

# Evaluating the Potential of the Metaverse as a Therapeutic Platform in Individuals with Depression

Fabiha Islam, Purushothaman Muthukanagaraj, Mei-Hsiu Chen, Liang Zhan, Alex Leow, Chao Shi

Submitted to: JMIR XR and Spatial Computing (JM XR)  
on: August 14, 2025

**Disclaimer:** © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

## *Table of Contents*

---

**Original Manuscript..... 5**



# Evaluating the Potential of the Metaverse as a Therapeutic Platform in Individuals with Depression

Fabiha Islam<sup>1\*</sup> MSci; Purushothaman Muthukanagaraj<sup>2\*</sup> MD; Mei-Hsiu Chen<sup>3\*</sup> PhD; Liang Zhan<sup>4\*</sup> PhD; Alex Leow<sup>5\*</sup> PhD; Chao Shi<sup>1\*</sup> PhD

<sup>1</sup> UHS Binghamton General Hospital Binghamton US

<sup>2</sup> Binghamton University Binghamton US

<sup>3</sup> University of Pittsburgh Pittsburgh US

<sup>4</sup> University of Illinois Chicago Chicago US

\* these authors contributed equally

## Corresponding Author:

Chao Shi PhD

## Abstract

**Background:** Depression affects millions globally, with significant barriers to accessing effective therapy. The application of the Metaverse, a three-dimensional (3D) environment where users can interact with other users using avatars in a virtual world, has gained significant attention as a potential tool for depression treatment in recent years.

**Objective:** This study investigates the potential of the Metaverse as a platform for eliciting therapeutic emotional responses in depressed individuals while they perform an emotional elicitation task in the Metaverse and a real-world environment.

**Methods:** A between-subjects experiment involving 28 participants (14 with self-diagnosed depression and 14 with minimal or no depression) was conducted, with participants randomly assigned to either a real-world or Metaverse environment. Second Life (SL), a persistent 3D virtual world that utilizes human-like avatars for navigation, served as the metaverse environment, and a desktop computer represented the real-world settings. Participants watched emotion-eliciting video clips to evoke amusement, anger, disgust, fear, and sadness. They reported their emotional arousal, mental workload, and emotional engagement using a 16-item self-report inventory, the NASA Task Load Index (NASA-TLX), and the Positive and Negative Affect Schedule (PANAS), respectively.

**Results:** The study found no significant differences between the real-world and Metaverse settings regarding perceived emotional arousal, mental workload, or emotional engagement, suggesting that SL offers comparable emotional responses to real-world environments. Furthermore, participants with minimal or no depression reported lower perceived effort in the SL environment compared to the real-world setting, indicating the Metaverse's potential to alleviate cognitive stress during emotionally eliciting tasks.

**Conclusions:** These findings suggest that Metaverse platforms may offer viable alternatives for therapeutic interventions for depression.

(JMIR Preprints 14/08/2025:82422)

DOI: <https://doi.org/10.2196/preprints.82422>

## Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.

Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

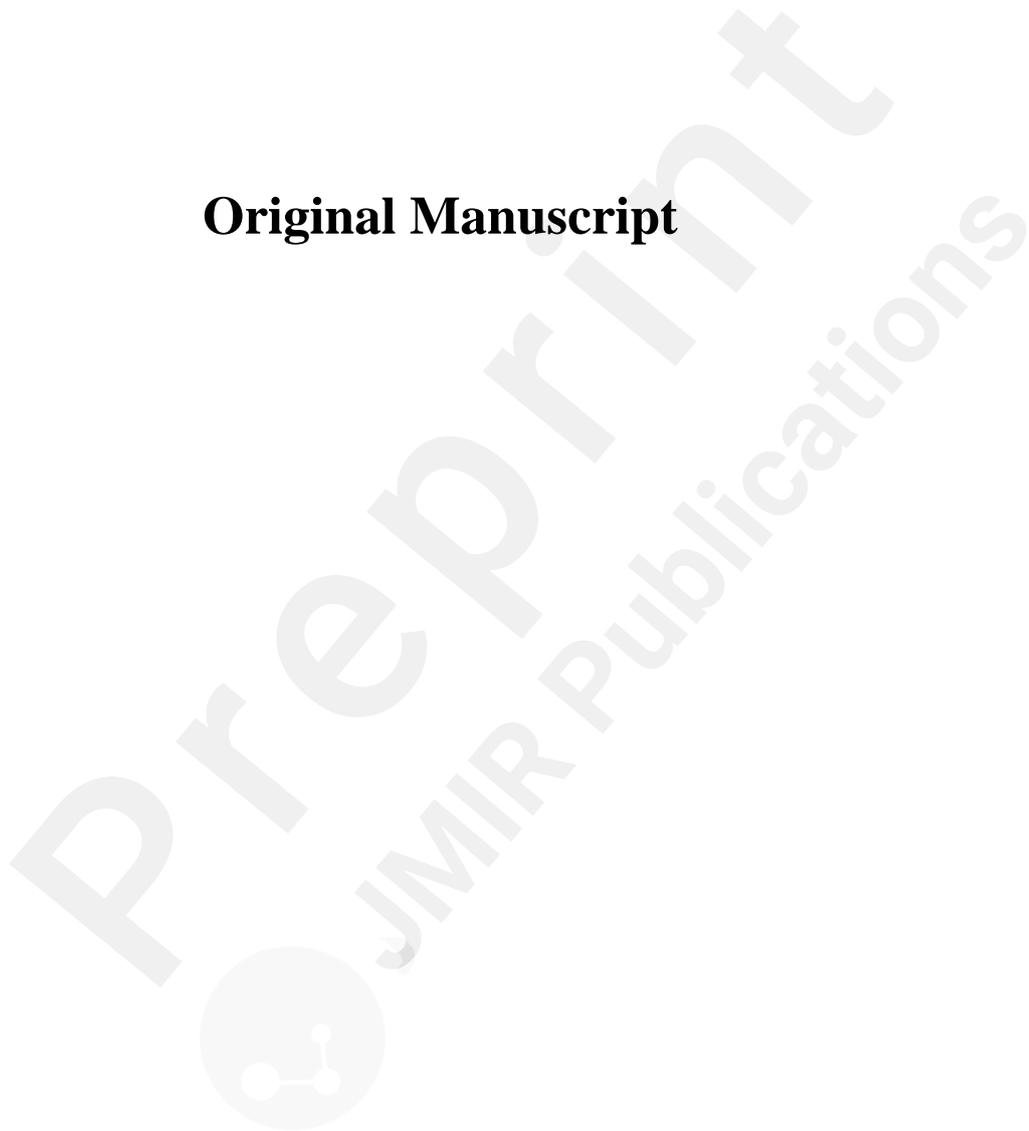
✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to all users.

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <https://preprints.jmir.org/preprint/82422>  
No. Please do not make my accepted manuscript PDF available to anyone. I understand that if I later pay to participate in <https://preprints.jmir.org/preprint/82422>

Preprint  
JMIR Publications

**Original Manuscript**



# Evaluating the Potential of the Metaverse as a Therapeutic Platform in Individuals with Depression

Fabiha Islam <sup>1</sup>, Purushothaman Muthukanagaraj <sup>2</sup>, Mei-Hsiu Chen <sup>1</sup>, Liang Zhan <sup>3</sup>, Alex Leow <sup>4</sup>, Chao Shi <sup>1,\*</sup>

<sup>1</sup> Binghamton University; [fislam17@binghamton.edu](mailto:fislam17@binghamton.edu), [mchen@binghamton.edu](mailto:mchen@binghamton.edu), [cshi@binghamton.edu](mailto:cshi@binghamton.edu)

<sup>2</sup> UHS Binghamton General Hospital; [Purushothaman.Muthukanagaraj@nyuhs.org](mailto:Purushothaman.Muthukanagaraj@nyuhs.org)

<sup>3</sup> University of Pittsburgh; [liang.zhan@pitt.edu](mailto:liang.zhan@pitt.edu)

<sup>4</sup> University of Illinois Chicago; [weihliao@uic.edu](mailto:weihliao@uic.edu)

\* Correspondence: [cshi@binghamton.edu](mailto:cshi@binghamton.edu)

## Abstract

**Background:** Depression affects millions globally, with significant barriers to accessing effective therapy. The application of the Metaverse, a three-dimensional (3D) environment where users can interact with other users using avatars in a virtual world, has gained significant attention as a potential tool for depression treatment in recent years.

**Objective:** This study investigates the potential of the Metaverse as a platform for eliciting therapeutic emotional responses in depressed individuals while they perform an emotional elicitation task in the Metaverse and a real-world environment.

**Methods:** A between-subjects experiment involving 28 participants (14 with self-diagnosed depression and 14 with minimal or no depression) was conducted, with participants randomly assigned to either a real-world or Metaverse environment. Second Life (SL), a persistent 3D virtual world that utilizes human-like avatars for navigation, served as the metaverse environment, and a desktop computer represented the real-world settings. Participants watched emotion-eliciting video clips to evoke amusement, anger, disgust, fear, and sadness. They reported their emotional arousal, mental workload, and emotional engagement using a 16-item self-report inventory, the NASA Task Load Index (NASA-TLX), and the Positive and Negative Affect Schedule (PANAS), respectively.

**Results:** The study found no significant differences between the real-world and Metaverse settings regarding perceived emotional arousal, mental workload, or emotional engagement, suggesting that SL offers comparable emotional responses to real-world environments. Furthermore, participants with minimal or no depression reported lower perceived effort in the SL environment compared to the real-world setting, indicating the Metaverse's potential to alleviate cognitive stress during emotionally eliciting tasks.

**Conclusion:** These findings suggest that Metaverse platforms may offer viable alternatives for therapeutic interventions for depression.

**Keywords:** depression, emotional response, mental health, metaverse, second life.

## 1. Introduction

Depressive disorder, also referred to as depression, is a widespread mental health condition characterized by persistent feelings of melancholy, low mood, and reduced interest or pleasure in activities [1], [2], [3]. According to the WHO, as of 2023, depressive disorders and other mental

health issues have affected approximately 280 million people globally. It is estimated that around 3.8% of the global population experiences depression, including 5% of adults (4% male and 6% female) and 5.7% of older adults over the age of 60 [3]. In the United States, depression is the leading cause of disability among individuals aged between 15 and 44, affecting more than 18 million adults annually. This condition results in approximately 490 million lost workdays annually, translating to an estimated \$23 billion in lost productivity and over \$100 billion in economic costs to U.S. businesses yearly [2]. Symptoms of depression include irritability, excessive guilt or low self-worth, emptiness, low mood, prolonged disinterest or lack of pleasure in daily activities, impaired concentration and decision-making abilities, fatigue, sleep abnormalities, fluctuations in appetite and weight, pessimism, hopelessness, persistent sadness, restlessness, and thoughts of suicide [1], [3]-[10]. To address this public health issue, the obstacles to accessing mental care services should be brought under the spotlight. These obstacles include workforce shortages of mental health professionals, limited awareness and understanding of mental health needs, financial burdens due to inadequate insurance reimbursement, reliance on social service agencies, the social stigma associated with seeking mental health treatment, insufficient resources for treatment referrals, and limited time for mental health discussions during medical appointments [5], [11]. One way to overcome those obstacles is the utilization of digital therapeutics or digital health in psychotherapy. In digital mental healthcare, mobile applications can help individuals track their daily mood changes, take meditation courses as prescribed, and access real-time online psychotherapy sessions. Digital mental health services have evolved rapidly, aiming to enhance the efficiency and quality of healthcare services, including diagnosis, monitoring, treatment, and data management, through digital communication technologies [12], [13]. However, most current digital mental health services only allow text or voice-based communications (Tess IBH [14], Woebot Health [15], WYSA [16]) while visually appealing and dynamic environments are essential in creating an immersive and realistic therapy environment to improve the therapy experience.

The Metaverse is a three-dimensional (3D) environment where users can interact with other users using avatars in a virtual world. Metaverse is a broad concept that uses a variety of technologies, including virtual reality (VR), augmented reality, mixed reality, cryptocurrency, and the internet that facilitates social interactions and user-generated content in a persistent digital environment across numerous domains, such as economics, ecology, and healthcare [13], [17], [18]. This expansive network of Metaverse allows users to experience a fully immersive environment, providing them a feeling of being inside the internet, where they can engage with other users, objects, and digital spaces as unique avatars, replicating real-world activities like socializing, working, and playing in a virtual setting [18]. By integrating physical and digital environments through devices such as tablets and smartphones, the Metaverse can link various technologies, including artificial intelligence, blockchain, tangible interfaces, and the Internet of Things into 3D environments. This technology integration enables seamless interactions between the virtual and real worlds, opening new possibilities for applications in multiple sectors [19].

The application of the Metaverse in the treatment of mental health disorders such as depression, anxiety, and autism has gained significant attention in recent years [13], [17]. It can potentially enhance the immersiveness, realism, accessibility, and affordability of mental health interventions while maintaining their reliability and efficiency [20], [21], [22]. For example, patients can interact with mental health professionals using customizable, anonymous avatars in simulated environments, which may fascinate individuals reluctant to seek in-person treatment due to stigma, anxiety, or fear of discrimination and face-to-face interactions [21], [22]. Furthermore, the metaverse supports telemedicine and medical consultations, enabling doctors to monitor patients' health records and vital signs and provide remote guidance [22], [23]. For patients with limited access to mental healthcare due to disabilities, geographic barriers, or time constraints, virtual interventions in the metaverse can offer vital support [18].

Numerous companies and governments from various countries have established VR counseling

and therapy associations, aiming to provide real-time mental health services within the metaverse [17], [18]. For example, Ezawa [20] et al. evaluated a cognitive behavior immersion program for coach-led cognitive behavioral skill training delivered through the metaverse app Innerworld. Involving 127 participants with clinical depression or anxiety, the study found significant reductions in symptoms after multiple sessions. Participants accessed the program via various devices and interacted as customizable avatars using real voices, fostering anonymity and engagement. Athar [23] et al. developed a metaverse-based AI recommendation system for patients with anxiety and depression. The system analyzed clinical notes and survey responses uploaded by users to predict condition severity and recommend treatments, including medications, psychiatrist referrals, and therapeutic activities like exercise and music. However, little fundamental research has been done to explore whether metaverse could elicit various needed emotions to provide therapy effectively. In this study, we evaluated the efficacy of the metaverse using Second Life (SL), the most widely used metaverse application, regarding its ability to provide emotional support.

SL is a persistent 3D virtual world designed to simulate various aspects of real life. Created by Linden Research, Inc. and released in 2003, SL allows users to utilize human-like avatars to navigate its online environment, participate in activities, and engage with other avatars [24], [25]. These avatars can be customized and come with animations for body language expressions such as laughing, waving, or flinching, enhancing the realism of interactions [26]. SL comprises interconnected regions, including land, water, and sky, where users can freely alter their avatars' appearances and engage with other community members [27]. Within SL, communication can occur through text-based messaging or vocal conversations, creating a dynamic space for social engagement [25]. SL holds significant potential for telehealth and therapeutic applications. The platform allows therapists and clients to conduct sessions remotely, using virtual environments as a setting for therapy. With customizable avatars and diverse virtual locations, SL offers a flexible range of visual stimuli, enabling therapists to integrate immersive exposure exercises into sessions for therapeutic purposes [25].

SL has rapidly emerged as a metaverse platform for health-related initiatives. In recent years, organizations have recognized SL's potential to create supportive health communities, prompting increased involvement. Many users report that SL offers emotional support beyond traditional telehealth, making it an appealing alternative for those seeking meaningful connections in a virtual setting. As a result, mainstream healthcare providers are beginning to explore SL as a tool for technology-enabled care delivery [26]. Additionally, SL has demonstrated considerable promise in supporting individual and group-based therapeutic interventions entirely online, establishing a virtual environment that allows clients and therapists to interact seamlessly [24]. Over the years, numerous studies have explored its effectiveness and acceptance as a therapeutic intervention. For example, Yuen [25] et al. demonstrated the feasibility and efficacy of using SL for cognitive-behavioral therapy in social anxiety disorder, with participants reporting significant improvements in mental health and appreciating the convenience of remote therapy. Hoch [26] et al. found SL effective for relaxation and mindfulness training, with participants reporting reduced stress, depression, and anxiety, and valuing the virtual sessions as a viable alternative to in-person training. In another study, Kandalaf [28] et al. demonstrated the potential of SL for social cognition training in high-functioning autism, with participants practicing real-life scenarios and showing significant improvements in emotional recognition and social communication skills after ten sessions. However, few studies have explored metaverse's effectiveness in eliciting patients' emotional responses to provide emotional support. Our study will explore if the metaverse is as realistic and effective as the real-world therapy environment by examining its ability to elicit emotional responses. We created a dedicated SL island as a metaverse environment where participants could immerse themselves using avatars and engage in activities designed to evoke emotional responses.

### **1.1 Research Gap and Study Aim**

While various studies have assessed the potential of the Metaverse environments for mental health therapy, a significant research gap remains in investigating their effectiveness in eliciting targeted emotional responses crucial for effective treatment, which may impact the realism of these environments. Specifically, there is a lack of studies analyzing the ability of the Metaverse platform to evoke emotional reactions comparable to those experienced in real-world therapy environments. Furthermore, few studies have measured perceived MWL and emotional engagement within the Metaverse environments while performing emotionally engaging tasks compared to real-world settings. This study addresses these gaps by evaluating the potential of the Metaverse environment to elicit emotions that could happen during therapy. The study's objectives are to assess individuals' emotional arousal, perception of MWL, and emotional engagement while performing an emotional elicitation task in Metaverse and a real-world setting and compare these measures between the two environments to determine the effectiveness of Metaverse in eliciting emotions. We recruited 14 healthy individuals (with either no or minimal symptoms of depression), as well as 14 individuals with self-reported depression. A between-subjects experiment was conducted, where participants were asked to watch emotion-eliciting video clips in two identical settings: one using a desktop computer and the other within an SL island. Emotional arousal, MWL, and emotional engagement were evaluated using a 16-item self-report inventory, the NASA Task Load Index (NASA-TLX), and the Positive and Negative Affect Schedule (PANAS), respectively.

## 2. Materials and Methods

### 2.1 Sample Size Calculation

An a priori power analysis was conducted using G\*Power software to determine the required sample size. The effect size was estimated from pilot data (the means and standard deviations of the NASA-TLX scores) involving five participants in each group. Using a one-tailed test with  $\alpha = 0.05$  and  $\beta = 0.20$ , the required sample size was calculated as five participants in each group. To improve data accuracy, we included 14 participants in each group.

### 2.2. Participants

We recruited 28 individuals, equally divided into those with minimal or no depression (ND) and those with self-diagnosed depression (SD). Participants were randomly assigned to either a real-world setting or an SL environment, with each group consisting of seven participants from both depression categories. In both settings, participants watched emotion-eliciting videos. The demographic information of all the participants is given in Table 1.

**Table 1.** Demographics of the Participants.

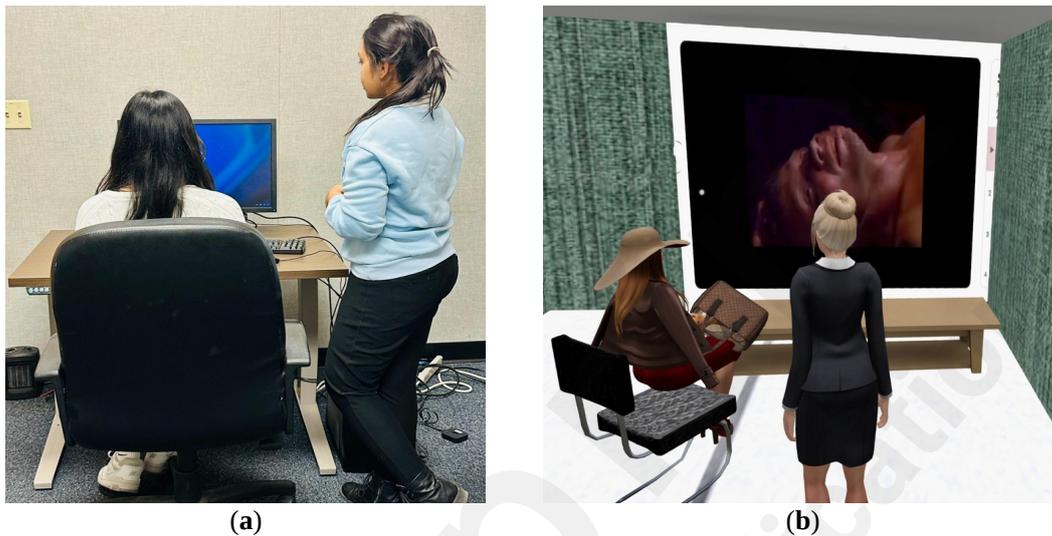
Environment	Gender	Depression Level	# of Participants	Mean age (Std)
Real World	Male	Minimal or ND	5	23.60 (5.68)
		SD	4	25.25 (1.50)
		Total	9	24.33 (4.21)
	Female	Minimal or ND	2	20.50 (0.71)
		SD	3	23.00 (4.36)
		Total	5	22.00 (3.39)
	Total	Minimal or ND	7	22.72 (4.89)
		SD	7	24.29 (2.98)
		Total	14	23.50 (3.98)
SL	Male	Minimal or ND	4	22.75 (4.79)
		SD	3	25.33 (2.08)
		Total	7	23.86 (3.85)
	Female	Minimal or ND	3	27.33 (0.58)
		SD	4	22.75 (5.62)
		Total	7	24.72 (4.68)
	Total	Minimal or ND	7	24.72 (4.19)
		SD	7	23.86 (4.38)

Total	14	24.29 (4.14)
-------	----	--------------

### 2.3. Apparatus

#### 2.3.1 Real-World Settings

The real-world setting for this study consisted of a soundproof laboratory room located at Binghamton University. The room was furnished with a desktop computer, a table, and a chair. Participants were invited to the lab to watch the videos on the desktop using YouTube as the media platform. The layout of the real-world setting is shown in Figure 1 (a).



**Figure 1.** Experimental settings: (a) Real-world settings; (b) Metaverse settings.

#### 2.3.2 Metaverse Settings

For the metaverse environment, we utilized the SL platform. A room replicating the real-world setting was created within the SL environment. This virtual room was equipped with a projector for video playback, as well as a table and a chair. Two customizable avatars were developed: one represented the researcher, and the other represented the participant. A short training video was provided to the participants beforehand to familiarize them with the SL system. This training video included instructions on navigation, communication through talking and chatting, and watching videos within the SL environment. The setup of the SL environment is shown in Figure 1 (b).

#### 2.3.3 Emotional Eliciting Task

In this experiment, we asked the participants to watch short emotional clips as an emotional eliciting task. Five short videos were selected to elicit emotions including amusement, anger, disgust, fear, and sadness. These emotions were chosen for their relevance to therapeutic applications for depression. The video clips were identified through a literature review of previous studies that successfully used these stimuli to evoke the targeted emotions. Table 2 describes each video clip and its associated emotion.

**Table 2.** Description of Emotional Eliciting Videos.

Targeted Emotion	Film Name	Description of Clip	Length (sec)	Reference
Amusement	I love lucy	Clip of a candy factory where two women struggle with the rapid speed of a conveyor belt and start stuffing the chocolate candies into their mouths.	178	Sturm et al., (2015)
Anger	My Bodyguar	Clip of a moment where two bullies attack a young boy, beat him, break his	249	Gross & Levenson

	d	bike, and throw it into the water.		(1995)
Disgust	Pink Flamingos	Clip of a scene where a person eats dog feces.	29	Gross & Levenson (1995)
Fear	Silence of the Lambs	Clip of a scene where an FBI agent pursues a suspect into the basement and uncovers a decomposing corpse.	216	Gross & Levenson (1995)
Sadness	The Champ	Clip of a moment where a young boy tearfully calls out to a boxer, who, severely injured after a match, collapses in the locker room and takes his final breaths, leaving those around him devastated.	158	Gross & Levenson (1995)

#### 2.3.4 Patient Health Questionnaire-9 (PHQ-9)

The PHQ-9 [29], a brief self-report questionnaire, was employed to screen for depression and its severity among participants. This nine-item measure includes eight items addressing depressive symptoms and one item evaluating suicidal ideation, each corresponding to the diagnostic criteria for major depressive disorder as outlined in the DSM-IV. Participants were asked to rate how frequently they experienced these symptoms over the past two weeks using a 4-point scale ranging from 0 (not at all) to 3 (nearly every day). The final PHQ-9 score, ranging from 0 to 27, indicates depression severity, with established thresholds used to categorize the level of depressive symptoms. Scores of 0–4 indicate minimal or no depression, 5–9 reflect mild depression, 10–14 indicate moderate depression, 15–19 represent moderately severe depression, and scores between 20–27 signify severe depression. Additionally, the PHQ-9 includes an item that assesses functional impairment by asking participants who reported any symptoms, “How *difficult* have these problems made it for you to do your work, take care of things at home, or get along with other people?” [30]. For this study, participants scoring between 0 and 4 were categorized as having minimal or ND, while a score of 5 or higher was considered indicative of the presence of depression.

#### 2.3.5 16-Item Self-Report Inventory

This study utilized a 16-item self-report inventory to assess discrete emotions. The items included amusement, anger, arousal, confusion, contempt, contentment, disgust, embarrassment, fear, happiness, interest, pain, relief, sadness, surprise, and tension. Participants were asked to rate each item on a 9-point scale, ranging from 0 to 8, where 0 indicated no experience of the emotion, and 8 represented the highest intensity of the emotion they felt. The order of the 16 items was randomized for each participant. This rating procedure was adapted from the study by Gross and Levenson [31].

#### 2.3.6 NASA Task Load Index (NASA-TLX)

The NASA-TLX [32], a multi-dimensional, survey-based tool, collected subjective feedback on mental workload (MWL) following the emotional eliciting task. NASA-TLX includes six subscales: mental demand (MD), physical demand (PD), temporal demand (TD), frustration, effort, and performance. To assess MWL, participants rated each of the six subscales on twenty-step bipolar scales based on their experience after completing the task. Each scale generated a score of 0 to 100, rounded to the nearest multiple of 5. To determine the weight of each subscale in overall MWL, participants completed fifteen paired comparisons, representing all possible permutations of the six subscales. The overall MWL score was calculated as the weighted mean of the six dimensions, yielding a score between 0 and 100, where low scores indicate low MWL, and high scores indicate high MWL [33].

#### 2.3.7 Positive and Negative Affect Schedule (PANAS)

In this experiment, we utilized the PANAS [34], a widely used adjective-based questionnaire, to assess the participants' emotional engagement. The PANAS consists of ten positive affect (PA) terms and ten negative affect (NA) terms, which measure pleasurable feelings and distress or unpleasurable feelings toward a situation, respectively. The specific PA and NA terms used in the scale are listed in Table 3. To assess participants' emotional responses, they were asked to rate how much they experienced each of the 20 emotions after completing the task, using a Likert scale ranging from 1 to 5. Lower scores on the Likert scale indicated a weaker association with the specific term, while higher scores indicated a stronger association. The final PA and NA scores were calculated by summing the ten positive and ten negative terms, respectively [35].

**Table 3.** Terms of PA and NA

PA	NA
Attentive	Hostile
Active	Irritable
Alert	Ashamed
Excited	Guilty
Enthusiastic	Distressed
Determined	Upset
Inspired	Scared
Proud	Afraid
Interested	Jittery
Strong	Nervous

#### 2.4. Experimental Procedure

This study was approved by the Institutional Review Board of Binghamton University, and participants were recruited by distributing a brief informational leaflet. Interested individuals were asked to complete the PHQ-9 questionnaire to determine their eligibility. Individuals scoring between 0 and 4 on PHQ-9 were classified as healthy participants with no or minimal depression symptoms, while those scoring 5 or higher were categorized as participants experiencing self-reported depression. Eligible participants were randomly assigned to the real-world or metaverse environment group.

In the real-world setting, the experimental procedure was described upon the participants' arrival at the laboratory, and informed consent was obtained. Demographic information, including age and gender, was collected before the experiment. Participants were then instructed to complete the emotional elicitation task, which involved watching six emotional video clips on a desktop computer via YouTube. In this setting, communication between the researcher and participants took place face-to-face and in person.

For the metaverse group, participants received a prerecorded training video with instructions on navigating SL, the metaverse platform used in this study, and an electronic copy of the informed consent form. They were asked to review these materials, submit a signed consent, and reach out with any questions for clarification before attending their scheduled session. The SL environment was pre-configured on the laboratory's desktop computer, including a virtual room with a video playback projector. Upon arrival, participants were guided through the procedure virtually, with all communication between the researcher and participants conducted through SL avatars to eliminate direct interaction. After providing their demographic data, participants performed the emotional eliciting task of watching the six emotional video clips using the SL platform.

Participants from both groups completed the 16-item self-report inventory after watching each video clip to report their emotional arousal. To reduce fatigue, a two-minute rest period was provided

between clips. The video clips were presented randomly for each participant to control for order effects. After viewing all six video clips and completing the associated self-report inventories, participants completed the NASA-TLX and PANAS questionnaires to report their perceived MWL and emotional engagement, respectively. Upon completing the experiment, each participant was compensated with a \$15 Amazon gift card for their time and participation.

### 2.5. Data Analysis

Four sets of subjective data were collected in this experiment: the PHQ-9, 16-item self-report inventory, NASA-TLX, and PANAS. The total score from the PHQ-9 was used to classify participants into two categories: minimal or ND symptoms (score between 0 and 4) and SD (score of 5 or higher). For the 16-item self-report inventory, scores from five dimensions corresponding to the five video clips were analyzed (Table 4). All six subscales of the NASA-TLX, including MD, PD, TD, performance, effort, frustration, and the overall MWL, were evaluated. PANAS scores for PA and NA were calculated by summing each dimension's emotional factors. Table 4 provides a list of dependent and independent variables for this study. Data analysis was performed using IBM SPSS Statistics version 28. To examine the effect of the independent variables on the dependent variables, a two-way Analysis of Variance (ANOVA) was conducted. The threshold for statistical significance was set at a p-value of less than 0.05. To compare the means for any significant main effect or interaction effect, Tukey's Least Significant Difference (LSD) method was adopted.

**Table 4.** List of Independent and Independent Variables.

<b>Independent Variables</b>	<b>Dependent Variables</b>
Environment	16-item self-report inventory
● Real-world	● Amusement
● Metaverse	● Anger
Depression Severity	● Disgust
● Minimal or ND	● Fear
● SD	● Sadness
	NASA_TLX
	● MD
	● PD
	● TD
	● Performance
	● Effort
	● Frustration
	● Overall MWL
	PANAS
	● PA
	● NA

## 3. Results

### 3.1. 16-Item Self-Report Inventory

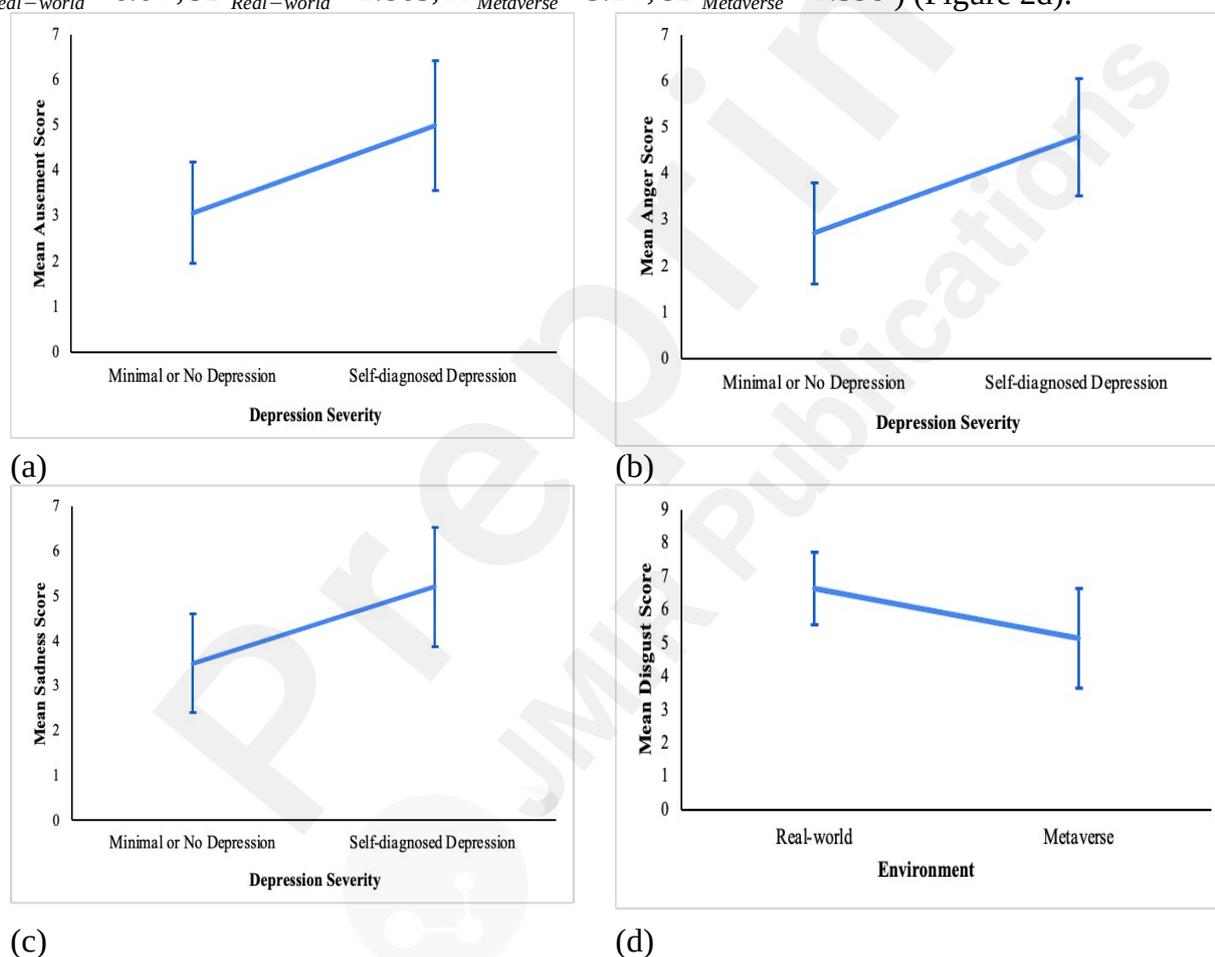
The two-way between-subjects ANOVA showed that depression severity had a significant effect on the mean amusement scores reported by the participants ( $F = 4.882$ ,  $p = 0.037$ ). Participants with minimal or ND reported a significantly lower mean amusement score compared to the participants

with SD (  $M_{ND}=3.07, SD_{ND}=1.940, M_{SD}=5.00, SD_{SD}=2.481$  ) (Figure 2a).

The two-way ANOVA showed that depression severity had a significant effect on the mean anger scores reported by the participants ( $F = 7.067, p = 0.014$ ). Participants with minimal or ND reported a significantly lower mean anger score compared to the participants with SD (  $M_{ND}=2.71, SD_{ND}=1.899, M_{SD}=4.79, SD_{SD}=2.190$  ) (Figure 2b).

The two-way ANOVA showed that depression severity had a significant effect on the mean sadness scores reported by the participants ( $F = 4.353, p = 0.048$ ). Participants with minimal or ND reported a significantly lower mean sadness score compared to the participants with SD (  $M_{ND}=3.50, SD_{ND}=1.912, M_{SD}=5.21, SD_{SD}=2.293$  ) (Figure 2c).

The two-way ANOVA showed that the environment had a marginally significant effect on the mean disgust scores reported by the participants ( $F = 3.128, p = 0.090$ ). Participants who watched the video clips in a real-world environment reported a higher mean disgust score than those who watched the video clips in a metaverse environment (  $M_{Real-world}=6.64, SD_{Real-world}=1.865, M_{Metaverse}=5.14, SD_{Metaverse}=2.598$  ) (Figure 2d).



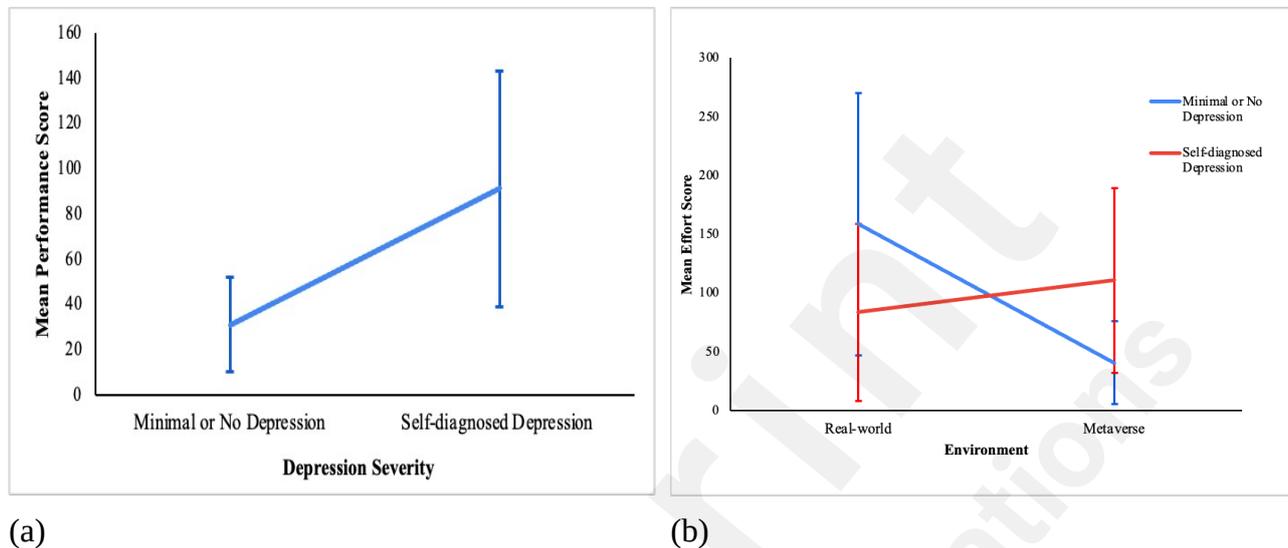
**Figure 2.** Effect of independent variables on dependent variables: (a) Main effect of depression severity on mean amusement score; (b) Main effect of depression severity on mean anger score; (c) main effect of depression severity on mean sadness score; (d) main effect of depression severity on mean disgust score.

### 3.2. NASA-TLX

The two-way ANOVA showed that depression severity had a significant effect on the mean performance scores reported by the participants ( $F = 4.939, p = 0.036$ ). Participants with minimal or ND reported a significantly lower mean performance score compared to the participants with SD (  $M_{ND}=31.07, SD_{ND}=36.278, M_{SD}=91.07, SD_{SD}=90.302$  ) (Figure 3a)

The two-way ANOVA showed that depression severity and environment had no significant main effect on the mean effort perceived by the participants, however, a significant interaction effect was

discovered ( $F = 4.931$ ,  $p = 0.036$ ). Tukey's LSD revealed that there was a significant difference between the mean effort score perceived by the participants with minimal or no depression in the two different environments, where participants in the real-world environment reported higher effort scores compared to the metaverse environment ( $p=0.017$ ,  $M_{Real-world} = 158.571$ ,  $SD_{Real-world} = 120.441$ ,  $M_{Metaverse} = 40.71$ ,  $SD_{Metaverse} = 38,016$ ) (Figure 3b).



**Figure 3.** Effect of independent variables on dependent variables: (a) Main effect of depression severity on mean performance score; (b) Interaction effect of environment and depression severity on mean effort score.

### 3.3. PANAS

The two-way ANOVA showed that neither the environment nor the severity of depression significantly affected the mean PA and NA scores reported by the participants.

## 4. Discussion

The present study aimed to evaluate the potential of a Metaverse environment as a platform for eliciting therapeutic emotions compared to a real-world setting. Twenty-eight participants, both healthy and individuals with self-reported depression symptoms, were recruited to perform an emotional eliciting task in real-world and Metaverse environments using a desktop computer and SL platform, respectively. Subsequently, they rated their perceptions of emotional arousal, MWL, and emotional engagement by completing a 16-item self-report inventory, NASA-TLX, and PANAS questionnaires immediately after completing the tasks.

The findings of our study revealed that participants with self-diagnosed depression reported significantly higher amusement, anger, and sadness scores compared to those with minimal or no depression, regardless of the environment. These results align with prior research indicating that individuals with depressive symptoms often experience heightened emotional arousal in response to stimuli [36]. Emotional arousal, which encompasses the brain and bodily responses to arousing stimuli, is closely tied to emotional reactivity and is often found abnormal in mental disorders. For instance, depression is frequently associated with hyperarousal and sustained tension [37]. This heightened arousal, along with intensified perception of emotional stimuli, can exacerbate depressive symptoms like prolonged sadness and impair emotional and social regulation [36]. Interestingly, disgust responses were marginally higher in the real-world setting compared to the SL environment. This finding suggests that some negative emotions, such as disgust, maybe more strongly elicited in real-world environments, possibly due to enhanced realism compared to metaverse environments. It has been found that the more naturalistic and engaging the stimulus material, the more effective it is

in inducing emotional arousal [38]. This finding further supports the potential of the Metaverse as a therapeutic tool, suggesting that its virtual environments might help mitigate disgust responses, offering positive implications for the treatment of depression. However, no significant effect of the environment was observed for most emotional arousal responses, including amusement, anger, sadness, and fear. This finding suggests that these specific emotions are not significantly influenced by whether the setting is metaverse or real-world, indicating that the Metaverse has the potential to evoke emotional arousal comparable to traditional real-world scenarios. In therapeutic contexts, these findings imply that the Metaverse may not inherently alter specific emotional arousal, supporting its potential as an alternative platform for emotional engagement.

An interesting finding of this study was the significant interaction effect of environment and depression severity on perceived effort. Participants with minimal or no depression reported higher effort in the real-world environment compared to the Metaverse. This result suggests that the Metaverse environment provided a platform that required less hard work for participants to achieve their performance levels, leading them to perceive the task as requiring less effort. Though individuals with depression did not perceive a significant difference in effort between the environments for the task selected in this experiment, the Metaverse could offer a therapeutic advantage by mitigating task-related stress for those who are particularly sensitive to cognitive stressors. This study found no significant differences in overall MWL, MD, PD, TD, or frustration between the real-world and Metaverse environments. Individuals with depressive symptoms did not report perceiving MWL differently than those without symptoms. In contrast to these findings, prior research indicates that work demands are positively associated with depression, irrespective of individuals' socioeconomic position, personality traits, or psychiatric history [39], as depressed individuals often struggle to make adjustments that could alleviate symptoms and impairments [40]. Moreover, depression has been linked to impaired performance, which is aggravated by exposure to cognitive stressors such as high cognitive demands [40]. However, in our study, depression severity was significantly associated with higher perceived performance, which reflects a heightened perception of being successful in accomplishing the task among individuals with depression. No significant differences in perceived performance were observed between the real-world and Metaverse environments. One possible explanation for these findings is the high task similarity between the two environments. The Metaverse environment was intentionally designed to closely replicate the real-world settings, which may have minimized the perceived differences in the dimensions of MWL. Another explanation could be the duration of exposure to the environment. Participants were exposed to each environment for a relatively short period, and appropriate rest periods were provided between the task sessions. This brief exposure and rest periods may have contributed to the lack of significant differences in workload perception among participants. These findings suggest that if designed carefully, the virtual environment of Metaverse can provide a comparable experience to the real world in terms of workload perception, even among individuals with varying mental health conditions.

This study did not exhibit any significant differences in PA or NA scores reported by the participants between the two environments or between participants with differing depression severity. This lack of variation suggests that both settings elicited comparable positive and negative emotional engagement levels. This result may support the feasibility of using SL as a Metaverse environment for therapeutic purposes, as no noticeable difference was observed compared to real-world settings during emotionally evocative tasks. However, further research is needed to identify specific interventions or design elements that could enhance emotional engagement in Metaverse environments, as previous studies have shown both positive and negative emotional reactions, reflecting overall mixed perceptions [41]. The Metaverse can help alleviate negative emotions like fear and boredom by offering tools and connections that enable users to explore real-world

opportunities [42]. While users express positive feelings such as contentment, curiosity, and enthusiasm [41], excessive time spent in virtual environments may lead to social alienation, with negative emotions extending into the real world, contributing to isolation, anxiety, and identity confusion [43], [44]. Additionally, using avatars to communicate within the Metaverse cannot effectively convey tactile emotions, such as handshakes or hugs, which may further impact users' emotional engagement [43].

The findings suggest that the Metaverse can evoke emotional responses comparable to real-world environments, reinforcing its potential as a therapeutic platform. Individuals with self-diagnosed depression exhibited heightened emotional responses in both settings, indicating the Metaverse's viability for emotional processing and therapeutic engagement. Additionally, the lower cognitive effort reported in the Metaverse highlights its potential to provide a less demanding alternative for those struggling with traditional therapy. These results support the integration of Metaverse environments into therapeutic programs to simulate real-life emotional experiences in a controlled, adaptable, and accessible setting. Future research should explore personalized Metaverse therapy, guided emotional regulation exercises, and immersive exposure therapy to enhance mental health interventions.

While the results of this study provide valuable information about the potential of Metaverse as an emotional eliciting platform, several limitations should be acknowledged. First, the study sample was limited to adults aged 18 to 35. As the use of Metaverse as an emotional eliciting platform may include various age groups, it is crucial to include more diverse participants to confirm these findings. Second, this study relied solely on self-reported measures, which may introduce potential biases, such as subjective interpretation of depression, MWL, and emotional engagement. Incorporating objective data such as physiological measures and clinical data for detecting depression could provide a more comprehensive assessment and enhance the validity and robustness of the results. Third, the participants in the experiment were exposed to the real world and the Metaverse environment for a brief period. Prolonged exposure may reveal additional insights and more significant findings. Finally, the study utilized a single Metaverse platform (SL), and these results may not be generalized for other Metaverse platforms. Future research could incorporate additional Metaverse platforms with varying levels of immersion or interactivity to evaluate how these factors influence emotional engagement.

## 5. Conclusions

This study highlights the potential of Metaverse platforms like SL as effective tools for therapeutic emotional elicitation. The ability of SL to evoke similar levels of emotional arousal, perceived MWL, and emotional engagement in real-world settings suggests that Metaverse-based interventions offer an innovative approach to mental health care. The reduced perceived effort and enhanced performance in the Metaverse demonstrate its potential as a complementary tool in therapy. Researchers and practitioners can leverage these findings to incorporate Metaverse environments into treatment plans, helping to reduce emotional distress, provide controlled exposure, and alleviate cognitive stress, particularly for patients who may find real-world environments overwhelming.

**Acknowledgments:** All the authors have made substantial contributions to the research.

**Data Availability:** The datasets generated or analyzed during this study are not publicly available due ethical issues but are available from the corresponding author on reasonable request.

**Funding:** This research received no external funding.

**Conflicts of Interest:** The authors declare no conflicts of interest.

**Institutional Review Board Statement:** The study was approved by the Institutional Review Board of Binghamton University (IRB ID: STUDY00004022 and date of approval: 7/19/2023).

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Author Contributions:** Conceptualization: Chao Shi, Purushothaman Muthukanagaraj, Mei-Hsiu Chen, Liang Zhan, and Alex Leow; methodology: Fabiha Islam, Chao Shi, Purushothaman Muthukanagaraj, Mei-Hsiu Chen, Liang Zhan, and Alex Leow; validation: Chao Shi, Purushothaman Muthukanagaraj, Mei-Hsiu Chen, Liang Zhan, and Alex Leow; formal analysis: Fabiha Islam; investigation: Chao Shi, Purushothaman Muthukanagaraj, Mei-Hsiu Chen, Liang Zhan, and Alex Leow; resources: Chao Shi, Purushothaman Muthukanagaraj, Mei-Hsiu Chen, Liang Zhan, and Alex Leow; data curation: Fabiha Islam; writing—original draft preparation, Fabiha Islam; writing—review and editing: Chao Shi, Purushothaman Muthukanagaraj, Mei-Hsiu Chen, Liang Zhan, and Alex Leow; visualization: Fabiha Islam; supervision: Chao Shi; project administration: Chao Shi; funding acquisition: Chao Shi. All authors have read and agreed to the published version of the manuscript

### Abbreviations

The following abbreviations are used in this manuscript:

3D	Three-dimensional
VR	Virtual Reality
SL	Second Life
NASA-TLX	NASA Task Load Index
PANAS	Positive and Negative Affect Schedule
ND	No depression
SD	Self-diagnosed depression
MWL	Mental workload
PD	Physical demand
TD	Temporal demand
PA	Positive affect
NA	Negative affect
ANOVA	Analysis of Variance
LSD	Least Significant Difference

### References

- Bell, I. H., Pot-Kolder, R., Rizzo, A., Rus-Calafell, M., Cardi, V., Cella, M., ... & Valmaggia, L. (2024). Advances in the use of virtual reality to treat mental health conditions. *Nature Reviews Psychology*, 3(8), 552-567.
- Hope for Depression. (2021, January 25). *Facts about Depression | Hope for Depression*. [https://www.hopefordepression.org/depression-facts/?utm\\_source=google\\_cpc&utm\\_medium=ad\\_grant&utm\\_campaign=depression\\_facts&gad\\_source=1&gclid=Cj0KCQiArby5BhCDARIsAIJvjiQQ0kAFurdbwqHjFQi4TwpSXGU5S7RPtGtKXl790BzZa2W0eZpKYT8aAkKnEALw\\_wcB](https://www.hopefordepression.org/depression-facts/?utm_source=google_cpc&utm_medium=ad_grant&utm_campaign=depression_facts&gad_source=1&gclid=Cj0KCQiArby5BhCDARIsAIJvjiQQ0kAFurdbwqHjFQi4TwpSXGU5S7RPtGtKXl790BzZa2W0eZpKYT8aAkKnEALw_wcB)
- World Health Organization: WHO & World Health Organization: WHO. (2023, March 31). *Depressive disorder (depression)*. <https://www.who.int/news-room/fact-sheets/detail/depression>
- Chong, P. S., Fung, M. L., Wong, K. H., & Lim, L. W. (2020). Therapeutic potential of *Hericium erinaceus* for depressive disorder. *International journal of molecular sciences*, 21(1), 163.
- Colligan, E. M., Cross-Barnet, C., Lloyd, J. T., & McNeely, J. (2020). Barriers and facilitators to depression screening in older adults: a qualitative study. *Aging & mental health*, 24(2), 341-348.
- Colombo, D., Suso-Ribera, C., Ortigosa-Beltrán, I., Fernández-Álvarez, J., García-Palacios, A., & Botella, C. (2022). Behavioral activation through virtual reality for depression: A single case experimental design with multiple baselines. *Journal of Clinical Medicine*, 11(5), 1262.

- 7 Gautam, S., Jain, A., Gautam, M., Vahia, V. N., & Grover, S. (2017). Clinical practice guidelines for the management of depression. *Indian journal of psychiatry*, 59(Suppl 1), S34-S50.
- 8 Kennedy, S. H. (2022). Core symptoms of major depressive disorder: relevance to diagnosis and treatment. *Dialogues in clinical neuroscience*.
- 9 Pfennig, A., Ritter, P. S., Höfler, M., Lieb, R., Bauer, M., Wittchen, H. U., & Beesdo-Baum, K. (2016). Symptom characteristics of depressive episodes prior to the onset of mania or hypomania. *Acta Psychiatrica Scandinavica*, 133(3), 196-204.
- 10 Zhai, K., Dilawar, A., Yousef, M. S., Holroyd, S., El-Hammali, H., & Abdelmonem, M. (2021). Virtual Reality therapy for depression and mood in long-term care facilities. *Geriatrics*, 6(2), 58.
- 11 Sadavoy, Joel, Rosemary Meier, and Amoy Yuk Mui Ong. "Barriers to access to mental health services for ethnic seniors: The Toronto study." *The Canadian Journal of Psychiatry* 49.3 (2004): 192-199.
- 12 Patel, N. A., & Butte, A. J. (2020). Characteristics and challenges of the clinical pipeline of digital therapeutics. *NPJ digital medicine*, 3(1), 159.
- 13 Yang, L., Zhang, L., Yang, W., Tang, F., Du, Y., & Liu, J. (2023). Exploring the potential of the metaverse medical paradigm in drug addiction treatment: a preliminary discussion and future prospects. *General Psychiatry*, 36(6).
- 14 Tess IBH. (2024). <https://www.x2ai.com/uprisehealth>
- 15 Woebot Health. (2024, December 4). *Scalable enterprise solution for mental health | Woebot Health*. <https://woebothealth.com/>
- 16 WYSA - *Everyday Mental Health*. (2024). WYSA - *Everyday Mental Health*. <https://www.wysa.com/>
- 17 Singh, J., & Nijjer, S. (2024). Metaverse in Psychological Treatments: Is MEDverse the Next Normal?. In *Entrepreneurship and Creativity in the Metaverse* (pp. 20-25). IGI Global.
- 18 Usmani, S. S., Sharath, M., & Mehendale, M. (2022). Future of mental health in the metaverse. *General Psychiatry*, 35(4).
- 19 Cerasa, A., Gaggioli, A., Marino, F., Riva, G., & Pioggia, G. (2022). The promise of the metaverse in mental health: the new era of MEDverse. *Heliyon*, 8(11).
- 20 Ezawa, I. D., Hollon, S. D., & Robinson, N. (2023). Examining predictors of depression and anxiety symptom change in cognitive behavioral immersion: observational study. *JMIR mental health*, 10(1), e42377.
- 21 Ramos, F. N., Bernstein, R. A., & Ezawa, I. D. (2024). Assessing Predictive Factors of Attitudes Toward Peer-Supported Mental Health Interventions in the Metaverse: Mixed Methods Study. *JMIR XR and Spatial Computing (JMXR)*, 1(1), e57990.
- 22 Yang, C. (2023). Using Cognitive Therapy to Explore the Potential Application of Traditional Therapy and Metaverse Therapy from a Cognitive Perspective. In *SHS Web of Conferences* (Vol. 171, p. 01030). EDP Sciences.
- 23 Athar, A., Mozumder, M. A. I., Fathima, K., Hussain, A., Ali, S., & Kim, H. C. (2023, September). Anxiety and Depression Detection and Rehabilitation in the Metaverse: A BERT-Based Recommendation System. In *2023 International Conference on Intelligent Metaverse Technologies & Applications (iMETA)* (pp. 1-5). IEEE.
- 24 Rehm, I. C., Foenander, E., Wallace, K., Abbott, J. A. M., Kyrios, M., & Thomas, N. (2016). What role can avatars play in e-mental health interventions? Exploring new models of client-therapist interaction. *Frontiers in Psychiatry*, 7, 186.
- 25 Yuen, E. K., Herbert, J. D., Forman, E. M., Goetter, E. M., Comer, R., & Bradley, J. C. (2013). Treatment of social anxiety disorder using online virtual environments in second life. *Behavior therapy*, 44(1), 51-61.
- 26 Hoch, D. B., Watson, A. J., Linton, D. A., Bello, H. E., Senelly, M., Milik, M. T., ... & Kvedar, J. C. (2012). The feasibility and impact of delivering a mind-body intervention in a virtual

- world. *PloS one*, 7(3), e33843.
- 27 Kemp, J., & Livingstone, D. (2006, August). Putting a Second Life “metaverse” skin on learning management systems. In *Proceedings of the Second Life education workshop at the Second Life community convention* (Vol. 20). CA, San Francisco: The University of Paisley.
- 28 Kandalafi, M. R., Didehbani, N., Krawczyk, D. C., Allen, T. T., & Chapman, S. B. (2013). Virtual reality social cognition training for young adults with high-functioning autism. *Journal of autism and developmental disorders*, 43, 34-44.
- 29 Spitzer, R. L., Kroenke, K., Williams, J. B., Patient Health Questionnaire Primary Care Study Group, & Patient Health Questionnaire Primary Care Study Group. (1999). Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. *Jama*, 282(18), 1737-1744.
- 30 Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: validity of a brief depression severity measure. *Journal of general internal medicine*, 16(9), 606-613.
- 31 Gross, J. J., & Levenson, R. W. (1995). Emotion elicitation using films. *Cognition & emotion*, 9(1), 87-108.
- 32 Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In *Advances in psychology* (Vol. 52, pp. 139-183). North-Holland.
- 33 Grier, R. A. (2015, September). How high is high? A meta-analysis of NASA-TLX global workload scores. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 59, No. 1, pp. 1727-1731). Sage CA: Los Angeles, CA: SAGE Publications.
- 34 Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of personality and social psychology*, 54(6), 1063.
- 35 Seib-Pfeifer, L. E., Pugnaghi, G., Beauducel, A., & Leue, A. (2017). On the replication of factor structures of the Positive and Negative Affect Schedule (PANAS). *Personality and Individual Differences*, 107, 201-207.
- 36 Wenzler, S., Hagen, M., Tarvainen, M. P., Hilke, M., Ghirmai, N., Huthmacher, A. C., ... & Oertel-Knoechel, V. (2017). Intensified emotion perception in depression: Differences in physiological arousal and subjective perceptions. *Psychiatry Research*, 253, 303-310.
- 37 Xie, M., Huang, Y., Cai, W., Zhang, B., Huang, H., Li, Q., ... & Han, J. (2024). Neurobiological underpinnings of hyperarousal in depression: A comprehensive review. *Brain Sciences*, 14(1), 50.
- 38 Berretz, G., Dutschke, C., Leonard, E., & Packheiser, J. (2023). Ewww—Investigating the neural basis of disgust in response to naturalistic and pictorial nauseating stimuli. *Frontiers in Psychiatry*, 13, 1054224.
- 39 Melchior, M., Caspi, A., Milne, B. J., Danese, A., Poulton, R., & Moffitt, T. E. (2007). Work stress precipitates depression and anxiety in young, working women and men. *Psychological medicine*, 37(8), 1119-1129.
- 40 Lerner, D., Adler, D. A., Rogers, W. H., Lapitsky, L., McLaughlin, T., & Reed, J. (2010). Work performance of employees with depression: the impact of work stressors. *American Journal of Health Promotion*, 24(3), 205-213.
- 41 Mahmoud, A. B. (2024). Analysing the public's beliefs, emotions and sentiments towards Metaverse workplace: A big-data qualitative inquiry. *Acta Psychologica*, 250, 104498.
- 42 Hagel, J. (2022, November 20). *The metapsychology of the metaverse*. John Hagel Edge Strategy and the Future of Work. <https://www.johnhagel.com/the-metapsychology-of-the-metaverse/#:~:text=In%20short%2C%20the%20metaverse%20could,world%20and%20in%20virtual%20worlds>.
- 43 Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., ... & Wamba, S. F. (2022). Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International journal of information management*, 66, 102542.

- 44 Govindankutty, S., & Gopalan, S. P. (2024). The Metaverse and Mental Well-Being: Potential Benefits and Challenges in the Current Era. In *The Metaverse for the Healthcare Industry* (pp. 131-152). Cham: Springer Nature Switzerland.

