

A Study on Constructing Immersive Cross-Sensory Experiences to Influence Temporal Perception

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Abstract

In the current era, marked by an overwhelming influx of information, the concept of time undergoes a personal and collective transformation shaped by individual experiences and societal interactions. The endeavor to quantify and comprehend time perception presents a complex challenge owing to its inherently subjective essence. This research delves into the effects of virtual reality (VR) on the perception of time within the sphere of art. By employing immersive VR scenarios that stimulate multiple senses simultaneously, this study investigates the potential of VR technology to extend beyond traditional temporal limits in artistic expressions. The manipulation of time in VR is a fascinating process, achieved through innovative elements such as the “corridor,” “light and shadow,” and “curtain.” In a confined physical space measuring 4m x 4m, participants embark on a virtual journey through a “corridor” that symbolizes a slowing of time and the concept of infinity. This journey, visually represented as an endless circular path, encapsulates the dual essence of sluggishness and perpetuity. The dynamic interplay between light and shadow represents transient temporal states, and the tactile interaction with a physical “curtain” enhances the experience of temporal flow. The findings indicate that VR technology significantly influences individual perceptions of time, as reflected in the varied subjective experiences reported by participants. This investigation enhances our understanding of temporal aesthetics in art and immersive environments, underscoring the pivotal role of VR in molding our perception of time. Through the seamless integration of sensory elements, the study elucidates the blurred boundaries between actuality and appearance, offering profound insights into the constructive collaboration between art, technology, and the cognition of time in contemporary settings.

Keywords

Virtual Reality, Immersive Experience, Time Perception, Cross-Sensory Experiences, Illusion

Introduction

In an era of information explosion, the need to redefine time's value and significance has become increasingly apparent. As social and individual temporal dimensions

converge, understanding time and its fundamental nature becomes more obscure.

This study explores the perception of time within artistic contexts through Virtual Reality (VR) technologies, aiming to uncover the discrepancies between individual and collective perceptions of time [1].

By integrating a combination of sensory experiences, our goal is to confound the understanding of temporal progression, thereby creating an environment rooted in the knowledge of time. This cross-sensory exploration examines the divergences in time perception between the individual and society, further investigating how virtual reality technologies can manipulate participants' time experiences to deepen our collective and individual understanding of time perception.

Literature Review

Social and Individual Temporality

During the early stages of human cultures, the understanding of time was predominantly influenced by observations of natural occurrences, including the cyclic patterns of day and night, the rhythmic movements of tides, and seasonal fluctuations. These objects functioned as the mechanisms by which individuals viewed and documented the progression of time. As societal advancements have unfolded throughout history, humanity has persistently pursued increasingly accurate methods of measuring time. Throughout history, the progression of time measurement devices has encompassed the evolution of sundials and hourglasses and, later, during the industrial era, the introduction of clocks and watches. The concept of time has undergone continuous subdivision, evolving from larger units, such as years and days, to smaller units, like hours, minutes, and seconds. This progression has led to the establishment of the standardized metric time system that is widely acknowledged today.

The notion of time encompasses many interpretations across different domains, beyond the limitations of a conventional chronological framework and assuming a subjective nature that differs across individuals. The temporal awareness of individuals converges, collectively influencing the perceived subjective reality. The idea of “social time” emerges from many social groups' rhythmic activities and customs [2]. It encompasses ethical values related to time, including

timeliness, tardiness definitions, and efficiency requirements, among other factors. Nevertheless, it is essential to acknowledge that these norms are socially constructed and sometimes fail to recognize the intrinsic variations across individuals. When the discourse shifts towards the individual level, it becomes apparent that each person's experience of time is characterized by a distinct and invaluable "inner time consciousness." [3].

In the era of technological advancements, society seems to have acquired additional time for human pursuits. However, this time continues to be divided into distinct periods as efforts are made to accommodate a growing range of activities. Consequently, individuals are compelled to incessantly pursue time, resulting in a discordance between their internal perception of time and the prevailing cultural perception.

Time Perception

Humans' subjective awareness of time is shaped by the integration and interplay of several sensory modalities, such as auditory, visual, gustatory, olfactory, and tactile experiences. The modification or stimulation of subjective consciousness can lead to temporal illusions, such as "time expansion," "chronostasis," [4] and "time-shrinking," which affect people's perception of time in events. Several factors, including human memory, attention, emotions, and perceptions of spatiotemporal connections, influence the temporal experience.

Further expanding on the concept of temporal illusions within virtual environments, Lozano's doctoral research, *It is About Time: The Illusions of Time Perception and Travel in Immersive Virtual Reality*, delves into the specific illusions of time that VR can create. By examining immersive virtual experiences, Lozano illustrates how VR alters and can amplify the experience of time travel and perception, enriching our understanding of virtual manipulation of time [5]. Building upon the insights provided by Lozano, Mullen, and Davidenko's study, *Time Compression in Virtual Reality* introduces a nuanced perspective on how VR experiences can compress perceived time. Their empirical evidence demonstrates how immersive experiences in VR can significantly alter the perceived duration of events, suggesting a profound capacity of VR to condense our sense of time [6].

Recent research by Read, Sanchez, and De Amicis delves deeper into this subject, exploring the interplay between engagement and time perception within virtual reality environments. Their findings highlight the intricate ways VR technology can alter our understanding and experience of time [7], providing a crucial foundation for the present study's exploration of time perception in VR artistic contexts.

Immersive Virtual Reality Artworks with Cross-Sensory Experiences

This chapter examines various literary and artistic works to investigate the amplification of sensory sensations inside virtual reality.

- Ya-Lun Tao's "Wandering Ghosts" [8]: This artwork integrates virtual reality technology with mobile installations to provide a unique artistic experience. The participants position themselves on a mobile mechanical platform, enabling them to track the virtual visual content inside the artwork. Within this particular series, spectators assume the role of ethereal entities traversing the confines of the artwork, skillfully maneuvering through a diverse array of meticulously produced settings meticulously curated by the artist. The physical installation controls the spectator's movement, creating an immersive experience through sensory movement and visual input.



Figure 1. Wandering Ghosts

- NAXS Corp.'s "Render Ghost" [9]: The theatrical play known as "Render Ghost" integrates virtual reality technology with a tangible soundscape and lighting setup, resulting in an immersive experience. Experiencers interact with the artwork through a virtual visual presentation on a circular stairway, enabling them to generate an unending circular trajectory inside the given environment. As individuals engage in locomotion, the ground under them is adorned with polystyrene particles, eliciting diverse tactile perceptions upon contact with the feet and producing corresponding auditory stimuli. Upon removing the virtual reality equipment, the artwork elicits a perception of unreality inside the tangible environment. The experiencer's perception of reality and virtuality becomes indistinct due to the interplay between the virtual and the real and the interaction between visual and tactile experiences.



Figure 2. Render Ghost

Both artworks incorporate a range of sensory experiences, leveraging virtual reality's immersive properties to surround the observer within the visual domain. Furthermore, the integration of virtual reality and the actual environment

is employed uniquely to enhance the total experiential value of the artworks.

Research Methods

This chapter utilizes virtual reality technology to investigate its influence on the temporal perception of experiences. This analysis aims to explore the correlation between the artwork and its experiences and the impact of various temporal states shown within the artwork. The objective is to shed light on the ambiguous temporal awareness and disconnect between individual and collective time that the artwork evokes.

This study integrates virtual reality technology with physical space and installations to construct an immersive setting that effectively restricts individuals' ability to disengage from the experience. The environment in question incorporates a range of sensory stimuli, encompassing visual, tactile, and aural components. By utilizing the distinctive features of VR headsets, this study effectively immerses participants in a simulated environment, leading to sensory manipulation that triggers distortions in the sense of time. The objective is to encourage deep reflection on an individual's connection with the concept of external time.

This study integrates virtual reality technology with physical space and installations to construct an immersive setting that effectively restricts individuals' ability to disengage from the experience. For this purpose, we recruited twenty participants aged between 19 and 55 with varying degrees of experience with virtual reality, aiming to cover a wide range of time perception experiences.

Design of Content Elements

The artwork contains three discrete visual and sensory components: The "Tower," "Light and Shadow," and "Curtains," each symbolizing separate chronological periods.

- The emblem of the "Tower" represents the concepts of sluggishness and perpetuity. When those who are through an experience find themselves situated within the architectural structure known as "The Tower," it becomes evident that the corridor within this edifice exhibits a visual characteristic wherein it continuously grows upward and repeats itself. As individuals progress within the tower, they encounter a predicament they cannot depart from, resulting in their entrapment within our established cyclic pattern.



Figure 3. Tower (provided in this study)

- The fluctuating interplay between light and shadow symbolizes the continuously changing temporal condition within the given spatial context. The transition between morning and evening occurs cyclically, wherein the permanent presence of daylight serves as the overarching context for the interplay of light and shadow.



Figure 4. Light and shadow effects (provided in this study)

- The "Curtains," however, function as an intermediary between the virtual and physical realms, mirroring the inherent transience of light. These devices facilitate individuals' engagement in the current moment using tactile interaction.



Figure 5. Curtains and tactile treatments (provided in this study)

Through direct physical contact with the curtains, individuals can assimilate the spatial relationship between the virtual and actual curtains, therefore receiving haptic input that aids in realigning their cognitive focus towards the present moment.

Within the framework of this creative composition, there is a pre-established duration of experience time; nonetheless, it lacks clear chronological instructions. The accomplishment of this phenomenon is facilitated by the complex integration of a chronological framework comprised of three unique components, covertly shaping the observer's temporal perception. The dynamic between the individual engaging with the artwork involves investigation, wandering, and contemplation. The acts of each participant inside the context of the artwork take place within the temporal framework of the piece, eventually leading to a distinct sensory experience for each experience.

By strategically guiding the experiencer's attention towards the imposing structure they have crossed along their journey, the artwork establishes a profound link between the experiencer's present location and the historical context of the past. The statement above elicits a deep reflection in the one seeing it, fostering a refined depiction of time that skillfully contrasts the concepts of "past" and "present."



Figure 6. Tower (provided in this study)

Artwork Development

- The development of the artwork utilizes a VR wearable headset: Oculus Quest 2.
- The VR headset is wirelessly connected to a computer via Wi-Fi 5GHz, facilitating unrestricted movement within the virtual setting.
- Achieving a one-to-one scale between the virtual reality space and the physical spatial environment allows for a seamless integration of dimensions. In addition, the curtains offer tactile sensations that enhance the experiential immersion in the artwork.
- Within a 4x4 square meter flat space, a circular structure in the virtual space is employed to create an infinite looping state, affording the experience the freedom to navigate within the confines of this limited physical area.

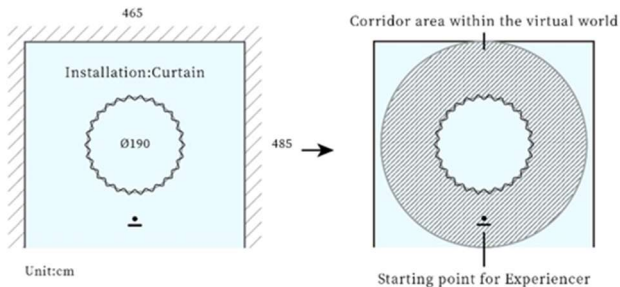


Figure 7. Circular structure in VR (provided in this study)

This study explores using a virtual tower in a virtual environment to simulate ascending or descending sensations while participants walk on a level surface. Initial experiments used collider-based techniques for vertical tower movement within virtual reality. The virtual plane features a circular arrangement of sector colliders with the central point as the origin. Tower movement aligns with the participant's movement vector within this circular setup. However, this method produced a discontinuous and uneven gait pattern, deviating from the desired perception of an inclined surface.

To address this issue, the approach was refined to regulate tower movement based on the subject's distance covered. The current method calculates the tower's central coordinates (x, z) as the circular origin, considering the subject's original and subsequent coordinates (x, z) during movement. An algorithm computes the angle between these vectors and the center point, determining tower ascent or descent. The

degree of subject movement relative to the center correlates directly with the tower's ascent or descent by a single unit. Counterclockwise motion causes autonomous tower descent, creating the illusion of upward ascent for the subject, while clockwise motion reverses the effect.

The Experimental Procedure

- The artwork's overall experiential duration is 10 minutes; the participants are not notified of this duration before viewing it.
- Participants are instructed to stand in the VR space's designated position.
- An operator assists participants in donning the VR headset and entering the virtual reality environment.
- Once the artwork commences, participants can begin exploring and meandering at their discretion.
- The fusion of virtual imagery with the physical setting creates tactile sensations that blur the boundaries between reality and the virtual realm.
- Additionally, through the arrangement of the physical space, participants can roam limitlessly.
- When the allotted time elapses, the experiential session concludes.

The final physical presentation of the artwork is depicted in the diagram below.



Figure 8. Physical presentation of the artwork (provided in this study)

Conclusion And Discussion

In the final phase of this study, the amalgamation of tangible space and virtual reality enables participants to encounter an unrestricted vertical expanse inside a limited physical setting. Regarding the experiential notion of time, the artwork predominantly employs three visual components, namely "the tower," "light and shadow," and "curtains," to expand distinct timeframes. Participants find themselves immersed in an experienced condition characterized by an ambiguous perception of time, wherein the interacting dynamics between individuals and the artwork impact their subjective experience of temporal progression.

The artwork facilitated the engagement of a heterogeneous cohort of individuals aged 19 to 55 years. Approximately half of the participants possessed prior VR expertise, while the remainder lacked such familiarity. Upon the experiment's conclusion, data was gathered from 38 individuals. Within the cohort of subjects, 42% exhibited a subjective sense of time that exceeded the objective passage of time. The most abbreviated instance of this phenomenon was recorded at a mere 3 minutes, representing a discrepancy of 7 minutes

compared to the verifiable duration. Contrarily, 31% of individuals experienced a slower passage of time, with the most extreme reported impression being 20 minutes, twice the measured duration.

These experiment outcomes affirm the fundamental goal of this study, which sought to illustrate how individuals' temporal perception may be shaped by their social surroundings via creative means. This research has effectively established a completely immersive setting through virtual reality technology while integrating tactile and kinesthetic experiences. Consequently, the study has successfully improved the circumstances surrounding the creation of a profoundly

immersive encounter. This research aims to provide a framework for future investigations on the perception of time across different thematic contexts.

Future studies could explore time perception under different thematic backgrounds, such as historical reenactments, educational simulations, or therapeutic environments, to understand how these factors influence individuals' time perception in virtual reality environments. Investigating the long-term effects of prolonged exposure to virtual reality environments on time perception and cognition could provide valuable insights for various real-world applications, including education, therapy, and entertainment.

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