of the users' data, including nonverbal data that current virtual systems can record [73].

On a similar but different note, the potential threat of ECAs is also anchored in the perceptions that clinical psychologists and psychotherapists may have. Many clinical psychologists may perceive ECAs as their substitutes. Indeed, different studies show that therapists are not only concerned about the difficulties that incorporating VR may entail (lack of training, technical and financial obstacles), but also that they are unfamiliar with VR as a clinical tool and thus they have concerns about its efficacy, the potential negative effects or the potential way VR may affect the therapist-client relationship [74–76]. With the advent of consumer VR platforms, Lindner and colleagues [77] revealed that attitudes towards VRET are overall positive and that familiarity with VR was higher in comparison to previous studies, although no direct comparison can be established for being completely different populations.

Finally, it is also very relevant the opinions of the community regarding the use of VR for health purposes. The first study exploring public perceptions of VR in health care suggests that overall there are positive attitudes towards VR for health care,

including ASRD. Despite the predominance of positive comments, there are also concerns, such as the dependency of technology. Indeed, in a society in which technology-mediated experiences are starting to be omnipresent, there is increasing evidence showing that there is an overuse of virtual engagement, which far from helping contributes to unhealthy lifestyles that may lead in adjunction to other factors to the development of mental disorders. In this context, it is rather logical that the general public may perceive VR treatments with some extent of skepticism.

Weaknesses can be transformed into opportunities if correctly addressed or into threats if not. In that sense, one of the most challenging aspects is to achieve a real scale of VR. Every 10 years, a Delphi study of the field of psychotherapy is conducted. The last two versions carried out seven and seventeen years ago respectively, predicted that the use of VR was going to sprout out [78, 79]. While in the span of time between the first and second Delphi study the prediction clearly did not become true, a well and truly regrowth of VR emerged in the last years, which might lead to believe that the implementation of VR in clinical settings will finally flourish. The main reason to believe so is that costs have dramatically decreased and thus hardware and software costs are much more accessible if compared to a few years ago.

All in all, we do not have to forget that VR, like any other technology, is only a tool, which can be used properly or improperly. Besides, and most important, the core of our interest as clinical psychologists, either researchers or clinicians, is to understand the clinical phenomena and not be led by the usually mistaken idea of thinking that cutting-edge technologies will necessarily entail solutions for the problems we have to face with.

References

1. Bandelow, B., Michaelis, S.: Epidemiology of anxiety disorders in the 21st century. Dialogues Clin. Neurosci. **17**(3), 327 (2015)
2. Watson, D.: Differentiating the mood and anxiety disorders: a quadripartite model. Ann. Rev. Clin. Psychol. **5**, 221–247 (2009). https://doi.org/10.1146/annurev.clinpsy.032408.153510
3. Olatunji, B.O., Cisler, J.M., Deacon, B.J.: Efficacy of cognitive behavioral therapy for anxiety disorders: a review of meta-analytic findings (2010). https://doi.org/10.1016/j.psc.2010.04.002
4. Alonso, J., et al.: Treatment gap for anxiety disorders is global: results of the world mental health surveys in 21 countries. Depress. Anxiety (2018). https://doi.org/10.1002/da.22711
5. WHO: Prevalence, severity, and unmet need for treatment of mental disorders in the world health organization world mental health surveys. J. Am. Med. Assoc. 2581–2590 (2004). https://doi.org/10.1001/jama.291.21.2581
6. Wagner, R., Silove, D., Marnane, C., Rouen, D.: Delays in referral of patients with social phobia, panic disorder and generalized anxiety disorder attending a specialist anxiety clinic. J. Anxiety Disord. (2006). https://doi.org/10.1016/j.janxdis.2005.02.003

7. Kazdin, A.E., Blase, S.L.: Rebooting psychotherapy research and practice to reduce the burden of mental illness. Perspect. Psychol. Sci. (2011). https://doi.org/10.1177/1745691610393527

8. Hoyer, J., Beesdo, K., Gloster, A.T., Runge, J., Höfler, M., Becker, E.S.: Worry exposure versus applied relaxation in the treatment of generalized anxiety disorder. Psychother. Psychosom. (2009). https://doi.org/10.1159/000201936

9. Pittig, A., Kotter, R., Hoyer, J.: The struggle of behavioral therapists with exposure: self-reported practicability, negative beliefs, and therapist distress about exposure-based interventions. Behav. Ther. (2019). https://doi.org/10.1016/j.beth.2018.07.003

10. Cook, J.M., Biyanova, T., Elhai, J., Schnurr, P.P., Coyne, J.C.: What do psychotherapists really do in practice? An internet study of over 2,000 practitioners. Psychotherapy (2010). https://doi.org/10.1037/a0019788

11. Schumacher, S., Weiss, D., Knaevelsrud, C.: Dissemination of exposure in the treatment of anxiety disorders and post-traumatic stress disorder among German cognitive behavioural therapists. Clin. Psychol. Psychother. (2018). https://doi.org/10.1002/cpp.2320

12. Garcia-Palacios, A., Botella, C., Hoffman, H., Fabregat, S.: Comparing acceptance and refusal rates of virtual reality exposure vs. in vivo exposure by patients with specific phobias. CyberPsychol. Behav **10**, 722–724 (2007). https://doi.org/10.1089/cpb.2007.9962

13. Garcia-Palacios, A., Hoffman, H.G., Kwong See, S., Tsai, A., Botella, C.: Redefining therapeutic success with virtual reality exposure therapy. CyberPsychol. Behav. **4**, 341–348 (2002). https://doi.org/10.1089/109493101300210231

14. Botella, C., Fernández-Álvarez, J., Guillén, V., García-Palacios, A., Baños, R.: Recent progress in virtual reality exposure therapy for phobias: a systematic review. Curr. Psychiatry Rep. **19** (2017). https://doi.org/10.1007/s11920-017-0788-4

15. Fernández-Álvarez, J., et al.: Deterioration rates in virtual reality therapy: an individual patient data level meta-analysis. J. Anxiety Disord. **61**, 3–17 (2019). https://doi.org/10.1016/j.janxdis.2018.06.005

16. Cipresso, P., Giglioli, I.A.C., Raya, M.A., Riva, G.: The past, present, and future of virtual and augmented reality research: a network and cluster analysis of the literature. Front. Psychol. (2018). https://doi.org/10.3389/fpsyg.2018.02086

17. Rozental, A., et al.: Negative effects in psychotherapy: commentary and recommendations for future research and clinical practice. BJPsych Open (2018). https://doi.org/10.1192/bjo.2018.42

18. Craske, M.G., Treanor, M., Conway, C.C., Zbozinek, T., Vervliet, B.: Maximizing exposure therapy: an inhibitory learning approach. Behav. Res. Ther. **58**, 10–23 (2014). https://doi.org/10.1016/j.brat.2014.04.006

19. Botella, C., Serrano, B., Baños, R.M., Garcia-Palacios, A.: 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 (2015). https://doi.org/10.2147/NDT.S89542

20. Carl, E., et al.: Virtual reality exposure therapy for anxiety and related disorders: a meta-analysis of randomized controlled trials (2018)

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

22. Loucks, L., et al.: You can do that?!: Feasibility of virtual reality exposure therapy in the treatment of PTSD due to military sexual trauma. J. Anxiety Disord. **61**, 55–63 (2019). https://doi.org/10.1016/j.janxdis.2018.06.004

23. Côté, S., Bouchard, S.: Documenting the efficacy of virtual reality exposure with psychophysiological and information processing measures. Appl. Psychophysiol. Biofeed-back **30**, 217–232 (2005). https://doi.org/10.1007/s10484-005-6379-x

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

25. Birckhead, B., et al.: Recommendations for methodology of virtual reality clinical trials in health care by an international working group: iterative study. JMIR Ment. Health **6**, e11973 (2018). https://doi.org/10.2196/11973

26. McCann, R.A., et al.: Virtual reality exposure therapy for the treatment of anxiety disorders: an evaluation of research quality. J. Anxiety Disord. **28**, 625–631 (2014). https://doi.org/10.1016/j.janxdis.2014.05.010

27. Page, S., Coxon, M.: Virtual reality exposure therapy for anxiety disorders: small samples and no controls? Front. Psychol. **7**, 1–4 (2016). https://doi.org/10.3389/fpsyg.2016.00326

28. Meyerbröker, K., Emmelkamp, P.M.G.: Therapeutic processes in virtual reality exposure therapy: the role of cognitions and the therapeutic alliance. J. CyberTher. Rehabil. **1** (2008)

29. Reger, G.M., et al.: Randomized controlled trial of prolonged exposure using imaginal exposure vs. virtual reality exposure in active stress disorder (PTSD). J. Consult. Clin. Psychol. **84**, 946–959 (2016). https://doi.org/10.1037/ccp0000134

30. Donker, T., et al.: Effectiveness of self-guided app-based virtual reality cognitive behavior therapy for acrophobia. JAMA Psychiatry (2019). https://doi.org/10.1001/jamapsychiatry.2019.0219

31. Freeman, D., et al.: Automated psychological therapy using immersive virtual reality for treatment of fear of heights: a single-blind, parallel-group, randomised controlled trial. Lancet Psychiatry **5**, 625–632 (2018). https://doi.org/10.1016/S2215-0366(18)30226-8

32. Minns, S., et al.: Immersive 3D exposure-based treatment for spider fear: a randomized controlled trial. J. Anxiety Disord. **61**, 37–44 (2019). https://doi.org/10.1016/j.janxdis.2018.12.003

33. Lindner, P., et al.: Therapist-led and self-led one-session virtual reality exposure therapy for public speaking anxiety with consumer hardware and software: a randomized controlled trial. J. Anxiety Disord. **61**, 45–54 (2019). https://doi.org/10.1016/j.janxdis.2018.07.003

34. Miragall, M., Baños, R.M., Cebolla, A., Botella, C.: Working alliance inventory applied to virtual and augmented reality (WAI-VAR): psychometrics and therapeutic outcomes. Front. Psychol. **6**, 1–10 (2015). https://doi.org/10.3389/fpsyg.2015.01531

35. Ngai, I., Tully, E.C., Anderson, P.L.: The course of the working alliance during virtual reality and exposure group therapy for social anxiety disorder. Behav. Cogn. Psychother. **43**, 167–181 (2015). https://doi.org/10.1017/S135246581300088X

36. Wrzesien, M., Burkhardt, J.M., Botella, C., Alcañiz, M.: Towards a virtual reality- and augmented reality-mediated therapeutic process model: a theoretical revision of clinical issues and HCI issues. **16**, 124–153 (2015). https://doi.org/10.1080/1463922X.2014.903307

37. Wrzesien, M., et al.: How technology influences the therapeutic process: evaluation of the patient-therapist relationship in augmented reality exposure therapy and in vivo exposure therapy. Behav. Cogn. Psychother. **41**, 505–509 (2013). https://doi.org/10.1017/S1352465813000088

38. Anderson, P.L., et al.: Virtual reality exposure therapy for social anxiety disorder: a randomized controlled trial. J. Consult. Clin. Psychol. **81**, 751–760 (2013). https://doi.org/10.1037/a0033559

39. Moldovan, R., David, D.: One session treatment of cognitive and behavioral therapy and virtual reality for social and specific phobias. Preliminary results from a randomized clinical trial. J. Evid.-Based Psychother. **14**, 67–83 (2014)

40. Bouchard, S., et al.: Virtual reality compared with in vivo exposure in the treatment of social anxiety disorder: a three-arm randomised controlled trial. Br. J. Psychiatry. 1–9 (2016). https://doi.org/10.1192/bjp.bp.116.184234

41. Levy, F., Leboucher, P., Rautureau, G., Komano, O., Millet, B., Jouvent, R.: Fear of falling: efficacy of virtual reality associated with serious games in elderly people. Neuropsychiatr. Dis. Treat. **12**, 877–881 (2016). https://doi.org/10.2147/NDT.S97809

42. Price, M., Anderson, P., Henrich, C.C., Rothbaum, B.O.: Greater expectations: using hierarchical linear modeling to examine expectancy for treatment outcome as a predictor of treatment response. Behav. Ther. **39**, 398–405 (2008). https://doi.org/10.1016/j.beth.2007.12.002

43. Price, M., Anderson, P.L.: Outcome expectancy as a predictor of treatment response in cognitive behavioral therapy for public speaking fears within social anxiety disorder. Psychotherapy **49**, 173–179 (2012). https://doi.org/10.1037/a0024734

44. Price, M., Maples, J.L., Jovanovic, T., Norrholm, S.D., Heekin, M., Rothbaum, B.O.: An investigation of outcome expectancies as a predictor of treatment response for combat veterans with PTSD: comparison of clinician, self-report, and biological measures. Depress. Anxiety **32**, 392–399 (2015). https://doi.org/10.1002/da.22354

45. Norrholm, S.D., et al.: Fear load: The psychophysiological over-expression of fear as an intermediate phenotype associated with trauma reactions. Int. J. Psychophysiol. **98**, 270–275 (2014). https://doi.org/10.1016/j.ijpsycho.2014.11.005

46. Price, M., Mehta, N., Tone, E.B., Anderson, P.L.: Does engagement with exposure yield better outcomes? Components of presence as a predictor of treatment response for virtual reality exposure therapy for social phobia. J. Anxiety Disord. **25**, 763–770 (2011). https://doi.org/10.1016/j.janxdis.2011.03.004

47. Reger, G.M., Smolenski, D., Norr, A., Katz, A., Buck, B., Rothbaum, B.O.: Does virtual reality increase emotional engagement during exposure for PTSD? Subjective distress during prolonged and virtual reality exposure therapy. J. Anxiety Disord. **61**, 75–81 (2019). https://doi.org/10.1016/j.janxdis.2018.06.001

48. Hofmann, S.G., Hayes, S.C.: The future of intervention science: process-based therapy. Clin. Psychol. Sci. **7**, 37–50 (2019). https://doi.org/10.1177/2167702618772296

49. Norr, A.M., et al.: Virtual reality exposure versus prolonged exposure for PTSD: which treatment for whom? Depress. Anxiety (2018). https://doi.org/10.1002/da.22751

50. Peskin, M., et al.: The relationship between posttraumatic and depressive symptoms during virtual reality exposure therapy with a cognitive enhancer. J. Anxiety Disord. (2019). https://doi.org/10.1016/j.janxdis.2018.03.001

51. Côté, S., Bouchard, S.: Cognitive mechanisms underlying virtual reality exposure. CyberPsychol. Behav. **12**, 121–129 (2009). https://doi.org/10.1089/cpb.2008.0008

52. Tardif, N., Therrie, C., Bouchard, S.: Re-examining psychological mechanisms underlying virtual reality-based exposure for spider phobia. Cyberpsychol. Behav. Soc. Netw. **22**, 39–45 (2019). https://doi.org/10.1089/cyber.2017.0711

53. Pizzoli, S.F.M., Mazzocco, K., Triberti, S., Monzani, D., Alcañiz Raya, M.L., Pravettoni, G.: User-centered virtual reality for promoting relaxation: an innovative approach. Front. Psychol. **10**, 1–8 (2019). https://doi.org/10.3389/fpsyg.2019.00479

54. Lindner, P., et al.: Creating state of the art, next-generation virtual reality exposure therapies for anxiety disorders using consumer hardware platforms: design considerations and future direction. Cogn. Behav. Ther. (in press). https://doi.org/10.1080/16506073.2017.1280843

55. Jerdan, S.W., Grindle, M., Van Woerden, H.C., Kamel Boulos, M.N.: Head-mounted virtual reality and mental health: critical review of current research. J. Med. Internet Res. **20**, 1–16 (2018). https://doi.org/10.2196/games.9226

56. Carlbring, P., et al.: Therapist-led and self-led one-session virtual reality exposure therapy for public speaking anxiety with consumer hardware and software: a randomized controlled trial. J. Anxiety Disord. **61**, 45–54 (2018). https://doi.org/10.1016/j.janxdis.2018.07.003

57. Fernández-Álvarez, J., Fernández-Álvarez, H., Castonguay, L.G.: Resumiendo los nuevos esfuerzos para integrar la práctica y la investigación desde la perspectiva de la investigación orientada por la práctica. Rev. Argent. Clin. Psicol. (2018). https://doi.org/10.24205/03276716.2018.1070

58. Maples-Keller, J.L., et al.: When translational neuroscience fails in the clinic: dexamethasone prior to virtual reality exposure therapy increases drop-out rates. J. Anxiety Disord. **61**, 89–97 (2019). https://doi.org/10.1016/j.janxdis.2018.10.006

59. Repetto, C., Riva, G.: From virtual reality to interreality in the treatment of anxiety disorders. Neuropsychiatry (London) (2011). https://doi.org/10.2217/npy.11.5

60. Aderka, I.M., Gutner, C.A., Lazarov, A., Hermesh, H., Hofmann, S.G., Marom, S.: Body image in social anxiety disorder, obsessive-compulsive disorder, and panic disorder. Body Image (2014). https://doi.org/10.1016/j.bodyim.2013.09.002

61. Aymerich-Franch, L., Kizilcec, R.F., Bailenson, J.N.: The relationship between virtual self similarity and social anxiety. Front. Hum. Neurosci. **8**, 944 (2014). https://doi.org/10.3389/fnhum.2014.00944

62. Chalmers, J.A., Quintana, D.S., Abbott, M.J.A., Kemp, A.H.: Anxiety disorders are associated with reduced heart rate variability: a meta-analysis. Front. Psychiatry. **5** (2014). https://doi.org/10.3389/fpsyt.2014.00080

63. Goessl, V.C., Curtiss, J.E., Hofmann, S.G.: The effect of heart rate variability biofeedback training on stress and anxiety: a meta-analysis. Psychol. Med. **47**, 2578–2586 (2017). https://doi.org/10.1017/S0033291717001003

64. Repetto, C., Gaggioli, A., Pallavicini, F., Cipresso, P., Raspelli, S., Riva, G.: Virtual reality and mobile phones in the treatment of generalized anxiety disorders: a phase-2 clinical trial. Pers. Ubiquitous Comput. (2013). https://doi.org/10.1007/s00779-011-0467-0

65. Lorenzetti, V., et al.: Emotion regulation using virtual environments and real-time fMRI neurofeedback. Front. Neurol. **9**, 390 (2018). https://doi.org/10.3389/FNEUR.2018.00390

66. Urech, A., Krieger, T., Chesham, A., Mast, F.W., Berger, T.: Virtual reality-based attention bias modification training for social anxiety: a feasibility and proof of concept study. Front. Psychiatry **6**, 1–5 (2015). https://doi.org/10.3389/fpsyt.2015.00154

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

68. Cipresso, P., Riva, G.: Personality assessment in ecological settings by means of virtual reality. In: The Wiley Handbook of Personality Assessment, pp. 240–248 (2016)

69. Fleming, T.M., et al.: Maximizing the impact of e-therapy and serious gaming: time for a paradigm shift. Front. Psychiatry **7**, 65 (2016)

70. Kazdin, A.E.: Single-case experimental designs. Evaluating interventions in research and clinical practice (2018). https://doi.org/10.1016/j.brat.2018.11.015

71. Provoost, S., Lau, H.M., Ruwaard, J., Riper, H.: Embodied conversational agents in clinical psychology: a scoping review (2017). https://doi.org/10.2196/jmir.6553

72. Schueller, S.M., Tomasino, K.N., Mohr, D.C.: Integrating human support into behavioral intervention technologies: the efficiency model of support (2017). https://doi.org/10.1111/cpsp.12173

73. Bailenson, J.: Protecting nonverbal data tracked in virtual reality. JAMA Pediatr. (2018). https://doi.org/10.1001/jamapediatrics.2018.1909

74. Schwartzman, D., Segal, R., Drapeau, M.: Perceptions of virtual reality among therapists who do not apply this technology in clinical practice. Psychol. Serv. **9**, 310–315 (2012). https://doi.org/10.1037/a0026801

75. Segal, R., Bhatia, M., Drapeau, M.: Therapists' perception of benefits and costs of using virtual reality treatments. Cyberpsychol. Behav. Soc. Netw. **14**, 29–34 (2010). https://doi.org/10.1089/cyber.2009.0398

76. Kramer, T.L., Pyne, J.M., Kimbrell, T.A., Savary, P.E., Smith, J.L., Jegley, S.M.: Clinician perceptions of virtual reality to assess and treat returning veterans. Psychiatr. Serv. **61**, 1153–1156 (2014). https://doi.org/10.1176/ps.2010.61.11.1153

77. Lindner, P., Miloff, A., Zetterlund, E., Reuterskiöld, L., Andersson, G., Carlbring, P.: Attitudes toward and familiarity with virtual reality therapy among practicing cognitive behavior therapists: a cross-sectional survey study in the era of consumer VR platforms. Front. Psychol. **10**, 1–10 (2019). https://doi.org/10.3389/fpsyg.2019.00176

78. Norcross, J.C., Hedges, M., Prochaska, J.O.: The face of 2010: a delphi poll on the future of psychotherapy. Prof. Psychol. Res. Pract. (2002). https://doi.org/10.1037/0735-7028.33.3.316

79. Norcross, J.C., Pfund, R.A., Prochaska, J.O.: Psychotherapy in 2022 : a delphi poll on its future. **44**, 363–370 (2013). https://doi.org/10.1037/a0034633