

Color Coding in 3D Game Scenes and Its Effect on Episodic Memory

Yuquan Liang

Faculty of Human-Environment Studies, Kyushu University, Fukuoka City, Fukuoka Prefecture, Japan

Abstract: This paper explores the impact of color coding in 3D game scenes on episodic memory. By reviewing relevant previous studies, a research gap is identified, and the study aims to investigate how different color coding strategies in 3D game environments affect players' episodic memory performance. Questionnaire surveys and interviews are employed as the main research methods to collect data from game players. The results show that specific color coding methods can significantly enhance players' episodic memory of game scenes, providing valuable insights for game design and memory research.

Keywords: 3D game scenes; color coding; episodic memory; effect

1. Introduction

In the rapidly developing field of 3D games, the creation of immersive game scenes is crucial for attracting players and enhancing their gaming experience. Color, as an important visual element in 3D game scenes, not only endows the game world with vividness and realism but also plays a potential role in affecting players' cognitive processes. Episodic memory, which refers to the memory of personal experiences, including the time, place, and relevant details of events, is an important part of human memory. Understanding how color coding in 3D game scenes impacts episodic memory can not only contribute to the improvement of game design but also deepen our understanding of the relationship between visual stimuli and memory[1].

2. Background and Previous Research

Over the past decade, numerous studies have explored the relationship between color and memory. For example, when transitioning to research in game scenes, studies have shown that color's role in memory extends to interactive environments. In a study by Brown et al. (2015), it was found that color can significantly enhance the recall of visual information[1]. They conducted an experiment where participants were shown a series of colored and grayscale images, and the results indicated that the recall rate of colored images was much higher than that of grayscale ones. This suggests that color has a positive impact on memory encoding and retrieval. Additionally, Li et al. (2020) explored color coding in virtual reality games and found that distinct color schemes improved players' spatial memory retention[2].

In the context of 3D game research, Zhang et al. (2018) investigated the influence of color schemes on players' emotional responses in 3D games[3]. Their study showed that different color combinations can evoke various emotions, which in turn may affect players' attention and memory during the gaming process.

Classic research by Baddeley (1992) proposed the working-memory model, which provides a theoretical basis for understanding how visual information, including color, is processed and stored in memory. This model emphasizes the role of the visuospatial sketchpad in handling visual and spatial information, suggesting that color coding in 3D game scenes may interact with this component of working memory to influence episodic memory[4].

3. Research Objectives and Questions

Although previous studies have laid a foundation for understanding the role of color in the gaming context, there is still a lack of research specifically focusing on how color coding in 3D game scenes affects episodic memory. Therefore, the main objective of this study is to fill this research gap. The specific research questions are as follows:

- (1) What are the common color coding strategies used in 3D game scenes?
- (2) How do different color coding strategies influence players' episodic memory of game scenes?
- (3) Are there any differences in the impact of color coding on episodic memory among players with different gaming experience levels?

4. Research Methods

4.1 Questionnaire Survey

To ensure the validity of data, only participants with at least 6 months of experience playing 3D games were eligible to complete the questionnaire. A questionnaire was designed to collect data from game players. The questionnaire consisted of three main parts. The first part was about the basic information of the respondents, including age, gender, and the average time spent on 3D games per week, which can help analyze whether these factors have an impact on the research results. The second part focused on the respondents' awareness and perception of color coding in 3D game scenes.

The questionnaire was distributed through online platforms, including game-related forums, social media groups for gamers, and professional game websites. A total of 200 valid questionnaires were collected. Questionnaires were screened for validity by excluding responses with inconsistent answers (e.g., claiming to play 3D games daily but failing to recognize any color-coded elements) and incomplete entries.

4.2 Interviews

Semi-structured interviews were conducted with 20 randomly selected respondents from the questionnaire survey. The interviews aimed to gain in-depth insights into players' experiences and thoughts regarding color coding and episodic memory in 3D games. Interview questions were designed to explore more detailed aspects, such as "Can you describe a specific instance where color coding in a 3D game helped you remember an important event or location?" and "Do you think color coding affects your ability to remember the story of a 3D game? Why?". The interviews were recorded with the consent of the interviewees and then transcribed for analysis.

5. Data Analysis

Descriptive statistical analysis of the questionnaire data was conducted to obtain the basic characteristics of respondents and their overall perception of color coding in 3D game scenes. The specific results are as follows:

Sample Screening Criteria: Only participants with at least 6 months of 3D gaming experience were included. Questionnaires with contradictory answers (e.g., claiming daily play but failing to recognize any color-coded elements) or incomplete information were excluded, yielding 200 valid samples.

Key Result Interpretations:

Age & Gender: The mean age of 24.5 (SD 4.2) and 68% male ratio reflect the typical demographic of 3D game players captured by the survey.

Gaming Intensity: Weekly gaming duration of 10.2 (SD 3.5) hours confirms consistent engagement, while the 30% proportion of players with >5 years experience, alongside stratified experience groups (15% <1 year, 30% 1-3 years, 25% 3-5 years), enables comparative analysis via survey metrics.

Semi-structured interviews were conducted with 20 randomly selected respondents. Following transcription, thematic analysis was employed to code the text, focusing on identifying core themes related to the impact of color coding on episodic memory, such as "color-coded landmarks" and "color-associated storylines" (detailed analysis in Section 6.2).

6. Results

6.1 Findings from the Questionnaire Survey

The results of the descriptive statistics showed that 85% of the respondents noticed the use of color to distinguish different areas in 3D games. Among the color-coded elements, color-coded landmarks (such as unique-colored towers or buildings) were the most impressive, with 72% of the respondents choosing this option.

The correlation analysis revealed a significant positive correlation ($r = 0.65$, $p < 0.01$) between the degree of attention paid to color-coded elements and the accuracy of episodic memory recall. This indicates that the more attention players pay to color-coded elements in 3D game scenes, the better their episodic memory performance.

The independent-samples t-tests showed that there were significant differences in episodic memory performance between players with more than 5 years of gaming experience and those with less than 5 years of gaming experience. Players with more gaming experience had a higher accuracy rate in recalling color-coded game scenes.

6.2 Findings from the Interviews

The thematic analysis of the interview data identified several important themes that align closely with the key. The most frequently mentioned term, "Color-coded" (25 mentions), was central to multiple themes. One of the main themes was the role of color-coded landmarks ("Landmarks" mentioned 18 times) in enhancing episodic memory ("Memory" mentioned

22 times). Many interviewees mentioned that distinctive color-coded landmarks helped them quickly locate specific areas in the game and remember important events that occurred nearby. For example, an interviewee said, “In a fantasy 3D game, the bright red tower in the middle of the map was very memorable. Every time I saw it, I would remember the quests and battles that happened around it.”

7. Discussion

The results of this study demonstrate that color coding in 3D game scenes has a significant impact on players’ episodic memory. The positive correlation between attention to color-coded elements and episodic memory recall is consistent with the previous theory that visual cues can enhance memory encoding. When players pay more attention to color-coded elements in 3D game scenes, these elements are more likely to be encoded into long-term memory, facilitating subsequent retrieval.

The differences in episodic memory performance among players with different gaming experience levels may be due to the fact that more experienced players have developed better cognitive strategies for processing visual information in 3D games. They are more likely to notice and utilize color-coded cues to organize and remember game-related information.

However, this study also has some limitations. First, the sample size of the interview part is relatively small, which may affect the generalizability of the interview results. Second, the research only focused on a limited number of 3D games, and different game genres may have different effects of color coding on episodic memory. Future research can expand the sample size and cover a wider range of game genres to further explore this topic.

8. Conclusion

In conclusion, this study has investigated the impact of color coding in 3D game scenes on episodic memory through questionnaire surveys and interviews. The results show that color coding can significantly enhance players’ episodic memory of 3D game scenes, and different color coding strategies and players’ gaming experience levels can also affect this relationship. The findings of this study provide new insights for both game design and memory research. In the future, more in-depth research can be carried out to fully explore the potential of color coding in 3D games for enhancing players’ cognitive experiences.

References

- [1] Brown, A., Smith, B., & Johnson, C. The Effect of Color on Visual Memory Recall. *Journal of Cognitive Psychology*, 2015,27(3), 289-301.
- [2] Li, W., Liu, X., & Zhao, H. (2020). Color coding in virtual reality games: Impacts on spatial memory. *Journal of Gaming Research*, 2020,12(1), 12-25.
- [3] Zhang, L., Wang, Y., & Chen, X. The influence of color schemes on players’ emotional responses in 3D games. *International Journal of Virtual Reality*, 2018,17(2), 45-58.
- [4] Baddeley, A. Is working memory working? *The Quarterly Journal of Experimental Psychology*, 1992,44(1), 1-31.

Author Bio

yuquan Liang (June, 1999) female, Han nationality, Master’s degree, Research direction: Mental rotation, spatial cognition and human portrait cognition are related.