Original Paper

Examining the Efficacy of Extended Reality–Enhanced Behavioral Activation for Adults With Major Depressive Disorder: Randomized Controlled Trial

Margot Paul[1], PsyD; Kim Bullock[1], MD; Jeremy Bailenson[2], PhD; David Burns[1], MD

[1]Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, Stanford, CA, United States

[2]Department of Communication, Stanford University, Stanford, CA, United States

Corresponding Author:
Margot Paul, PsyD
Department of Psychiatry and Behavioral Sciences
Stanford University School of Medicine
401 Quarry Rd
Stanford, CA, 94305
United States
Phone: 1 781 572 4136
Email: mdpaul@stanford.edu

Abstract

Background: Major depressive disorder (MDD) is a global concern with increasing prevalence. While many evidence-based psychotherapies (EBPs) have been identified to treat MDD, there are numerous barriers to patients accessing them. Virtual reality (VR) has been used as a treatment enhancement for a variety of mental health disorders, but few studies have examined its clinical use in treating MDD. Behavioral activation (BA) is a simple yet effective and established first-line EBP for MDD that has the potential to be easily enhanced and adapted with VR technology. A previous report by our group explored the feasibility and acceptability of VR-enhanced BA in a small clinical proof-of-concept pilot. This study examines the clinical efficacy of a more immersive extended reality (XR)–enhanced BA (XR-BA) prototype. This is the first clinical efficacy test of an XR-BA protocol.

Objective: This study examined whether XR-BA was feasible and efficacious in treating MDD in an ambulatory telemedicine clinic.

Methods: A nonblinded between-subject randomized controlled trial compared XR-BA to traditional BA delivered via telehealth. The study used a previously established, brief 3-week, 4-session BA EBP intervention. The experimental XR-BA participants were parti1157 Tm (proof-of-concept)Tj 1 0 (telehealth.)Tjj 1

KEYWORDS

virtual reality; extended reality; major depressive disorder; behavioral activation; depression; Meta Quest 2

Introduction

Background

Major depressive disorder (MDD) is a global concern with increasing cases worldwide [1]. Depressive disorders are the most significant contributors to nonfatal health loss worldwide, with a 37.9% increase in their economic burden from 2010 to 2020 [1,2]. MDD is associated with suicide, which is one of the leading causes of death in young adults. Although many evidence-based

December 19, 2022, and July 24, 2023. The trial was registered on ClinicalTrials.gov (ID NCT05525390).

Participants were recruited locally via study flyers posted in the Stanford School of Medicine Department of Psychiatry and Behavioral Sciences located in Palo Alto, California, United States. The description of the study was also electronically listed on Stanford University's website for currently recruiting studies, ClinicalTrials.gov, and Craigslist. Without solicitation, a private web-based company called *Power* included our study on its website and connected participants with this study without any formal agreement, consent, or payment from our research group.

The inclusion criteria were as follows: age of ≥18 years; ability to speak English; and meeting of the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*, criteria for MDD. The exclusion criteria were as follows: substance use disorder in the previous year, diagnosis of any psychotic or bipolar I disorder, seizure in the previous 6 months or untreated epilepsy, current suicidal urges or intent, current nonsuicidal self-injury or parasuicidal behavior, changing psychotherapy treatment within the last 4 months before study entry, or changing psychotropic medication within 2 months of study entry. This study offered no compensation for participation.

The initial screening procedure consisted of 2 steps: an initial phone screening and a face-to-face Zoom intake session. During the initial phone screening, callers were assessed for preliminary eligibility using the Patient Health Questionnaire–8 (PHQ-8) and a brief screening questionnaire and were given the opportunity to ask questions about the study (Multimedia Appendix 1). If the initial eligibility criteria were met, as determined by the answers to the questionnaire and a PHQ-8 score of ≥10, potential participants were securely emailed a consent form to read, review, and sign at their leisure [12] (Multimedia Appendix 2). Potential participants were informed that they could reach out to the clinician with any questions before signing the consent form. After potential participants securely returned their signed consent forms, a Zoom intake session was held to determine complete study eligibility and obtain demographic information (Multimedia Appendix 3). Complete study eligibility was determined using the clinician-administered Mini-International Neuropsychiatric Interview [13]. The previously published case report and feasibility study provide further details [10,14].

Enrollment and Randomization

When a participant met the full study eligibility criteria and was enrolled to take part in the study, they were randomly assigned to 1 of the 2 study arms in a single-blind fashion using permuted blocks of 4 in sealed envelopes. Participants were notified of their randomization outcome via secure email before session 1.

Procedure

A clinical psychologist met with each participant for 30 to 50 minutes once per week for 4 sessions over Zoom to administer a brief BA therapy protocol. At the beginning of each session, all participants were verbally administered the PHQ-9. If item 9 was endorsed, a risk assessment was conducted

Figure 1. Study timeline. BA: behavioral activation; CBT: cognitive behavioral therapy;

range (either 0-12 for 3 questions or 0-16 for 4 questions). The average percentage of acceptance was also calculated by dividing the average score by the maximum score within the outcome range. To determine the degree of

Figure 2. CONSORT (Consolidated Standards of Reporting Trials) diagram. BA: behavioral activation; MINI: Mini-International Neuropsychiatric Interview; XR-BA: extended reality–enhanced behavioral activation.

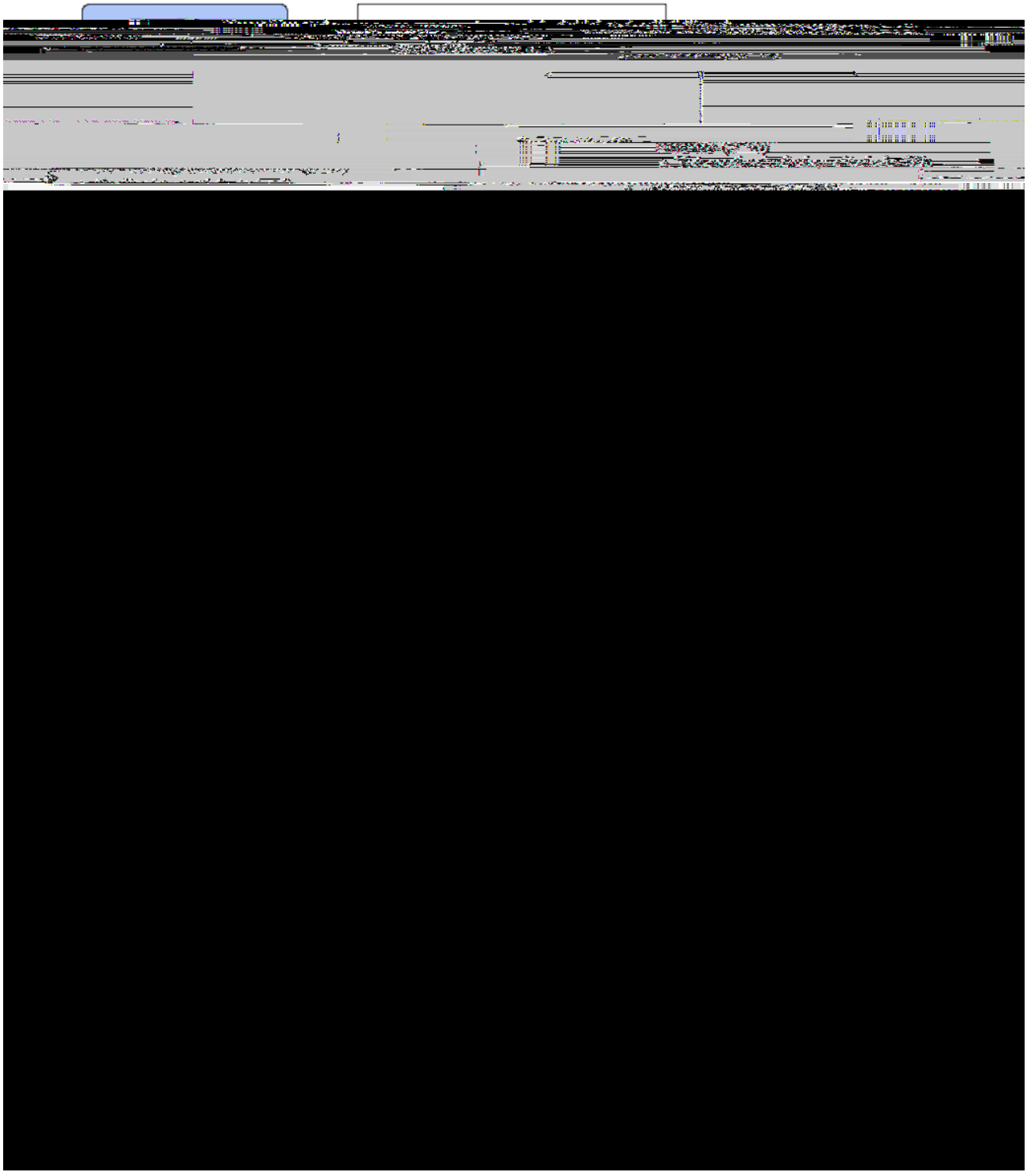

Table 1. Participant demographics (N=26).

Characteristic	XR-BA[a] (n=13), n (%)	Traditional BA[b] (n=13), n (%)	Total, n (%)
Gender			
Male	1 (8)	5 (38)	6 (23)
Female	11 (85)	8 (62)	19 (73)
Nonbinary or third gender	1 (8)	0 (0)	1 (4)
Age group (y)			
20 to 29	3 (23)	2 (15)	5 (19)
30 to 39	3 (23)	0 (0)	3 (12)
40 to 49	1 (8)	2 (15)	3 (12)
50 to 59	3 (23)	3 (23)	6 (23)
60 to 69	1 (8)	5 (38)	6 (23)
70 to 79	2 (15)	1 (8)	3 (12)
Race or ethnicity			
Asian	1 (8)	1 (8)	2 (8)
Black	0 (0)	1 (8)	1 (4)
Hispanic or Latino	0 (0)	1 (8)	1 (4)
Indian	1 (8)	2 (15)	3 (12)
Mexican	1 (8)	0 (0)	1 (4)
Non-Hispanic White	10 (77)	8 (62)	18 (69)
Previous mental health treatment			
Yes	12 (92)	12 (92)	24 (92)
No	1 (8)	1 (8)	2 (8)
Current mental health treatment			
Yes	11 (85)	6 (46)	17 (65)
Psychotherapy only	1 (9)	1 (17)	2 (12)
Psychotropic medications only	3 (27)	3 (50)	6 (35)
Psychotherapy and medications	7 (64)	2 (33)	9 (53)
No	2 (15)	7 (54)	9 (35)
Previous experience using VR[c]			
0 times	9 (69)	9 (69)	18 (69)
1 to 4 times	3 (23)	3 (23)	6 (23)
5 to 9 times	1 (8)	1 (8)	2 (8)
≥10 times	0 (0)	0 (0)	0 (0)
Purpose of previous VR use			
Gaming	3 (75)[d]	2 (50)[d]	5 (62)[e]
Treatment	0 (0)[d]	0 (0)[d]	0 (0)[e]
Research	1 (25)[d]	2 (50)[d]	3 (38)[e]

[a]XR-BA: extended reality–enhanced behavioral activation.

[b]BA: behavioral activation.

[c]VR: virtual reality.

[d]n=4.

[e]n=8.

XR-BA Prototype Feasibility

The completion rates were 77% (10/13) in the XR-BA arm and 85% (11/13) in the traditional BA arm. No participants reported any serious adverse events. The participants in the XR-BA arm used the headset, on average, slightly less than suggested (encouraged a minimum of 12 times), with the completer average being 12 (SD 2.67) and the ITT participant average being 11.18 (SD 3.71). Only 8% (1/13) of the participants did not submit a post-XR questionnaire during 1 week of treatment. This participant reported that she did not use the headset during that week due to being busier than usual with work deadlines and feeling physically ill.

The average total presence rating of the ITT XR-BA participants was 68% (8.1/12; SD

Table 2. Extended reality–enhanced behavioral activation acceptability.

	Perceived usefulness[a] (0-12; 3 items), mean (SD)	Perceived ease of use[a] (0-12; 3 items), mean (SD)	Attitudes toward use[b] (0-16; 4 items), mean (SD)	Intention to use the technology[a] (0-12; 3 items), mean (SD)
Completer average	8.4 (2.2)	7.7 (2.6)	11.7 (2.6)	9.2 (1.9)
ITT[c] average	8.1 (2.3)	7.5 (2.5)	11.1 (3.0)	8.4 (3.3)

[a]Domains comprising the Technology Acceptance Model (higher numbers indicate greater acceptability). Perceived usefulness, perceived ease of use, and intention to use the technology comprised 3 items with a range of 0 (*strongly disagree*) to 4 (*strongly agree*) for each item.

[b]Attitudes toward use comprised 4 items with a range of 0 (*strongly disagree*) to 4 (*strongly agree*) for each item.

[c]ITT: intention to treat.

XR-BA Tolerability

Physical tolerability was determined using the SSQ. Possible responses for the 16 items ranged from 0 (*no more than usual*) to 3 (*severely more than usual*). Lower numbers indicate greater tolerability. The average overall physical tolerability of those who completed

confound when compared to traditional BA. Yet, in practice and outside of clinical trials, it may be necessary to do so at this time when technical onboarding to commercial headsets is still complex and challenging for the average person. However, the challenges of onboarding may just as likely provide an opportunity to engage in a mastery or pleasant activity

studies have had similar or smaller sample sizes [39,40]. It is important to recognize that this could underscore an inherent challenge in depression studies, where health state and conditional altruism are large contributing factors to participation interest [41]. In addition, the small sample size hindered our ability to address other interesting research questions, such as whether different subtypes or severity of MDD would yield different effects from the treatment. For example, w

[

18. MacPhillamy DJ, Lewinsohn PM. The pleasant events schedule: studies on reliability, validity, and scale intercorrelation. J Consult Clin Psychol. 1982;50(3):363-380. [FREE Full text] [doi: 10.1037//0022-006x.50.3.363]
19. Marcoulides GA, Schumacker RE. Full information estimation in the presence of incomplete data. In: Advanced Structural Equation Modeling. London, UK. Psychology Press; 1996.
20. Wothke W. Longitudinal and multigroup modeling