



Research on the Design of Immersive Psychological Healing Spaces Based on Embodied Narrative and Serious Game Mechanisms

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Abstract. Addressing the contradiction between the surging public demand for mental health services in the post-pandemic era and the spatial-temporal limitations of traditional therapies, this paper explores the interdisciplinary application of Virtual Reality (VR) and serious games in the field of psychological healing. Based on Embodied Cognition, Flow Theory, and Attention Restoration Theory (ART), a three-in-one healing model of "Space-Narrative-Interaction" is constructed. The research indicates that through modular serious game mechanisms and the non-symbolic expression of abstract art, immersive media can effectively guide users from a passive "sensory experience" to active "cognitive restructuring." Combining empirical data with design cases, this paper proposes a set of design strategies for immersive healing spaces that function for both emotional arousal and behavioral intervention, providing a new theoretical perspective and practical path for the field of digital mental health.

Keywords: Virtual Reality, Serious Games, Embodied Narrative, Psychological Healing, Interaction Design.

1 Introduction

1.1 Research Background and Problem Statement

The global public health crisis has profoundly changed social operational models, making public mental health issues increasingly hidden and normalized. Particularly in universities and high-density urban environments, rates of anxiety, depression, and sub-health states have surged. However, traditional psychological counseling and art therapy are limited by physical space, time, professional labor costs, and patient "stigma," making it difficult to meet the growing social demand [1]. Against this backdrop, the integration of digital technology and the health industry has become inevitable, with "Digital Therapeutics" gradually moving from concept to clinical application.

Meanwhile, the experience economy is undergoing a value transformation from "sensory entertainment" to "spiritual healing." Although a large number of immersive light exhibitions have emerged in the market, existing products mostly remain at the level of creating visual spectacles, lacking deep narratives based on psychological mechanisms and long-term intervention capabilities [2]. Therefore, how to utilize the "embodiment" of Virtual Reality (VR) and the "goal-orientation" of Serious Games to construct a digital healing space that can both provide immediate emotional relief and guide cognitive restructuring has become an urgent problem to be solved.

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1.2 Current Status and Research Gaps

Current research on digital healing primarily follows two paths: First, empirical research from a medical perspective, focusing on verifying the clinical effects of VR Exposure Therapy (VRET), which often suffers from low user compliance due to a lack of engagement [3]; Second, interactive design research from an artistic perspective, focusing on the exploration of audiovisual language, which is mostly passive viewing and lacks deep behavioral induction [4].

Serious games, by embedding behavioral science principles (such as Social Cognitive Theory), can effectively enhance user self-efficacy [5][6]. However, few studies have effectively integrated the "mechanism feedback" of serious games with the "embodied narrative" of VR environments. Without effective narrative guidance and interaction mechanisms, immersive environments can easily degenerate into mere "electronic hallucinogens" [7].

1.3 Research Significance

This paper aims to construct a design model for immersive psychological healing spaces based on "Embodied Narrative + Serious Game Mechanisms." The main innovations are: Fusion of Perspectives, Breaking through the singular perspective of visual healing or functional games, proposing an integrated strategy of "Space as Narrative, Interaction as Healing." Modular Method, Drawing on modularity theory [8], psychological intervention is deconstructed into standardized modules such as catharsis, mindfulness, and cognitive restructuring, solving the pain point of poor content reusability.

2 Theoretical Basis and Mechanism Analysis

2.1 Embodied Cognition and Multi-Sensory Presence

The ontological characteristic of VR media lies in its "Embodiment." Unlike the "disembodied" viewing of screen media, VR narrative emphasizes the sensory participation of the body. The core logic of VR narrative is "Presence"—the creation of a psychological reality of "being there" through first-person sensory feedback [9]. This mechanism can break through psychological defense boundaries, allowing non-symbolic abstract art elements to transform into emotional media acting on the subconscious, effectively evoking deep emotional resonance [10].

2.2 Gamification Drive and Flow Channels

Gamification mechanisms solve the problem of maintaining motivation in the healing process. Based on Flow Theory, the optimal state of immersive experience occurs in the dynamic balance between challenge and skill. By constructing virtual tasks with moderate challenges, users can be guided into a highly focused flow state, blocking anxious rumination. Serious games utilize Social Cognitive Theory (SCT) to transform boring interventions into autonomous exploration processes through a "Trigger-Action-Reward" behavioral loop, enhancing users' self-efficacy and intrinsic motivation [5].

2.3 Attention Restoration and Emotional Interaction

According to Attention Restoration Theory (ART), virtual environments with characteristics of "Being Away" and "Extent" can help restore cognitive resources [10]. Furthermore, as a medium for emotional communication, video games allow users to establish emotional connections through micro-symbolic

stimuli and macro-interaction ritual chains during interactions with the virtual environment or characters, thereby alleviating loneliness and repairing social functions.

3 Construction of Interactive Narrative Modes in Immersive Healing Spaces

3.1 Spatial Narrative: From Physical Environment to Mental Projection

In the context of VR, space itself is the subject of the narrative. Design should not stop at simulating real landscapes but should use digital media to create surreal experiences that trigger "Reasonable Surprise". For example, constructing scenes with a sense of the sublime, such as weightless floating or microscopic particle worlds, can induce "awe," thereby psychologically reducing the anxiety of the "self". Meanwhile, light, color, and sound should serve as implicit narrative cues (e.g., using gradients of cool and warm color temperatures to metaphorically represent emotional transformation), achieving a resonance between the environment and the state of mind.

3.2 Interaction Mechanism: Multi-Level Feedback and Reconstruction of Control

Interaction design should progressively reconstruct the sense of psychological order through three levels: Sensory Level (Flow Feedback): Focuses on millisecond-level synchronization, such as breath triggering the flow of light dust, locking attention through high-responsiveness feedback. Systemic Level (Goal Orientation): Drawing on the logic of serious games, Cognitive Behavioral Therapy (CBT) is broken down into game levels (e.g., "Emotional Garbage Sorting"). By overcoming obstacles to gain visualized rewards, virtual success is transformed into real-world self-efficacy [5][6].

3.3 Role Intervention: Avatar Identification and Empathy

VR allows users to achieve "embodied existence" through virtual avatars [9].

(1) De-centering: By playing non-realistic roles (such as birds or points of light), users can temporarily shed social masks and examine self-emotions from a detached perspective, achieving "identity detachment" and cognitive restructuring.

(2) Social Resonance: In multi-user healing spaces, non-verbal social mechanisms (such as exchanging light and shadow hugs) are introduced to provide social support within virtual group rituals, repairing damaged social functions

4 Design Strategies and Methods Based on Quantitative Feedback

4.1 Construction of Parameterized Healing Modules

Drawing on modularity theory [8] and serious game behavioral data [5], healing functions are deconstructed into units with adjustable parameters (see Table 1).

Table 1: Parameter Mapping Matrix of Immersive Healing Modules

Module Type	Core Psychological Objective	Corresponding Game Mechanics Parameters	Key Performance Indicators (KPIs)	Expected Behavioral Outcomes
Cathartic Module	Reduce negative emotions and release stress	High-intensity interaction: striking, smashing	Interaction frequency > 60 actions/min System latency < 50 ms	Emotional arousal increase of 15–20%
Mindfulness Observation Module	Restore directed attention (ART)	Environmental immersion: automatic navigation, breath-following	Viewpoint movement < 1.5 m/s Background music (BGM) < 60 bpm	Increased HRV, enhanced α -wave activity
Cognitive Challenge Module	Enhance self-efficacy (SCT)	Task challenges: puzzle solving, item collection	Dynamic adjustment of difficulty coefficient Reward frequency: 3–5 min per reward	Improved task completion confidence

4.2 Audiovisual Immersion Thresholds and Physiological Regulation

Effective environmental design requires meeting specific audiovisual thresholds to induce significant physiological recovery [3]:

Visual: Field of View (FOV) > 110° to enhance presence; main color tone uses low-saturation cool colors (e.g., Pantone Classic Blue) to lower systolic blood pressure.

Auditory: Introduction of Binaural Beats technology (10Hz frequency difference between left and right ears) to induce α brainwaves; natural soundscape Signal-to-Noise Ratio (SNR) maintained above +5 dB.

4.3 Dynamic Difficulty Adjustment (DDA) and Flow Mode

To prevent states of anxiety ($C > S$) or boredom ($C < S$), a stepwise difficulty adjustment strategy is adopted. Specifically, the difficulty level is dynamically updated based on the user’s task performance, as expressed by the following formulation:

$$D_{t+1} = D_t + k \cdot (P_{success} - P_{target}) \tag{1}$$

D_t : current task difficulty level.

$P_{success}$: user's current task success rate.

P_{target} : predefined optimal success rate (typically set between 60% and 70%, a range most conducive to inducing a flow state).

k : adjustment coefficient.

Through this adaptive mechanism, task difficulty is continuously calibrated to align with the user's evolving skill level, thereby maintaining the interaction within the flow channel and supporting sustained engagement and emotional regulation.

4.4 Quantitative Evaluation Metrics for Embodied Interaction

Based on embodied narrative theory, the effectiveness of interaction design is assessed through the following post-experience evaluation metrics:

(1) Sense of Embodiment (SoE):

A standardized scale is used to measure the Body Ownership Illusion. The target score is set to greater than 4.5 out of 7.0.

(2) Valence and Arousal:

The Self-Assessment Manikin (SAM) scale is employed to record changes in emotional coordinates before and after the experience. The expected outcomes include a shift in arousal from high arousal (anxiety) to low arousal (calmness), and a shift in valence from negative to positive.

(3) Retention Rate:

Users' engagement in health-related behaviors (e.g., the number of days maintaining meditation practice) is monitored two weeks after exiting the game, in order to evaluate the long-term intervention effectiveness of the serious game.

5 Application Practice and Discussion of Empirical Benefits

5.1 Health Behavior Intervention in Serious Games

Taking the game *Escape from Diab*, designed for adolescent diabetes prevention, as an example [5], its design validates the transformation path of "Narrative-Mechanism-Behavior." The game constructs a dystopian narrative, using avatar identification to stimulate intrinsic motivation; core gameplay (self-monitoring, problem-solving) directly maps to SCT theory variables. Clinical data showed that the game effectively increased users' healthy eating behaviors, confirming the effectiveness of serious games in modifying behavioral patterns.

5.2 Virtual Reality Art Healing Practice

VR art healing focuses on emotional catharsis. For instance, TeamLab's works utilize synesthesia mechanisms (synchronization of touch and sound) to create a highly immersive "mindfulness field". In the abstract art VR application *Deep*, non-symbolic visual elements serve as containers for subconscious projection, combined with respiratory biofeedback, achieving the visual release of emotions

5.3 Comprehensive Discussion

Research indicates that VR intervention has significant short-term benefits for alleviating acute anxiety, but long-term behavioral changes require combination with Cognitive Behavioral Therapy for consolidation. Additionally, attention must be paid to the impact of "Cybersickness," and a "return mechanism" should be introduced in the design to prevent users from developing "Digital Escapism," ensuring that psychological energy can be effectively migrated back to real life.

6 Conclusion and Outlook

This research constructs an immersive healing space model based on "Embodied Narrative + Serious Games," achieving a paradigm shift from "passive sensory arousal" to "active cognitive restructuring." Through modular strategies, the system can precisely respond to different psychological needs at a low cost. Despite facing challenges regarding cybersickness and ethics, with the development of AIGC technology, the future holds the potential for personalized healing script generation based on biofeedback, building a "Virtual-Real Symbiotic" full-cycle mental health service system.

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