Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 20, No. 1, 2025

A review of the Application Research of Eye Movement Experiments in The Field of Tourism

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Abstract: With the rapid development of the tourism industry and the increasing demand for tourism experience, eye tracking experiments, as a quantitative and objective research tool, are gradually being applied in tourism research. Applying eye tracking experimental methods to the field of tourism research has been a new trend in recent years. By recording and analyzing the eye movement data of tourists in the tourism environment, eye movement experiments can reveal the visual attention mechanism, information processing process, and tourism decision-making behavior of tourists, providing scientific basis for the planning of tourism destinations, the design of tourism products, and the optimization of tourism services. This study first introduces the basic principles of eye movement experiments and their applications in the field of tourism. It summarizes the research results of eye movement experiments in recent years, including visual evaluation of tourism landscapes, tourism information search, evaluation of tourism advertising effectiveness, and tourism map design. Although eye tracking experiments have achieved certain results in the field of tourism, problems such as controlling the experimental environment, representativeness of samples, data interpretation, and technical limitations still exist. In the future, research on eye tracking experiments in the tourism field should pay attention to technological innovation and integration, deepening research content, interdisciplinary research, data fusion and mining, privacy protection and ethical norms, and subject diversification, To promote the deeper application and development of eye movement experiments in the tourism field.

Keywords: Travel; Eye movement experiment; Research review.

1. Introduction

With the rapid development of the tourism industry and the continuous improvement of people's requirements for tourism experiences, issues such as how to enhance the attractiveness of tourist destinations, optimise tourism product design, and improve tourism service quality have become hot topics in tourism research. Against this backdrop, eye-tracking experiments, as an objective and quantitative research method, have gradually gained widespread application in the tourism field. Eye-tracking experiments record and analyse the eye movements of observers in tourism environments, revealing the visual attention mechanisms, information processing processes, and tourism decision-making behaviours of tourists during the tourism process. This method not only helps to gain a deeper understanding of the psychological and behavioural patterns of tourists but also provides scientific basis for tourism destination planning, tourism product design, and tourism marketing. The application of eye-tracking experiments in the tourism field holds significant theoretical and practical significance.

This study searched China National Knowledge Infrastructure (CNKI) using the keyword 'tourism eye-tracking experiment,' with the time range set from 1 January 2013 to 31 December 2023, yielding a total of 35 eligible literature sources. Analysis of these sources revealed that in terms of experimental stimulus materials, most studies selected tourism photographs [1], tourism advertisements [2], or tourism map symbols [3]; In terms of data analysis methods, statistical methods such as analysis of variance and significance analysis were primarily used to process eye-tracking data such as the number of fixations, fixation duration, and fixation speed.

2. Introduction to Eye-Tracking Experimental Methods and Their Basic Principles

Eye-tracking experimental methods can collect data on eye movements during psychological activities. Cognitive psychology holds that the visual system is the most complex of the sensory systems [4]. Driven by the pursuit of certain knowledge, the ancient Greeks ultimately believed that vision was the primary means of understanding the world [5]. The process of discerning and thoroughly examining 'truth' involves repeated observation [6]. The extensive processing of visual information by the human brain forms the foundation for humans to recognise what they see [7]. In 1878, French ophthalmologist Javal demonstrated through experiments that humans can only perceive images clearly through brief fixations of the eyes [8]. Researchers refer to the activity of aligning the fovea with an object as 'fixation' [9]. Eye movements are categorised into three basic types: fixation, saccades, and pursuit movements. Based on the measurement methods of eye-tracking technology, eye-tracking experimental research methods can be categorised into three types: early natural observation methods, early mechanical recording methods, and modern eye-tracking research recording methods [8].

Eye-tracking experiments are a method of tracking and recording the eye movement trajectories of participants. Using devices such as eye-trackers, researchers can monitor participants' eye movements in real-time while they view specific stimuli, including fixation points, fixation duration, and saccades. These data reflect participants' visual attention and information processing processes, thereby providing researchers with information about participants' cognition,

emotions, and decision-making. Modern eye trackers consist of four components: an optical system, a pupil centre coordinate extraction system, a visual field and pupil coordinate overlay system, and an image/data recording and analysis system, and they also include a built-in data storage and processing system. Eye movement data comes in various formats, including numerical values, images, and dynamic eye movement trajectories (sequences of gaze points over time, dynamically reflecting the subject's eye movements during reading), as well as metrics such as gaze duration, number of gaze points, gaze point coordinates, first entry time (the time from when the stimulus target appears until the subject notices it; the shorter the time, the more likely it is to capture the subject's attention), interest area eye movement indicators, and heatmaps. Researchers can select appropriate eye-tracking metrics based on their needs for further analysis. Laboratory experiments can simulate tourist environments and activities, allowing participants to view tourist destination landscapes and videos while controlling various external stimuli. During the experiment, researchers can measure and record tourists' cognitive and emotional responses. By analysing the experimental results, researchers can understand the relationship between tourists' cognitive and emotional responses and factors such as tourist environments, service quality, and price, thereby gaining a better understanding of tourists' needs and expectations.

3. The Application of Eye Tracking Experiments in The Field of Tourism

3.1. Visual Evaluation of Tourist Attractions

Eye-tracking experiments play a significant role in the visual evaluation of tourist landscapes. By tracking and analysing visitors' eye movements while viewing tourist landscapes, eye-tracking experiments can reveal how visitors allocate their visual attention and preferences across different landscape elements, thereby assessing the landscape's visual appeal and aesthetic quality. Specifically, eye-tracking experiments can record visitors' gaze points, gaze duration, and saccades while viewing landscape images or videos. By analysing this data, we can understand visitors' visual search strategies and attention allocation patterns within the landscape, as well as their visual interests in different landscape elements. For example, Zhang Ting et al. conducted an eye-tracking experiment to study the aesthetic experience of the Longji Rice Terraces landscape. The participants' gaze hotspots were primarily concentrated on distinctive elements, main buildings, or the intersections of landscape elements. The four landscape types—settlements and buildings, ecology, ethnic culture, and agriculture—had no significant impact on the visual stimuli of the landscape [10]. Additionally, eye-tracking experiments can be combined with subjective evaluations, such as visitors' overall satisfaction and preferences regarding the landscape, to comprehensively assess the visual quality of the landscape. Wu Siqi et al. conducted eye-tracking experiments on visitors' day and night landscapes at tourist destinations, analysing eye-tracking heatmaps and eye-tracking trajectories, and found that nighttime landscapes had a more positive impact on visitors' emotional experiences [11]. Guo Suling et al. conducted an eye-tracking experiment on images of the Hongcun tourist landscape with university students as the research subjects, supplemented by questionnaires and mathematical statistical methods. They found that human visual attention to landscapes exhibits a natural affinity, with visitors primarily focusing on the intersections of fields, mountains, or water bodies when viewing the ecological and agricultural landscapes of Hongcun in Anhui Province [12]. This combination of objective and subjective evaluation methods provides a more comprehensive understanding of visitors' visual perceptions and needs regarding landscapes, offering scientific basis for the planning and design of tourist landscapes. In tourist landscape visual evaluation, eye-tracking experiments have also been applied to online travel platforms, where they can be used to optimise image and video displays, enhancing visitors' information search efficiency and satisfaction. Zhang Ziyang et al. found that tourist image information can enhance the overall gaze effect of OTA travel advertisements; advertising formats based on combinations of tourism text and image elements have the highest memory retention, while tourism price elements have the lowest memory retention, providing insights for tourism companies whose primary marketing strategy is low-price competition [2]. In summary, the application of eye-tracking experiments in the visual evaluation of tourism landscapes holds broad prospects and potential value. It not only provides objective and scientific methods for assessing visual quality but also offers targeted optimisation suggestions for the planning and design of tourism landscapes, thereby enhancing tourists' travel experiences and satisfaction. However, current research on the application of eye-tracking experiments in the visual evaluation of tourism landscapes remains relatively limited, necessitating further studies and practical applications to drive its development.

3.2. Tourist Information Search Behaviour

Tourists need to search for and process information during the decision-making process. Eye-tracking experiments can reveal the visual search strategies and attention allocation patterns of tourists when faced with tourism information. By studying eye-tracking data from tourists on online travel platforms, travel guides, or brochures, we can gain a deeper understanding of their information needs and behavioural habits, thereby providing optimised recommendations for the presentation and dissemination of tourism information. Using eye-tracking technology, researchers can observe the eye movements of tourists when faced with various types of tourism information, thereby understanding their information search strategies, preferences, and decision-making processes. In the research literature, eye-tracking experiments are widely applied to studies of information search behaviour on travel websites, travel advertisements, travel maps, and travel guides. For example, some studies have explored travellers' eye-tracking patterns when browsing travel websites, finding that travellers tend to first focus on prominent areas of the website, such as titles, images, and key information sections. These studies also note that travellers' eye-tracking trajectories are closely related to their information search objectives and decision-making needs.

3.3. Evaluation of the Effectiveness of Tourism Advertising

Travel advertisements serve as an important tool for promoting tourist destinations and travel products, playing a crucial role in attracting potential travellers. Eye-tracking experiments can help evaluate the effectiveness of travel advertisements by analysing participants' visual attention and

emotional responses while viewing the ads. By analysing participants' eye-tracking data, researchers can assess the appeal of advertising elements, the rationality of layout design, and the efficiency of information transmission, thereby providing guidance for the creative design and deployment strategies of travel advertisements. Zhang Ziyang et al.'s research found that tourism images can enhance the overall visual attention effect of OTA tourism advertisements; advertisement formats based on combinations of tourism text and image elements have the highest memory retention, while tourism price elements have the lowest memory retention, providing insights for tourism companies that primarily rely on low-price competition as their marketing strategy [2]. Yang Yang et al.'s research found that marketing text has a significant impact on visual attention in tourism advertisements. Inductive text has no significant effect on visual attention in the overall interest area of tourism advertisements, but certification text can significantly enhance visual attention in both the overall interest area and the landscape interest area of advertisements. When familiarity is high, inductive text can increase overall attention to the advertisement, but when familiarity is low, inductive text reduces visual attention to both the overall advertisement and the landscape [13].

3.4. Design of Tourist Maps and Guidance Systems

Tourist maps and navigation systems have become essential tools for tourists to obtain information and navigate during their travels. To better meet the needs of tourists and enhance the usability and user experience of these systems, eye-tracking experiments are widely applied in the design and evaluation of tourist maps and navigation systems. The application of eye-tracking experiments in tourist map design primarily focuses on aspects such as visual presentation, information layout, and symbol design. Through eye-tracking data, the readability of maps, information retrieval efficiency, and users' visual search strategies can be assessed. Different map symbol forms exhibit significant differences in impact, with pictorial symbol maps demonstrating significantly superior spatial cognition compared to abstract symbols. Users who frequently use tourist maps exhibit significantly superior spatial symbol cognition compared to occasional users, and this difference is more pronounced in abstract symbols [14]. Guidance systems typically include digital guidance and interactive guidance, aiming to help tourists better understand attractions and plan their itineraries. The application of eye-tracking experiments in guidance system design primarily focuses on users' information acquisition processes, interaction behaviours, and system usability. Through eye-tracking data, the information presentation methods, interaction interface design, and interaction efficiency between users and the system can be evaluated. Research has found that in terms of the location and number of signs, the first directional sign is the most important. The closer the sign is to the starting point and the greater the number of signs, the higher the participants' wayfinding efficiency. Visitors are more willing to use directional signs with specific directional information, and the text portion is more likely to attract visual attention and achieve higher interpretation efficiency than the map portion [15].

4. Current Issues in Research

4.1. Differences Between the Experimental Environment and The Real Environment

Eye-tracking experiments are typically conducted in artificial laboratory settings, meaning that participants are not exposed to real-world travel environments during the experiment. This ‘out-of-context’ state may lead to experimental biases among participants due to factors such as social expectations and political correctness. The ‘tourism setting’ in the laboratory differs significantly from real natural environments, which may affect participants' perceptions of tourism experiences. When using tourism landscape photographs or virtual tourism experience platforms for experiments, the eye-tracking data collected may be distorted due to differences in the ‘setting.’

4.2. Limitations of Sample Selection

Due to the limitations of data collection conditions in eye-tracking experiments, the selection of experimental samples may be limited. The current research primarily targets university undergraduates or postgraduates, with no investigations conducted on other population groups. This limitation may impact the generalisability and reliability of the experimental results. Additionally, some participants may have joined the experiment out of curiosity, interest, or for rewards, rather than genuine interest in tourism activities. Such differences may lead to their performance in the experiment not aligning with real-world scenarios, thereby affecting the accuracy of the experimental results.

4.3. Challenges in Interpreting Eye Movement Data

Although eye movement data can reveal participants' visual attention and information processing methods, interpreting and analysing it is a complex task. The selection of eye movement indicators, data processing methods, and interpretation of results can all influence experimental outcomes. In addition, how to combine eye movement data with other behavioural data or subjective reports to gain a more comprehensive understanding of participants' travel experiences and behavioural decisions is also one of the challenges currently faced.

4.4. Technical Limitations

Although eye-tracking technology has made significant progress, there are still some technical limitations. For example, data recording from fixed eye trackers usually requires a computer to collect the data, which may limit the presentation of experimental materials and the natural behaviour of subjects. In addition, the accuracy and stability of eye-tracking devices may also be affected by factors such as ambient light and head movements of subjects.

4.5. Ethical and Privacy Issues

When conducting eye-tracking experiments, it is necessary to record the eye movement data of the subjects, which may raise ethical and privacy issues. Researchers must ensure that subjects provide informed consent and that their personal information is kept confidential to avoid causing unnecessary distress or harm to the subjects.

4.6. The Hawthorne Effect

When conducting experimental research and observations,

research subjects may alter their behaviour because they are aware that they are being studied. During the implementation process, participants often unconsciously make choices and provide answers that align with the desired outcomes. Psychological research has shown that when laboratory participants are informed that their blinking behaviour will be counted, it significantly influences their blinking behaviour. Although the Hawthorne effect can be statistically adjusted for, it is difficult to eliminate it at its root.

5. Future Research Prospects and Trends

With the continuous development and improvement of eye-tracking technology, its application in the tourism industry will become more widespread and in-depth. Future research can focus on the following areas:

5.1. Technological Innovation and Integration

As technology continues to advance, eye-tracking technology is also evolving. Future tourism eye-tracking experiments may adopt more advanced and precise eye-tracking devices, such as AI-based eye-tracking systems, which can more accurately capture and analyse tourists' eye movements. Additionally, the development of virtual reality (VR) and augmented reality (AR) technologies has opened up new possibilities for tourism eye-tracking experiments, enabling the simulation of more realistic travel environments and thereby obtaining more accurate eye-tracking data.

5.2. Research Content

Future tourism eye-tracking experiments may further deepen our understanding of tourists' decision-making processes, perceptions of travel experiences, and information processing methods. For example, eye-tracking experiments can be used to explore tourists' decision-making processes when choosing travel destinations and products, and to understand the extent to which tourists pay attention to and process different types of travel information, thereby providing tourism companies with more accurate marketing strategies.

5.3. Interdisciplinary Research

Future tourism eye-tracking experiments may strengthen interdisciplinary research with other fields such as psychology, cognitive science, and neuroscience. The research methods and theories from these disciplines can provide new perspectives and insights for tourism eye-tracking experiments, aiding in a deeper understanding of tourists' travel behaviour and experiences.

5.4. Data Fusion and Mining

Future tourism eye-tracking experiments may integrate and mine data from other sources, such as visitor behaviour data, social media data, and tourism survey data. By integrating and mining multi-source data, researchers can gain a more comprehensive understanding of visitors' tourism needs and preferences, enabling tourism businesses to provide more precise and personalised services.

5.5. Privacy Protection and Ethical Standards

As awareness of data security and privacy protection continues to grow, future tourism eye-tracking experiments must place greater emphasis on privacy protection and ethical standards. When collecting and analysing eye-tracking data, it is essential to ensure visitors' informed consent and the confidentiality of their personal information, avoiding unnecessary inconvenience or harm to visitors.

5.6. Diverse Participants

Participants in research applications should come from diverse backgrounds, ages, genders, and educational levels to reflect a broader range of visitor groups. This can be achieved through partnerships, social media recruitment, public recruitment, and other methods to attract more individuals with diverse characteristics to participate in the experiment. Before the experiment, screen participants for motivation and attitude to ensure they are genuinely interested in tourism activities and willing to participate seriously in the experiment. This can be done through questionnaires, interviews, or other methods to assess participants' willingness to participate and their level of cooperation. Provide participants with necessary training and support to help them become familiar with eye-tracking equipment and technology. This can reduce participants' anxiety, improve their operational accuracy, and thereby enhance the reliability of experimental data.

6. Conclusion

This paper reviews the application of eye-tracking experiments in tourism research and finds that eye-tracking technology provides a new and effective method for exploring tourists' visual attention and information processing patterns. As an advanced visual tracking technology, eye-tracking experiments hold broad prospects and significant value for application in tourism research. This paper aims to provide references and insights for academic research and practical applications in related fields, thereby promoting the deeper application and development of eye-tracking experiments in tourism research. Eye-tracking experiments open a unique window into observing ‘the tourist's perspective,’ offering a powerful tool for revealing their underlying cognitive and behavioural patterns. Although current applications still face challenges in terms of environment, sample size, data, technology, and ethics, with the continuous innovation of technology, the ongoing optimisation of research methods, the deepening of interdisciplinary collaboration, and the increasing emphasis on ethical standards, the application of eye-tracking experiments in the tourism field will inevitably move toward a more in-depth, broader, and more ecologically valid stage. Their research findings will continue to provide indispensable scientific support and profound insights for understanding the essence of tourism phenomena, optimising tourism product and service design, enhancing tourism experience quality, and ultimately promoting the high-quality and sustainable development of the tourism industry.

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