Research on the Impact of Virtual Reality Technology on Human Visual Cognition (Postprint)

Authors: Xu Lide

Date: 2023-10-08T00:00:00+00:00

Abstract

Virtual reality technology has currently become an investment hotspot. With its immersive, interactive, and imaginative characteristics, it creates a virtual environment enabling real-time interaction for users. This technology will also be applied to various aspects of society, exerting influence on the social ecosystem. This paper primarily combines the characteristics of the human eye, Gestalt psychology theory, and visual cognition theory, focusing on the changing influences that virtual reality technology induces on the three stages of visual cognition: stimulus-input, cognition, and response-output. Employing case observation methodology and incorporating personal experience, it explores the reasons why virtual reality technology attracts humans, the process by which the human eye reconstructs visual experience, and the reactive influence of new visual experiences and cognition on human behavior.

Full Text

Preamble

Research on the Impact of Virtual Reality Technology on Human Visual Cognition

Abstract: Virtual reality technology has become a major investment hotspot, creating an immersive, interactive, and imaginative virtual environment that enables real-time interaction for users. This technology will be applied across all aspects of society, influencing the social ecosystem. This paper examines the impact of virtual reality technology on the three stages of visual cognition—stimulus-input, cognition, and response-output—by integrating the characteristics of the human eye, Gestalt psychology theory, and visual cognition theory. Using case observation methods combined with personal experience, it explores why virtual reality technology captivates humans, how the human eye

reconstructs visual experience, and how new visual experiences and cognition reciprocally influence human behavior.

Keywords: Virtual Reality Technology (VR); Visual Cognition; Gestalt Psychology

Author: Xu Lide, Graduate School of Journalism and Communication, China Youth University of Political Studies

---

1. Theoretical Foundations

1.1 Virtual Reality Technology

The concept of virtual technology first emerged in the United States in the 1950s, though it was not widely applied until the 1980s. Virtual reality technology refers to the use of modern high-tech centered on computer technology to generate a realistic, integrated virtual environment encompassing vision, hearing, and touch. Users interact naturally with objects in the virtual world through necessary equipment, generating feelings and experiences of being in a real environment. Virtual reality systems provide an advanced human-computer interface by offering intuitive and natural real-time sensory and interactive methods, maximizing user convenience, reducing user burden, and improving system efficiency. This efficiency is primarily determined by the system's degree of immersion and interactivity.

In 1993, American scientists proposed that virtual reality technology has three prominent characteristics: immersion—where users become active participants, immersed in the virtual world and participating in its activities, producing an environment perception even more real than reality; interactivity—where humans and the virtual world interact in natural ways, generating real-time perceptions identical to those in the real world; and imagination—where the virtual environment is imagined by humans, reflecting the designer's corresponding ideas and enabling the achievement of specific goals.

1.2 Human Eye Mechanism

When specifically elaborating on the physiological mechanisms of human eye visual cognition, several concepts require clarification: perception is the psychological process of obtaining meaning from stimuli through sensory organs; sensation is the direct process resulting from sensory organ activity, a kind of immediate emotional response. The human eye is the primary sensory organ for obtaining external information, and its basic process is as follows: external information enters the human field of vision, stimulates the retina, then the optic nerve transmits information to the visual cortex of the brain, which undergoes comprehensive processing, finally forming cognition. Visual cognition is both the physiological function of the human eye as a sensory organ and the

cooperative process with the brain, as well as the human understanding process of things from parts to whole. This process is the information processing procedure of the visual system and the process of human eye moving from sensation to perception.

Through long-term development, visual cognition has evolved from simple physiological-level cognition to a mature set of visual cognition theories. Visual cognition theory, centered on information processing theory, divides the visual cognition process into three stages: first, how visual information is input; second, how visual information is stored and in what form; and third, how stored information is sought, used, and even influences new rounds of visual information input.

2. The Impact of Virtual Technology on Visual Cognition

2.1 The Head-Mounted Display as an Artwork

The head-mounted display is a commonly used stereoscopic display in virtual reality systems. Relative to the human eye, the head-mounted display integrates multiple sensory channels including vision, touch, and hearing. The integration of virtual reality technology creates a virtual scene for the human eye, immersing both the eye and the person within it, bringing pleasure, imagination, and aesthetic beauty just as art presents.

Artworks exist as objects, and one of the primary issues is the question of space. How is an intentional space constructed and perceived? System simulation technology provides the possibility for this. The simulation system in virtual technology extracts key parameters of basic elements through understanding and knowledge of the real environment, establishing a simulation model corresponding to the real system that truly reflects the motion forms and spatial forms of the real world. In virtual space, objects present a certain proportion relative to real space, a spatial proportion that conforms to the human eye's viewing mechanisms and visual experience cognition in real space. The human eye can recognize the spatial proportion of images and determine the relationship between its own position and object space. Its real-time interactivity enables the display to automatically collect information from the real environment and generate virtual environments as the person moves, without causing a sense of dislocation from the real environment.

Gestalt psychology successor Arnheim stated: "If art could only copy natural objects or if artworks could not bring sensory pleasure, there would be no legitimate reason to reserve a lofty position for art in any known society." In other words, artworks only have value when they bring sensory pleasure and present what humans understand and confirm as real before their eyes. Human senses can only achieve correct understanding of the real environment when maintaining balance among all senses. The human eye is the primary means for humans to obtain external information, while the visual images provided by virtual technology are stimulation to a single sensory channel, which is unbal-

anced and cannot achieve true immersion. Therefore, the helmet simultaneously incorporates sensory characteristics such as hearing and touch to achieve balance of the user's own multi-sensory channels, thereby realizing balance among humans, the virtual environment, and the real environment.

2.2 The Beauty of "Immersion"

Visual cognition theory holds that the second stage of the visual cognition process is how visual information moves from sensation to perception. Beauty is human cognition of things, that is, perception. As an artwork, how does the head-mounted display bring aesthetic visual feasts to the human eye?

The Gestalt psychology school believes that human cognitive experience makes them tend to perceive things holistically—the whole is not equal to the sum of its parts, therefore the whole cannot be divided, and the whole is determined by its parts. Simultaneously, humans not only have the ability to grasp the whole but also have this natural tendency for "Gestalt" processing of things. The eye collects all visual stimuli, and the brain is responsible for organizing these sensations into continuous images, integrating various parts to achieve creative cognition.

In real environments, vision, hearing, and touch have clear distinctions, and as spatial distance increases, stimulation to human sensory organs gradually decreases. In virtual environments, hearing, touch, and other sensations become part of vision. Different aspects of our visual world are composed of thorough interdependence, with various senses interconnected and cooperating with visual images seen by the eye to form an immersive, beautiful virtual world in human cognition.

Meanwhile, Arnheim, an important successor of the Gestalt psychology school, combined viewing behavior with aesthetics, believing that the process of seeing is also the process of aesthetic psychology generation. He held that the interactivity of viewing means beauty is implied in the interactive process; viewing has creativity and is not the result of mechanical copying. In addition to the characteristic of immersion, virtual technology has interactive and imaginative features, which are important reasons why humans can generate immersion. Humans and machines achieve human-computer interaction—this is the process of humans viewing scenes in the virtual environment while simultaneously engaging in real-time interactive viewing with the virtual environment. This viewing process is integrated into the real environment, and the brain combines previous visual experience and cognition, allowing people to form an immersive beauty generated under the combined effect of virtual and real environments, that is, new visual cognition.

2.3 Visual Cognition Conflict

Human visual cognition is a dynamic, gradually constructed process. More visual sensations bring more visual cognition, and accumulated visual cognition

in turn influences human behavior through actions on the real environment, obtaining richer sensations. Sensation and perception influence each other through behavior. Supported by virtual technology, the human eye contacts two environments: the virtual environment and the real environment. The human eye continuously participates in interaction with the virtual environment, constantly experiencing and accumulating sensations in the virtual environment. These visual sensations gradually become new visual experience through brain analysis—a kind of visual cognition formed in the virtual environment. However, humans are living beings in real space. Humans form visual cognition in the real environment and apply it to the real environment, possessing the integrity of experience and behavior. When applying visual cognition formed in the virtual environment to the real environment, the balance of experience and behavior is broken, and the two no longer possess integrity. Applying cognition from one environment to another creates conflict in visual cognition and even produces incoordination, easily leading to "collapse" of the visual cognition system.

If the head-mounted display is viewed as a medium, the human eye obtains visual information through this medium, and this visual information forms human visual cognition. Media environment scholar Meyrowitz believed that changes in media inevitably lead to changes in the social environment, and changes in the social environment inevitably lead to changes in human behavior. Each specific medium requires corresponding adaptive behavior. In the context of virtual technology, humans form corresponding cognitive behaviors in two different media scenes—the virtual environment and the real environment. Scenes and behaviors have consistency, but when returning to the real media environment, humans must quickly adjust their behavior to adapt to the current scene; otherwise, behavioral anomie will result.

3. Conclusion

Based on the stage division of visual cognition theory, this paper analyzed the impact of virtual technology on the three stages of human eye visual cognition: the stimulus-input stage, the cognition stage, and the response-output stage. Virtual technology effectively handles spatial and balance issues through simulation technology, providing multi-sensory channels for the human eye and enabling people to obtain visual cognition formed in virtual environments. The integrity of human experience and behavior requires balance between environment and cognition. When people return from the virtual environment to the real environment and apply visual experience formed in the virtual environment to behavior in the real environment, it leads to the splitting of experience and behavior, resulting in cognitive conflict. Therefore, the physiological discomfort and cognitive conflict issues brought by virtual technology warrant further exploration.

References

[1] Hu Xiaoqiang. Virtual Reality Technology [M]. Beijing: Beijing University of Posts and Telecommunications Press, 2005: 2-3.

[2] Zhuang Keren. Introduction to Visual Communication [M]. Taipei: Wu-Nan Book Inc., 2010: 105.

[3] Li Yuan. The Development of Visual Cognition Theory and Its Application in Architectural Design [J]. Journal of Harbin Institute of Technology (Social Sciences Edition), 2011, 13(5).

[4] [US] Arnheim, Holland, Child, translated by Zhou Xian. The Psychological World of Art [M]. Beijing: China Renmin University Press, 2003: 105.

Note: Figure translations are in progress. See original paper for figures.