

Virtual Reality and Emotional Responses: A Comprehensive Literature Review on Theories, Frameworks, and Research Gaps

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Abstract. This extensive literature review examines virtual reality (VR) and emotional responses, including theories, paradigms, and research gaps. Foundational to VR is its ability to evoke profound emotional involvement through heightened presence. The study synthesizes presence theory, appraisal theory, and transportation theory to explain how they affect virtual emotional experiences. It also examines affective computing and multisensory integration frameworks for emotional design for VR and their importance in creating emotionally engaging VR experiences. Furthermore, the study highlights key research gaps and issues in the field. These include individual variances in emotional responses, the undiscovered long-term effects of repeated VR exposure, and ethical issues surrounding emotion manipulation and user permission. To fill these gaps, computer science, psychology, and allied sciences should work together to comprehend the complex relationship between VR and human emotions. The ethical, theoretical, and practical aspects of VR's emotional landscape are explored in this synthesis to guide future research.

Keyword: *virtual reality, emotional responses, theories, frameworks, research gaps*

1 Introduction

In recent times, there has been a surge of interest in VR technology, an immersive tool that enables users to delve into lifelike virtual environments [1][2]. With applications spanning healthcare, education, and entertainment, VR is at the forefront of technological innovation. As we navigate the realms of this advanced technology, it becomes paramount to comprehend

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and acknowledge the role of emotions, a fundamental aspect of human existence [3][4]. This literature review delves into the intricate connection between VR and emotional responses, providing a comprehensive exploration of theories, conceptual frameworks, and existing research gaps.

The dynamic landscape of VR technology has rapidly evolved, captivating diverse sectors such as gaming, tourism, education, and healthcare. Esteemed researchers across various disciplines affirm the potential of VR to augment user experiences and elicit emotional responses [3]. The growing body of research dedicated to exploring the impact of VR on emotional responses attests to the significance of this intersection [5]. This literature review serves as a thorough investigation into the concepts, frameworks, and areas where understanding remains limited in the domain of VR and emotional reactions. Emotions, being influential forces in our daily lives, play a pivotal role in cognition, behavior, and overall well-being [3].

The justification for this literature study lies in its objective to provide a comprehensive analysis and integration of existing research on VR and its implications for emotional reactions. By scrutinizing theories and frameworks, researchers can attain a deeper understanding of the underlying mechanisms influencing emotional responses in VR. The identification of unexplored areas serves to guide future research and facilitate the development of more effective methodologies for measuring and understanding emotional responses in virtual worlds.

The research objectives of this study are outlined as follows: 1. Scrutinize existing theories and frameworks regarding emotional responses in VR. 2. Analyze methodologies employed in previous studies to measure emotional reactions in VR. 3. Ascertain the factors within VR that impact emotional responses. 4. Identify specific areas of investigation required for studying emotional reactions in VR.

This research study uniquely centers on the correlation between VR and emotional reactions. [6]. Encompassing both scholarly and commercial literature, as well as studies from psychology, computer science, gaming, and healthcare industries, the review consolidates a broad spectrum of insights. It is imperative to note that this review does not present new empirical results; instead, it evaluates and synthesizes prior studies to offer a comprehensive overview of the current state of the art in the field of VR and emotional responses.

2 Methodology

To conduct a thorough examination of emotion recognition and media stimuli, it is essential to employ a systematic literature review approach that adheres to the PRISMA framework. This entails using a comprehensive search strategy to ensure the inclusion of relevant studies. The process entails conducting a comprehensive search across pertinent databases, including PubMed, Scopus, and Google Scholar, with suitable keywords pertaining to "virtual reality," "emotional responses," "theories," "frameworks," and "research gaps." To ensure the inclusion of current and pertinent studies, it is advisable to restrict the search to a specified timeframe, commonly the preceding five years. Furthermore, it is important to conduct a comprehensive examination of the reference lists of the recognized publications in order to ensure thoroughness. The review ought to adhere to the PRISMA framework, which encompasses the components of the search strategy, inclusion and exclusion criteria, data extraction, and assessment of study quality.

In order to guarantee the pertinence and dependability of the systematic literature review, it is imperative to set explicit search boundaries and inclusion criteria. This review centers on scholarly articles published in English-language peer-reviewed journals from 2019 to 2024. It primarily examines the topic of emotion identification in relation to media stimuli, with a particular emphasis on the most recent advancements and trends in this area of research. To improve the validity and reliability of the study, a systematic methodology and rigorous data analysis techniques are implemented. Exclusion criteria encompass studies that lack alignment with the research topic, studies not conducted in the English language, and studies that have not undergone the peer-review process for publication. The review seeks to enhance its utility in informing existing knowledge and future research paths by imposing stringent constraints and criteria, resulting in robust and relevant findings.

Figure 1 presents a flowchart that illustrates the systematic procedure of data identification and screening in the study. The preliminary search resulted in the retrieval of 190 entries from the database and its corresponding registry. After eliminating duplicate records (77) and records flagged as ineligible by automation technologies (65), the total number of screened records was reduced to 48. During the screening step, a total of 12 records were eliminated from the analysis due to not meeting the established criteria. As a result, a total of 36 records were successfully retrieved, while 5 records were not retrieved. Out of the initial pool of 31 records, a thorough evaluation was conducted to determine their eligibility. As a consequence, 4 studies were deemed irrelevant, 2 studies were excluded due to their publication dates, and 3 research were eliminated due to insufficient data. In conclusion, this review incorporated a total of 22 novel papers, maintaining an equivalent number of newly introduced research endeavors. The flowchart depicted in Figure 1 illustrates the methodical and clear procedure employed in the study for the identification and screening of data, in accordance with the PRISMA standards.

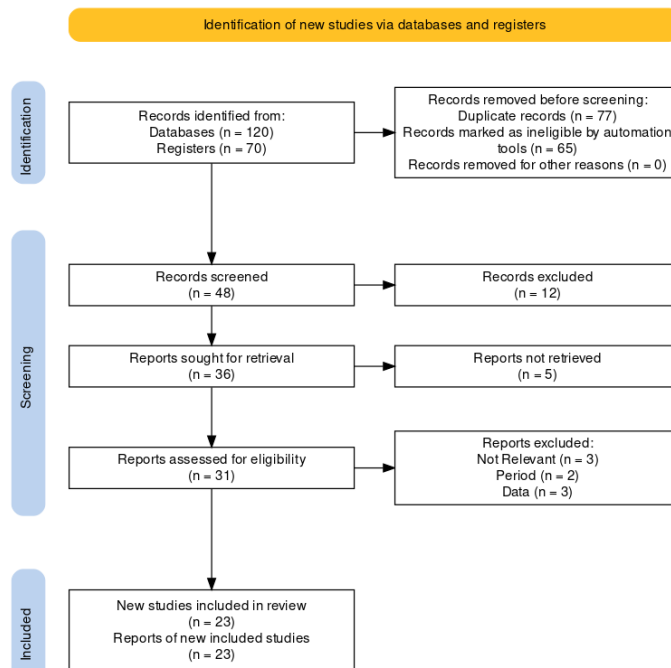


Figure 1. Flowchart of the study [7]

2.1 Theories of Emotion in VR

The emotional responses observed within the context of VR are subject to the effect of several theoretical frameworks, namely Appraisal Theory, Extended Mind Theory, Socioemotional Selectivity Theory, and Transportation Theory [8], [9]. According to appraisal theory, emotions are believed to originate from an individual's evaluation of a given circumstance, taking into account many criteria such as its importance, alignment with personal goals, and perceived ability to effectively manage it. The Extended Mind Theory posits that the cognitive and emotional experiences of individuals can transcend the confines of their physical bodies by incorporating virtual worlds. According to the Socioemotional Selectivity Theory, individuals tend to prioritize their emotional goals by considering their relative emotional significance.

The use of Transportation Theory, with a specific emphasis on immersive story experiences, has been found to significantly augment emotional engagement within the context of VR. Empirical evidence supports the importance of Appraisal Theory and Extended Mind Theory, as proven by research linking users' perceptions to emotional responses. The Socioemotional Selectivity Theory provides insights into the enduring effects of emotional experiences, whereas the Transportation Theory emphasizes the emotional involvement facilitated by narratives. Nevertheless, the existence of conflicting information, such as the impact of individual characteristics on emotional reactions, underscores the necessity for the utilization of standardized assessment instruments.

The emotional responses experienced in VR are intricately connected to cognitive evaluation processes. Specifically, individuals' assessments of virtual surroundings have a significant impact on the intensity of fear and anxiety, as well as the level of joy and excitement they experience. The influence of personal traits and biases on the impact of VR on emotional responses should also be considered. Additional investigation is required in order to comprehensively comprehend the underlying systems that propel emotional responses in VR and establish dependable methods for evaluating these reactions.

These ideas are backed by significant and diverse empirical evidence. Based on extensive studies [6], Emotional reactions in VR are closely linked to the assessment processes. Research has demonstrated that users' perceptions of virtual surroundings as menacing or challenging can heighten their fear and anxiety levels, whereas perceiving virtual settings as pleasurable or thrilling can amplify their feelings of joy and excitement. The Extended Mind Theory, which posits that individuals perceive virtual surroundings as an extension of their own cognitive processes, has garnered empirical backing in the study. Participants in a study conducted by Sánchez-Vives et al. exhibited comparable emotional reactions when exposed to a virtual setting as they would in an actual real-life situation [10]. Participants reported feelings of elation and enthusiasm when engaging in virtual activities, as well as apprehension and unease when confronted with virtual dangers.

Table 1 provides a detailed summary of the important theories that have influenced our knowledge of emotional responses in the context of VR. The Appraisal Theory provides insight into the process by which emotions arise as a result of evaluating VR scenarios. This theory enhances our understanding of emotions such as fear, worry, and delight. It is worth noting that the presence of individual variances highlights the necessity for the development of more precise measurement instruments. The Extended Mind Theory broadens our understanding by highlighting the incorporation of virtual experiences into cognitive processes, facilitating the connection of emotional reactions across virtual and real-world

environments. The Socioemotional Selectivity Theory emphasizes the temporal aspects of emotional objectives in VR, providing valuable insights into the enduring psychological and emotional effects that warrant additional investigation. Transportation Theory employs a narrative-focused perspective, emphasizing the affective consequences of experiencing a sense of "transportation" within a VR narrative. The table presented in this study highlights the complex relationship between human characteristics, immersive experiences, and temporal factors in influencing emotional responses in VR. This table serves as a fundamental reference for future research endeavors in this field.

Table 1. Theories of Emotion in VR

Theory	Key Concepts	Application in VR	Empirical Support	Contradictory Evidence	Research Gaps
Appraisal Theory	Emotions result from evaluation of a situation, considering relevance, goal congruence, and coping capacity	Pertinent to understanding emotional responses in VR, influencing feelings of dread, anxiety, joy, or excitement	Strong correlation between evaluation processes and emotional responses [5]	Individual characteristics, such as personality traits and prior experiences, can affect emotional reactions	Need for standardized measurement tools and assessment methodologies
Extended Mind Theory	Minds integrate virtual worlds into cognitive and emotional experiences, extending beyond physical bodies	Explains complete immersion in virtual worlds, treating them as extensions of the mind	Participants express similar emotional responses in virtual and real-world circumstances (Sánchez-Vives et al.) [10]	Individual characteristics can affect how VR impacts emotional reactions	Exploration of factors like presence, immersion, and involvement in emotional responses
Socioemotional Selectivity Theory	Emotional goals prioritize based on emotional significance, may change with age	Influences emotional priorities and aspirations	Supports the prioritization of emotional goals (as people age)	Research gaps in understanding long-term impacts of VR on mental and emotional health	Standardized measurement tools and methodologies needed
Transportation Theory	Focuses on the immersive narrative experience in VR, feeling "transported" into a story	Enhances emotional engagement when users feel immersed in a virtual narrative	Narratives leading to a sense of transportation evoke profound emotional responses	Individual differences in transportation experiences may impact emotional responses in VR	Further exploration of transportation theory in diverse VR scenarios and user populations

2.2 Frameworks and Concepts in VR

Several theories and concepts have been explored on the correlation between VR and emotional reactions. The concept of "positive technologies" is a theory that argues that VR has the capacity to enhance users' emotions, experiences, and overall state of well-being. [11]. This paradigm emphasizes the utilization of VR to create secure and regulated settings that can evoke positive emotions and enhance users' emotional well-being. The "presence" framework has been subject to investigation. The presence framework emphasizes the feeling of truly existing in the virtual environment and perceiving it as an authentic experience [12].

Consumers' emotional responses in VR can be significantly influenced by the level of presence they experience, as per this idea. [6]. The concept of "immersion" has been widely debated in relation to VR and emotions. The term "immersion" refers to the degree to which consumers are fully engaged and absorbed in the virtual environment [13].

The relationship between the media stimuli presented in the virtual environment and the emotional reactions of users in regards to VR and emotions is intricate. The specific sensory stimuli experienced in the virtual environment greatly influence the triggering of emotional responses in VR [14]. These signals mirror real-life scenarios and conditions to elicit similar emotional responses. A crowded, noisy city street in a virtual world may make users feel uneasy or frightened. Both virtual environment stimuli and user qualities and distinctions generate these emotional responses. Personalities, historical experiences, and cultural backgrounds affect how people react to a virtual world, according to studies. VR presence also affects users' emotions. People who feel present and view the virtual environment as real are more likely to have significant emotional reactions than those who don't. VR also links presence to emotions. Other feelings, like fear and panic, may only develop when the virtual environment feels real [15][16].

The correlation between media stimuli, immersion, and emotional responses is comprehensively established due to prior research on VR and affective experiences. Research indicates that individuals exhibit higher levels of engagement and immersion in VR compared to traditional media platforms [17]. This heightened sensation of presence and immersion may lead to more authentic and profound emotional encounters. Studies indicate that the emotional responses of individuals can be significantly influenced by the specific stimuli and context provided in the virtual environment [5]. An empirical investigation conducted by Suh and Prophet (year) revealed that consumers' responses to virtual environments that replicated social interactions encompassed contentment, delight, and even empathy. A separate investigation analyzed the impact of VR on levels of anxiety and found that certain virtual surroundings can elicit feelings of relaxation or concern, contingent upon the characteristics of the virtual setting and the individual's specific circumstances. Recent research indicates that individual variances, such as personality traits and life experiences, can influence emotional reactions in VR. Extraverted individuals may exhibit more pronounced emotional responses in VR compared to introverted individuals. Moreover, individuals' emotional reactions in VR may be shaped by their cultural backgrounds and unique personal encounters.

Table 2 analyzes VR emotional response frameworks and concepts in detail. pleasant Technologies, which designs secure and regulated VR environments to stimulate pleasant sensations and improve well-being, has empirical backing by boosting users' emotions. However, consistent testing tools and assessment procedures are needed to better examine

VR's long-term effects on mental and emotional health. Presence and Immersion shape VR users' emotions. The feeling of being in the virtual environment as a real experience closely correlates with emotional responses. Personality and background differences in responses suggest researching elements that affect presence and its long-term impacts. Immersion, the degree to which users are immersed in the virtual world, also suggests that deeper emotional experiences result. Understanding how virtual stimuli affect emotional responses involves a sophisticated assessment of context and stimulus effects. Media Stimuli Interaction emphasizes the intricate relationship between virtual media stimuli and users' emotional responses, highlighting that perceptual cues strongly influence VR emotions. Individual qualities and cultural variables affect emotional responses, requiring investigation to comprehend these differences. Presence and immersion are linked, with VR users' perceptions of presence causing higher emotional reactions. However, studying the link between media stimuli, immersion, and emotional responses is a promising research subject.

Table 2. Frameworks and Concepts in VR

Framework/ Concept	Key Concepts	Application in VR	Empirical Support	Contradictory Evidence	Research Gaps
Positive Technologies	Focus on designing secure, regulated VR environments for positive feelings and improved well-being	Arouses favorable feelings and elevates users' emotional states	Improved well-being in VR environments [5]	Need for standardized measurement tools and assessment methodologies	Further exploration of the long-term impacts on mental and emotional health
Presence	Focus on the sense of being in the virtual environment as a genuine experience	Degree of presence strongly impacts users' emotional reactions	Users' emotional reactions impacted by the degree of presence [6]	Individual variations in responses depending on personalities and backgrounds	Exploration of factors influencing the degree of presence and its long-term effects
Immersion	Describes how thoroughly absorbed and involved users feel in the virtual environment	Increased immersion leads to more genuine and deep emotional experiences	Users engage more in VR than traditional media, resulting in deep emotional experiences [17]	Impact of specific stimuli in the virtual environment on emotional responses	Understanding the context and stimuli effects on emotional responses in VR
Media Stimuli Interaction	Complex interaction between media stimuli in the virtual environment and users' emotional responses	Perceptual signals impact emotional reactions in VR	Virtual environments can trigger emotions similar to real-world experiences [14]	Users' unique traits and distinctions influence emotional responses	Exploration of individual variations, personality traits, and cultural influences
Presence and Immersion	Connection between users' feelings of	Presence directly related to	Users with a strong feeling of presence	Other emotions, like worry and terror, develop	Examination of the relationship

	presence, immersion, and emotional responses	stronger emotional reactions in VR	are more likely to experience stronger emotional reactions [15]	when there is a sensation of presence	between media stimuli, immersion, and emotional responses in VR
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2.3 Research gaps and challenges

Before achieving a complete understanding of VR and its impact on emotional reactions, there remain numerous unresolved inquiries. First, it is necessary to develop more comprehensive theoretical frameworks in order to comprehend the underlying mechanisms that influence emotional responses in VR. Second, there is a lack of established methodologies for measuring emotional responses in VR. This hinders the capacity to compare results between different studies and restricts the applicability of research findings. Additionally, further investigation is required to examine the enduring consequences of VR exposure on emotional welfare and psychological well-being. Furthermore, it is imperative to include a wider range of participants in VR research in order to ensure diversity and representation. Currently, a significant portion of the available literature mostly examines limited and uniform populations, such as college students.

Ultimately, VR has the capacity to evoke a diverse array of emotional reactions. These reactions are contingent upon the particular stimuli and context inside the virtual environment, as well as individual disparities and personal backgrounds. Nevertheless, there are still numerous deficiencies in the present comprehension of VR and its impact on emotional reactions. These areas of insufficient research and difficulties underscore the necessity for additional examination and inquiry in this domain. To summarize, although VR has demonstrated potential in evoking emotional reactions, there are still numerous uncertainties that persist. To be more precise, there are multiple areas of inquiry that lack information and provide difficulties that must be resolved.

The studies examined in this study demonstrate that exposure to VR has a notable influence on physiological factors and emotional states [18]. One key finding is that embodiment in VR can influence emotions [19]. Another important finding is that avatar personalization and gender can also influence emotional responses in VR. Nevertheless, it is crucial to acknowledge that the quantification and prediction of emotional reactions in VR remain relatively uncharted domains of investigation. Specifically, there is a dearth of study on the objective measurement of emotional responses in VR and their subsequent projection within the VR experience [20]. Furthermore, there is a necessity for more thorough examinations regarding the impact of avatar customization and gender on emotional reactions in VR. [19]. Moreover, our comprehension of the enduring consequences of VR on emotional well-being and mental health is restricted. Furthermore, the absence of established procedures for examining emotional reactions in VR poses challenges in terms of comparing and extrapolating results across various studies. In summary, this literature review emphasizes the significance of investigating VR and its impact on emotional reactions. It demonstrates that VR has the capacity to evoke intense emotional reactions and can be affected by aspects such as embodiment, customization of avatars, and gender. Moreover, it emphasizes the necessity for additional investigation to provide unbiased metrics and forecasting methods for emotional reactions in VR.

Table 3 lists important VR and emotional response research gaps and obstacles. Lack of complete theoretical frameworks hinders study interpretation, underlining the urgent need to establish such frameworks to better understand VR emotional responses. VR lacks clear methods for measuring emotional reactions, making it difficult to compare data between studies. Standardized measurement techniques and methods are needed to advance the field. Our grasp of the long-term consequences of VR exposure on emotional well-being is lacking, requiring a deliberate effort to study and understand them. More diversified and representative samples in VR research are needed to generalize research findings beyond limited and homogenous groups. The lack of research on cultural and contextual factors affecting VR emotional reactions and individual characteristics like personality traits and prior experiences highlight possibilities for further study.

Table 3. Research Gaps and Challenges in VR and Emotional Responses

Research Gap / Challenge	Key Issues	Implications	Current State of Knowledge	Proposed Areas for Future Research
Theoretical Frameworks	Lack of comprehensive theoretical frameworks to explain mechanisms behind emotional responses in VR	Difficulty in understanding and interpreting study findings	Limited theoretical frameworks available [3]	Development of comprehensive theoretical frameworks
Measurement Techniques	Absence of defined techniques for gauging emotional reactions in VR	Hindrance to comparing findings across studies	Lack of standardized methodologies [20]	Exploration of standardized measurement tools and methodologies
Long-Term Effects	Limited research on the long-term effects of VR exposure on emotional well-being	Lack of understanding of prolonged impacts	Scarcity of studies exploring long-term effects [18]	Investigation of long-term effects on emotional well-being
Sample Diversity	Need for more diverse and representative samples in VR research	Limitations in generalizability of research findings	Emphasis on small and homogenous populations [19]	Inclusion of diverse backgrounds and demographics in studies
Cultural and Contextual Factors	Lack of exploration of cultural and contextual factors influencing emotional responses in VR	Limited understanding of cultural influences	Emerging focus on individual differences [20]	Examination of cultural and contextual factors in emotional responses
Individual Differences	Limited exploration of individual differences, such as personality	Incomplete understanding of factors shaping emotional responses	Growing recognition of individual differences [19]	Investigation into the role of personality traits and experiences

	traits and prior experiences			
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2.4 Implications and Applications

The research findings on VR and emotional responses have significant significance for diverse sectors and industries. Comprehending emotional reactions in VR inside the realm of psychology can aid in the advancement of therapeutic treatments for individuals suffering from mental health illnesses [21]. VR can serve as a technique for exposure therapy, enabling patients to safely confront and regulate their fears and anxieties within a controlled virtual environment.

Moreover, VR can be employed in the realm of education to generate immersive learning encounters that elicit emotional involvement and augment cognitive functions. Comprehending emotional reactions in VR can assist marketers in developing advertising campaigns that are more influential and convincing in the field of marketing.

Moreover, within the healthcare sector, VR holds the capacity to transform pain management by offering immersive encounters that divert patients' attention away from their physical distress. In summary, the literature review emphasizes the significance of examining emotional reactions in VR and suggests many theories, paradigms, and areas of research that need further exploration in this field. [6]. Subsequent investigations should strive to address these deficiencies and offer a more all-encompassing comprehension of the correlation between VR and emotional reactions.

To summarize, the literature study illustrates that VR has the capacity to profoundly influence emotional reactions and overall well-being. However, it also emphasizes the necessity for meticulous deliberation of ethical considerations and conscientious utilization of VR technology in emotion research.

3 Conclusion

VR has emerged as a powerful tool for studying emotional responses due to its immersive capabilities [3]. Nevertheless, there are still deficiencies in our comprehension and investigation of the subject matter. These gaps encompass the requirement for more extensive theories and frameworks to elucidate the correlation between VR and emotional reactions. Additional investigation is required to examine the influence of various VR encounters on emotional reactions, as well as the enduring consequences of VR on emotional welfare. Furthermore, further investigation is required to gain a deeper comprehension of the variances in emotional reactions to VR encounters, as well as the capacity of VR to augment empathy and emotional intelligence in humans.

The present literature review has thoroughly investigated the theories, paradigms, and areas of research that pertain to VR and its impact on emotional reactions. VR has become a potent tool for investigating emotional reactions because of its ability to fully engage users. Studies have demonstrated that VR has the ability to evoke heightened emotional reactions in individuals when compared to conventional PC games. [21]. Moreover, VR has been employed across several sectors including education, marketing, healthcare, and tourism to augment emotional encounters and involvement [22].

Nevertheless, there are still deficiencies in our comprehension and investigation of the subject matter. A notable deficiency lies in the absence of comprehensive theories and frameworks that elucidate the correlation between VR and emotional reactions. Although prior research has acknowledged a greater intensity of emotional reaction in VR as opposed to desktop games, there is a requirement for more all-encompassing theories and frameworks to gain a deeper understanding of the underlying reasons for this discrepancy and how it may be utilized to augment emotional experiences in VR [21]. Furthermore, there is a need for more research on the individual differences in emotional responses to VR experiences.

This entails examining variables such as personality traits, cognitive capacities, and previous encounters that could impact an individual's emotional reaction to VR. Furthermore, it is necessary to investigate the possible therapeutic advantages of VR in evoking emotional reactions. Although VR exposure treatment has demonstrated efficacy in treating specific illnesses including phobias and post-traumatic stress disorder, further investigation is required to comprehend the underlying mechanisms and precise applications of VR in therapeutic contexts [23]. Additionally, further investigation is required to explore the enduring impacts of VR on emotional well-being. Gaining insight into the correlation between VR and emotional reactions is essential for maximizing the complete capabilities of this technology [3]. VR has shown great promise in eliciting intense emotional responses, surpassing those elicited by traditional desktop games [21]. However, further research is needed to develop comprehensive theories and frameworks that explain this relationship and to explore the individual differences in emotional responses to VR.

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