Virtual Reality Exposure Therapy in psychotherapeutic practice: Evidence-based applications for various mental disorders

Virtual Reality Exposure Therapy (VRET) has established itself as a transformative technology in psychotherapy, particularly in the treatment of anxiety disorders. The studies and guidelines analyzed here show a robust evidence base for its use in specific phobias, with meta-analyses demonstrating comparable efficacy to traditional in vivo exposure 1, 3, 10. Promising approaches exist for social phobia and agoraphobia with panic disorder, albeit with heterogeneous data 7, 10. For post-traumatic stress disorder (PTSD), controlled studies demonstrate significant symptom reductions, particularly in military populations 1, 4. In the field of ADHD diagnostics, VR-based test procedures enable novel, ecologically valid assessments of attention deficits 8. Depressive symptoms are addressed indirectly through the treatment of comorbid anxiety disorders, while direct interventions are still in the experimental stage 2, 15. Technological advances in immersion quality and automated therapy protocols are increasingly expanding the range of applications 4, 7.

Neurophysiological principles of the VRET mechanisms of action

Immersion-induced neuroplasticity

The immersive capacity of modern VR systems triggers physiological stress responses that cause neuroplastic changes in the prefrontal cortex and amygdala 10, 13. Studies with fMRI monitoring show a normalization of hyperactivity in the dorsolateral prefrontal cortex region after VRET in spider phobia 3, 10. Multisensory stimulation (3D audio, haptic feedback) enhances the extinction learning process by simultaneously activating multiple memory systems 4, 7.

Dopaminergic modulation in anxiety management

Pharmacological studies combine VRET with dopaminergic modulators, with D-cycloserine in particular accelerating the consolidation of extinction memories as a cognitive enhancer 5, 10. In ADHD patients, a synergistic effect of methylphenidate and VR-based attention training, mediated via frontostriatal circuits, has been shown 8, 15.

Range of applications for specific disorders

Phobias and anxiety disorders

The S3 guideline on anxiety treatment classifies VRET as an evidence-based procedure for phobias of flying, heights and spiders (evidence level Ib) 7, 12. A meta-analysis of 46 studies (n=1,056) shows comparable effect sizes (g=1.07) between VRET and in vivo exposure, with a significantly reduced dropout rate (16% vs. 19.6%) 10, 14. Automated VR protocols achieve complete remission rates of 68% for acrophobia in single sessions of 45-180 minutes 3, 7.

Post-traumatic stress disorders

Multicenter studies on veterans demonstrate a 54% reduction in CAPS-5 scores after 12 VRET sessions 14. Recontextualization of traumatic memories is achieved by parameterizable environmental variables (time of day, weather, acoustic triggers) that enable stepwise exposure hierarchies 4, 12. Combinations with EMDR show additive effects on hippocampal memory consolidation 5, 14.

Attention deficit hyperactivity disorder

Pilot studies use VR-based Continuous Performance Tests (CPT) for differential diagnostics: The analysis of eye-tracking data and motor microvariability achieves 89% specificity in ADHD/depression differentiation 8, 15. Therapeutically, adaptive attention training in virtual classrooms enables a 32% improvement in sustained attention 8.

Depressive disorders

Transdiagnostic approaches combine VRET with behavioral activation: virtual "reward environments" stimulate the nucleus accumbens, which in RCTs leads to 22% higher responder rates compared to purely cognitive therapy 15. Avatar-based social skills training reduces depressive symptoms in comorbid social phobia (BDI-II reduction Δ=14.2) 9, 15.

Technological innovations and protocol design

Dynamic exposure algorithms

Machine learning models analyze real-time biomarkers (HRV, electrodermal activity) to control the exposure gradient. An RCT in aviophobia shows 40% faster habituation with physiology-driven VRET compared to manual protocol guidance 4, 7.

Multimodal sensor integration

Wearable-enhanced VR systems combine HMDs with EMG wristbands and respiratory rate sensors. This multimodality enables the detection of subtle avoidance patterns in social anxiety with 92% precision 3, 10.

Limitations and future research directions

Despite progress, there is methodological heterogeneity in study designs (number of sessions: 1-12; duration: 15-180min) 10, 14. Long-term follow-up (> 12 months) is lacking for 73% of application areas 3, 9. Ethical conflicts arise due to data protection challenges in the storage of biomedical VR data 11.

Future studies should develop transdiagnostic protocols that address cross-disorder mechanisms (e.g. avoidance behavior). The integration of VRET into stepped-care models and the development of cost-effective tele-VRET systems are further priorities 7, 12.

Conclusion

The summarized evidence positions VRET as an equivalent alternative to traditional exposure therapy for specific phobias and as a promising complementary approach in the treatment of PTSD. For ADHD and depression, diagnostic and comorbidity-focused applications open up new dimensions in therapy. The convergence with AI-based therapy assistants and physiological monitoring will further improve the possibilities for personalization, but requires the development of standardized quality guidelines for clinical use.

(1) psychotherapie-wissenschaft.info/article/view/1664-9583-2023-1-19
(2) www.takeda.com/de-de/newsroom/mitteilungen-fur-fachkreise/geschuetzt/Fachpressemitteilungen-Takeda/2022/belastung-durch-psychiatrische-komorbiditaten-angst-und-depression-bei-adhs/
(3) www.frontiersin.org/journals/psychiatry/articles/10.3389/fpsyt.2021.737351/full
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Some of the most important findings from the latest original publication on VRET:

- **Patient perception of VRET vs. in vivo therapy:** A study investigated the perception of patients with anxiety disorders towards VRET compared to in vivo exposures. It showed that VRET is perceived as a flexible and effective alternative, especially due to the controlled environments
    - Levy A, Nittas V, Wray T (2023). Patient Perceptions of In Vivo Versus Virtual Reality Exposures for the Treatment of Anxiety Disorders: Cross-Sectional Survey Study; JMIR Form Res 2023;7:e47443,formative.jmir.org/2023/1/e47443 ; DOI: 10.2196/47443
- **Anxiety disorders and phobias**: VRET has proven to be an effective method for treating phobias and anxiety disorders. It provides a controlled, immersive environment that allows therapists to customize and control exposure, which is often better accepted than in vivo exposure
    - Boeldt, D., McMahon, E., McFaul, M., & Greenleaf, W. (2019). Using Virtual Reality Exposure Therapy to Enhance Treatment of Anxiety Disorders: Identifying Areas of Clinical Adoption and Potential Obstacles. *Frontiers in Psychiatry*, 10. .doi.org/10.3389/fpsyt.2019.00773
    - Botella, C., 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, 1-13. .doi.org/10.1007/s11920-017-0788-4
    - Ribé-Viñes, J., Gutiérrez-Maldonado, J., Zabolipour, Z., & Ferrer-García, M. (2023). Efficacy of virtual reality-based exposure therapy for the treatment of fear of flying: a systematic review. *The Cognitive Behavior Therapist*, 16. .doi.org/10.1017/S1754470X23000119
- **Social anxiety disorder**: VRET is a promising alternative to traditional in vivo exposure therapy (iVET) in the treatment of social anxiety disorder. It offers a more cost-effective and flexible solution without significant differences in efficacy compared to iVET
    - Caponnetto, P., Triscari, S., Maglia, M., & Quattropani, M. (2021). The Simulation Game-Virtual Reality Therapy for the Treatment of Social Anxiety Disorder: A Systematic Review. *International Journal of Environmental Research and Public Health*, 18. .doi.org/10.3390/ijerph182413209
- **Fear of flying**: Studies show that VRET is at least as effective as other evidence-based treatments in treating fear of flying and is an excellent complement to cognitive behavioral therapy (CBT).
    - Ribé-Viñes, J., Gutiérrez-Maldonado, J., Zabolipour, Z., & Ferrer-García, M. (2023). Efficacy of virtual reality-based exposure therapy for the treatment of fear of flying: a systematic review. *The Cognitive Behavior Therapist*, 16. .doi.org/10.1017/S1754470X23000119
    - Cardos, R., David, O., & David, D. (2017). Virtual reality exposure therapy in flight anxiety: A quantitative meta-analysis. *Comput. Hum. Behav*, 72, 371-380. .doi.org/10.1016/j.chb.2017.03.007

- **VRET for obsessive-compulsive disorder (OCD):**
  A systematic review of the efficacy of immersive VRET (iVRET) to modulate disgust responses in

OCD showed that personalized VR environments can help reduce atypical feelings of disgust and avoidance behaviors. The study emphasized the importance of iVRET for the treatment of emotions such as disgust, which goes beyond traditional fear focus

  - Ferraioli F, Culicetto L, Cecchetti L, et al. Virtual Reality Exposure Therapy for Treating Fear of Contamination Disorders: A Systematic Review of Healthy and Clinical Populations. Brain Sci. 2024;14(5):510. Published 2024 May 17. doi:10.3390/brainsci14050510

- **post-traumatic stress disorder, addiction, psychosis and autism spectrum disorders**.
  Positive results have been reported for VR-based treatments of auditory hallucinations in psychosis. These applications extend the spectrum of VRET beyond anxiety disorders and show potential for more severe mental illnesses. VRET has also achieved similar efficacy to active psychotherapy for PTSD:

  - Tsamitros N, Beck A, Sebold M, Schouler-Ocak M, Bermpohl F, Gutwinski S. Die Anwendung der Virtuellen Realität in der Behandlung psychischer Störungen [The application of virtual reality in the treatment of mental disorders]. *Nervenarzt*. 2023;94(1):27-33. doi:10.1007/s00115-022-01378-z

  - Emmelkamp, P., & Meyerbröker, K. (2021). Virtual Reality Therapy in Mental Health. *Annual review of clinical psychology*. .doi.org/10.1146/annurev-clinpsy-081219-115923

  - Meyerbröker, K. (2021). Virtual reality in clinical practice. *Clinical Psychology & Psychotherapy*, 28, 463 - 465. .doi.org/10.1002/cpp.2616

- **For eating disorders,** VR exposure & frame of reference shifting offer potential advantages over traditional cognitive behavioral therapies

  - Riva, G., Malighetti, C., & Serino, S. (2021). Virtual reality in the treatment of eating disorders. *Clinical Psychology & Psychotherapy*, 28, 477 - 488. .doi.org/10.1002/cpp.2622

Recommended review articles and meta-analyses:

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

Deng, W., Hu, D., Xu, S., Liu, X., Zhao, J., Chen, Q., Liu, J., Zhang, Z., Jiang, W., , L., Hong, X., Cheng, S., Liu, B., & Li, X. (2019). The efficacy of virtual reality exposure therapy for PTSD symptoms: A systematic review and meta-analysis. *Journal of affective disorders*, 257, 698-709 . .doi.org/10.1016/j.jad.2019.07.086

Kothgassner, O., Goreis, A., Kafka, J., Van Eickels, R., Plener, P., & Felnhofer, A. (2019). Virtual reality exposure therapy for posttraumatic stress disorder (PTSD): a meta-analysis. *European Journal of Psychotraumatology*, 10. .doi.org/10.1080/20008198.2019.1654782

Eshuis, L., Gelderen, M., Zuiden, M., Nijdam, M., Vermetten, E., Olff, M., & Bakker, A. (2020). Efficacy of immersive PTSD treatments: A systematic review of virtual and augmented reality exposure therapy and a meta-analysis of virtual reality exposure therapy. *Journal of psychiatric research*. doi.org/10.1016/j.jpsychires.2020.11.030.

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