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Abstract: This study systematically investigates the mechanisms through which patriotic-themed films shape audience emotion and cognition within the context of culture tourism integration, providing highly relevant scientific evidence for the field of patriotic education. On this basis, the study discusses the possibility of how internet of bodies (IoB) technology and social interaction can amplify these emotional effects on the network platform. This study reveals the neural mechanism of the influence of main melody films on the audience's patriotic feelings through neuroscience methods, and establishes the connection with IoB and generative artificial intelligence. The findings provide scientific support for film production and the development of culture tourism scenarios for patriotic education within the framework of culture tourism integration.

Keywords: neuroscience; patriotic-themed films; film audiences; patriotic sentiment; culture tourism integration.

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Biographical notes: Lihong Wen received her PhD in Film Studies, and a Lecturer. Her research interests are in film narrative ethics, genre film, and cinematics analysis.

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1 Introduction

1.1 Research background and motivations

With the rapid advancement of globalisation, the intensity of competition among nations has significantly escalated, positioning cultural soft power as a core indicator of comprehensive national strength. In this context, film emerges as a powerful medium for cultural transmission, functioning as a source of entertainment and a subtle influencer of ideology, emotional identification, and societal values (Lindsay, 2023; Hu and Guan, 2021; Wang, 2024). Patriotic-themed films, in particular, embody national policy objectives and convey positive societal messages while aligning with mainstream ideology, thus assuming a pivotal role in the promotion of patriotic education (Talmacs, 2020; Fan and Ip, 2023; Sparks, 2022). Within the broader context of culture tourism integration, film functions as a medium for cultural dissemination and serves as a significant driver of tourism development. Main melody films, as carriers of national policy objectives and positive social messages, align closely with mainstream ideology and play a critical role in patriotic education. Culture tourism integration creates new development opportunities for main melody films. Through approaches such as the reconstruction of film scenes and the development of film-themed tourism, the patriotic educational effects of these films are further amplified.

The concept of a ‘main theme’ originally emerged from music, describing the primary melody that defines the essence and central spirit of a composition (Martin, 2021; Fiske et al., 2024). Within film, the notion of patriotic-themed cinema took shape around 1978, coinciding with China’s reform and opening-up era, in response to calls for “emphasising the main theme and maintaining diversity” to address societal needs and reorient socialist literature and arts. Early patriotic-themed films drew inspiration from works produced between 1949 and 1966, including *Sons and Daughters of China*, *The White-Haired Girl*, *Steel Soldier*, *Battle on Shangganling Mountain*, and *The Red*

Detachment of Women. These films primarily portrayed revolutionary historical themes, celebrating the heroic spirit of Communist Party members, the people's army, and the masses, establishing a cinematic tradition grounded in themes of national pride and collective resilience. In recent years, patriotic-themed films have undergone significant evolution in their themes, content, and narrative strategies. This transformation has produced a diverse array of acclaimed films that resonate with contemporary audiences, promote national policies, and articulate mainstream ideology. Notable examples include *The Captain* (2019), *The Bravest* (2019), and *Leap* (2020). These films intertwine compelling ideological messages with artistic expression, skillfully conveying patriotic sentiments through engaging storytelling, intricate character development, and innovative narrative techniques (Huang and Lams, 2024; Song, 2022).

As a new technical trend, IoB aims to understand and predict human behaviour by collecting, integrating, and analysing behavioural data from various sources. In the media industry, the application of IoB is changing the way of content production and distribution. In the context of culture tourism integration, IoB enables the simultaneous collection of audience physiological data during film viewing and behavioural, emotional, and interaction data within offline culture tourism scenarios. This facilitates end-to-end emotion monitoring and adaptive content delivery. Based on these capabilities, more targeted content and scenario-based services can be developed for different audience groups, thereby enhancing emotional resonance in patriotic sentiment.

1.2 Research objectives

This study applies neuroscience methods to investigate how contemporary main melody films influence audience patriotic sentiment and its underlying neural mechanisms within the context of culture tourism integration. In addition, the role of social interaction mechanisms and IoB technology in this process is discussed, that is, how to enhance the influence of films on audience emotion through user interaction on social media platforms or data analysis based on IoB. By comparing neural activity changes elicited by different plot structures and character development strategies, key elements that stimulate and strengthen patriotic sentiment are identified. These findings provide a scientific basis for the creation of main melody films in the context of culture tourism integration.

2 Literature review

As a scientific discipline focused on the intricacies of the nervous system, neuroscience has found extensive applications in psychology, sociology, and cultural studies in recent years. Techniques such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) yield critical insights into neural activity patterns during the processing of diverse information types, thus enhancing the understanding of human emotions, cognition, and behaviour (Liao and Xia, 2023). Iglesias Amorín (2020) highlighted the capability of fMRI to enable real-time observation of neural activation in response to emotional stimuli, noting increased amygdala activity during scenes that evoke sadness. This indicated the amygdala's pivotal role in processing sorrow. EEG, by monitoring electrical changes within the cerebral cortex, also provided data on neural oscillation activity pertinent to emotional processing. Córdoba-Arroyo (2024) emphasised that employing neuroscientific methods to examine the influence of

patriotic-themed films on audiences' patriotic sentiments could illuminate the neural mechanisms through which these films stimulate and reinforce patriotic feelings, thereby establishing a scientific foundation for patriotic education.

Citlak and Mayer (2024) articulated that neuroscience delves into the neural underpinnings of emotion, cognition, and behaviour, while film emotion analysis sought to utilise technological tools to discern and comprehend audiences' emotional responses to cinematic content. Ho (2022) posited that interactions within the nervous system's affective-appraisal, perceptual-motor, and meaning-knowledge domains cultivated aesthetic experiences. This theoretical framework within film emotion analysis aided in clarifying how audiences elicit emotional reactions to visual and auditory stimuli, thereby assessing the value of cinematic offerings. Müller et al. (2024) argued that neuroimaging technologies granted researchers the ability to observe neural activity patterns during film viewings, yielding insights into the emotional states of audiences. When audiences participate in related online discussions after watching patriotic films, they can deepen their understanding of the film content and strengthen their emotional bond through communication with other audiences.

Under the trend of culture tourism integration, the combination of film intellectual property with tourism scenarios has become an important pathway for emotional reinforcement. After viewing films, audiences often visit red tourism sites, film shooting locations, and themed educational bases. Such experiences reactivate neural activity patterns similar to those elicited during film viewing, thereby facilitating the sustained consolidation of patriotic sentiment. As an emerging technological paradigm, the IoB enables the understanding and prediction of human behaviour through the collection, integration, and analysis of multi-source behavioural data. In the media and culture tourism industries, IoB applications are transforming modes of content production, distribution, and user experience. By analysing user browsing behaviour, likes, social interactions, and culture tourism experiences, audience preferences can be identified with greater precision. The integration of IoB and generative artificial intelligence (GAI) further supports the analysis of tourists' behavioural trajectories, emotional changes, and experiential feedback after engaging with culture tourism scenarios following film viewing.

In the field of film research, especially in the study of the impact of main theme films on audience patriotism, the application of neuroscience is important. Previous studies have confirmed that the brain has specific neural activity patterns when processing diverse emotional stimuli, which can be observed and analysed through neuroimaging techniques. In addition, research achievements in film sentiment analysis also provide a theoretical framework for understanding how audiences generate emotional responses through visual and auditory stimuli, as well as evaluating the value of film content. This study intends to combine the theories and methods of neuroscience and film emotion analysis to reveal at the neural level how main melody films can stimulate and strengthen audiences' patriotic sentiments, provide a scientific basis for patriotic education, and further deepen the understanding of the emotional interaction mechanism between films and audiences.

3 Method

3.1 Application of neuroscience in film emotion analysis

fMRI detects brain activity by measuring blood oxygenation level-dependent (BOLD) signals, providing a robust tool for understanding emotional responses during the processing of film content. Within the context of culture tourism integration, the incorporation of on-site visits to film shooting locations enables the use of fMRI to examine brain region activation when audiences recall film scenes. This approach facilitates the identification of how films influence emotional memory at the neural level. Increased neural activity is associated with heightened local blood flow and oxygen consumption, leading to an increase in oxygenated hemoglobin and the consequent generation of BOLD signals. The application process involves initially imaging the brains of subjects with a fMRI scanner while engaging in specific tasks. Subsequently, the collected images undergo preprocessing, which includes spatial normalisation and smoothing. Statistical models are then applied to analyse brain activity patterns and to identify specific brain regions linked to various emotional responses.

Figure 1 Application process of combining fMRI and EEG in film emotion analysis (see online version for colours)

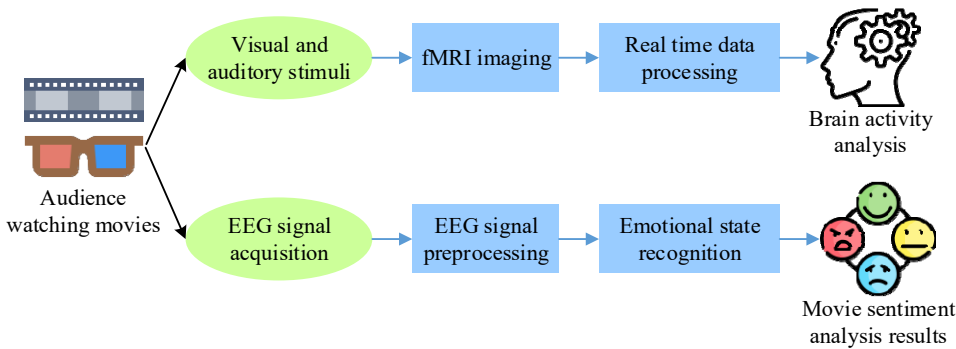
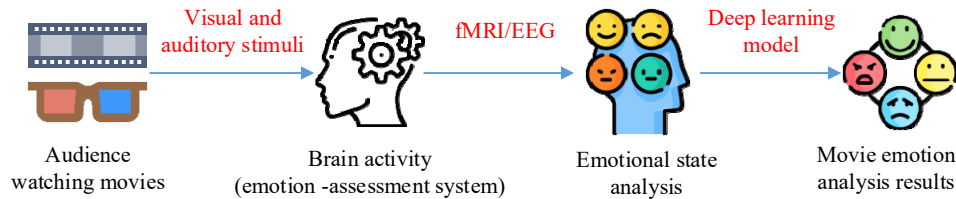


Figure 2 Application process of neuroscience in film emotion analysis (see online version for colours)



A wearable device is one of the important application forms of IoB technology in neural activity monitoring. An EEG cap is a common wearable device that can monitor the electrical activity of the brain in real time. These devices capture the discharge signals of brain neurons through high-precision sensors and send the data to the cloud or local devices for analysis through wireless transmission technology. This non-invasive monitoring method is convenient to wear and can continuously monitor brain activity in

daily life, which provides rich data for studying brain response in different situations. EEG captures electrical signals generated by neuronal activity through electrodes placed on the scalp. EEG, as a non-invasive monitoring method, captures neuronal firing signals through high-precision sensors and enables real-time tracking of brain activity. In culture tourism activities, the use of EEG devices during visits to film-themed exhibitions or the experiential reconstruction of film scenes allows the recording of brainwave variations across different contexts. These data support the analysis of audience emotional responses and cognitive states. Figure 1 demonstrates the integration of fMRI and EEG methodologies in the context of film emotion analysis, highlighting the complementary strengths of both techniques in understanding audience emotional responses to cinematic content.

Figure 2 illustrates the workflow for incorporating neuroscience into the analysis of emotions elicited by films. In the realm of sentiment analysis for film reviews, data preprocessing and feature extraction play crucial roles. The initial phase involves meticulous cleaning and tokenisation of raw film review data, converting the text into numerical representations, such as word embeddings. Subsequently, an appropriate deep learning model is selected to develop and train the sentiment analysis framework, facilitating a comprehensive interpretation of the emotional responses expressed in film critiques.

3.2 Analysis of the patriotic education function of patriotic-themed films

Main melody films evoke audience patriotic sentiment by presenting the nation's remarkable achievements and celebrating heroic figures. Within the context of culture tourism integration, the combination of film and tourism further amplifies these effects. The development of tourism routes based on film shooting locations enables audiences to experience cinematic scenes in real-world settings, thereby strengthening national identity and national pride associated with the country's history and culture. In addition, the portrayal of positive characters and the transmission of core values in films exert a constructive influence on audience behavioural tendencies, encouraging the practice of patriotic values in everyday life (Mattingly and Yao, 2022; Li and Feng, 2024; Patsiaouras and Fitchett, 2023). Notable characteristics of patriotic-themed films include:

- 1 Policy orientation: These films maintain a close alignment with the Party's significant policies and guidelines, effectively transmitting the nation's mainstream ideology and values through the cinematic medium.
- 2 Diverse themes: The thematic spectrum of patriotic-themed spans revolutionary history, social realities, and heroic figures, portraying the multifaceted landscape of Chinese society and the struggles of its people through varied thematic explorations.
- 3 Innovative narratives: Continuous innovation in narrative strategies characterises patriotic-themed films, employing metaphors, symbols, and various techniques to vividly and intuitively depict complex historical contexts and character dynamics.
- 4 Emotional guidance: A strong emphasis on emotional guidance is evident, with nuanced emotional expressions and character development designed to resonate with audiences, thereby evoking patriotic sentiments effectively.

The functions of patriotic education as conveyed through patriotic-themed films are summarised in Table 1. These films establish a clear connection with the stimulation of patriotic sentiments among audiences by emphasising the nation's glorious achievements, celebrating heroic figures, and showcasing the national spirit. Narratives that recount the historical journey of the nation reinforce national identity, convey mainstream values, and underscore the importance of national unity and ethnic solidarity. Furthermore, historical awareness is fostered through the re-enactment of significant events, the provision of historical context, and the dissemination of historical knowledge. Moral behaviour is guided by promoting positive social energy, imparting moral concepts, and highlighting responsibility and commitment. Additionally, aesthetic appreciation is enhanced by showcasing artistic beauty, conveying cultural values, and emphasising aesthetic experiences.

Table 1 Functions of patriotic education and film examples

Category	Specific expressions	Examples
Stimulating patriotic feelings	Presenting the Nation's Glorious Achievements	Scenes from <i>My People, My Country</i> , including the founding ceremony and the return of Hong Kong
	Celebrating Heroic Figures	The bravery of volunteer soldiers depicted in <i>The Battle at Lake Changjin</i>
Enhancing national identity	Presenting the Historical Process of the Nation	Historical context surrounding the founding of New China in <i>The Founding of a Republic</i>
	Emphasising National Unity and Ethnic Solidarity	Narratives in <i>Wolf Warrior 2</i> that uphold national sovereignty and territorial integrity
Cultivating historical awareness	Reenacting Historical Events	The struggles of revolutionary pioneers portrayed in <i>The 1911 Revolution</i>
	Providing Historical Context	The social backdrop of the War of Resistance against Japan in <i>The Flowers of War</i>
Guiding moral behaviour	Promoting Positive Social Energy	The heroic actions of firefighters depicted in <i>The Bravest</i>
	Conveying Moral Concepts	Themes of supporting vulnerable groups and the pursuit of justice in <i>Dying to Survive</i>
Enhancing aesthetic appreciation	Presenting Artistic Beauty	The exquisite visual design and colour schemes in <i>Hero</i>
	Conveying Cultural Values	The depiction of traditional Chinese culture and philosophical ideas in <i>Crouching Tiger, Hidden Dragon</i>

After viewing the films, audiences visit red tourism sites, revolutionary memorial halls, and film-themed culture tourism destinations, thereby transforming cinematic emotional experiences into immersive experiences, which continuously strengthen national identity and national pride. Films employ metaphorical and symbolic techniques to clearly and vividly present complex historical contexts and character development. Patriotic-themed films utilise techniques such as metaphor and symbolism to convey complex historical contexts and character portrayals with vividness and clarity (Gao and Feng, 2023; Hu et al., 2022; Sullivan and Wang, 2023). In *My People, My Country*, the director encapsulates the glorious history and national spirit of the Republic over seventy years by weaving together narratives from seven distinct historical periods. Iconic visual symbols

emerge within these stories – such as the flag-raising ceremony during the founding, the successful atomic bomb test, and the hosting of the Olympics – transforming into indelible patriotic memories for audiences.

A continuous innovation and diversification of narrative strategies characterise patriotic-themed films, utilising various storytelling techniques and perspectives that facilitate deeper emotional connections and cognitive resonance among audiences. This evolution in narrative approach amplifies the entertainment value and artistry of films and aids in shaping accurate national perceptions and values. In *The Battle at Lake Changjin*, a multi-threaded narrative combined with flashback techniques effectively illustrates the heroism and national spirit displayed during the Korean War. Meanwhile, *Leap* showcases the struggles and triumphs of the Chinese women's volleyball team, allowing the audience to experience the greatness and strength embodied in the 'women's volleyball spirit'. Such emotional guidance cultivates profound respect and admiration for the athletes, while simultaneously igniting a passion for the nation and fostering an interest in sports.

3.3 *The analysis of neural activity patterns of audiences watching main theme films based on IoB*

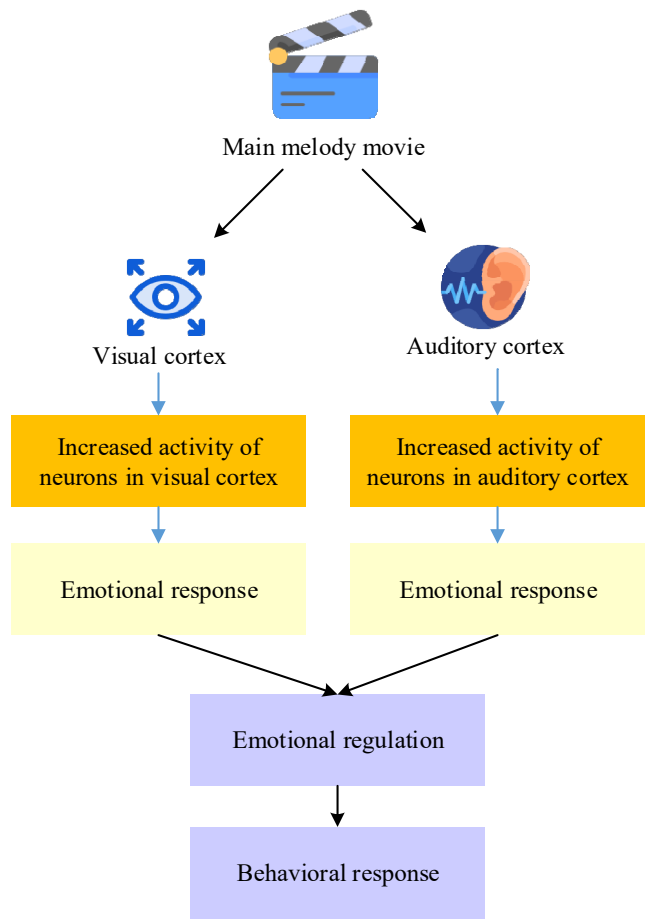
Patriotic-themed films often present visually intensive and emotionally arousing content, such as wartime turbulence, heroic protagonists, and spectacular representations of national achievements. Within the context of culture tourism integration, when audiences first watch films and subsequently enter red tourism sites and film-themed culture tourism experience zones, both the visual cortex and emotional centres of the brain are co-activated. This leads to significantly stronger neural activity compared with film viewing alone (Zhu, 2024; Kazharski and Makarychev, 2022; Pineda et al., 2022). From the perspective of IoB, the audience's behaviour of watching films is no longer an isolated event, but a complex process closely related to social environment, cultural background and personal experience. These striking images engage the visual cortex, a critical region for processing visual information. As the eyes capture these visuals, the neurons within the visual cortex activate, decoding and recognising the imagery to generate corresponding perceptions. When audiences witness the brutality and bloodshed of war, the visual cortex responds to significant negative stimuli, resulting in heightened neuronal activity levels (Montez de Oca and Suh, 2020; Chen et al., 2024; Clarke, 2022). In contrast, the depiction of heroic figures stimulates positive responses within the visual cortex, evoking emotions of admiration and reverence. Under the framework of IoB, this kind of visual stimulation is closely related to social interaction. In the process of watching films, the audience may associate with their own social experience, cultural background or values, thus producing a more profound emotional experience.

GAI technology can analyse and process complex data by simulating the neural network structure and function of human brain. In the analysis of neural activity, GAI technology GAI techniques can be employed to create predictive models of neural activity patterns. This allows for an exploration of how audience brain activity relates to their experiences while watching main melody films, particularly within the framework of culture tourism integration and their patriotic sentiments.

Accompanying these visuals, the music in patriotic-themed films often embodies inspiring and uplifting qualities, characterised by majestic symphonies and stirring marches. Entering the brain through auditory pathways, this music activates neurons in

the auditory cortex, which is responsible for processing auditory stimuli. The auditory cortex decodes these musical elements to produce corresponding auditory perceptions. Exposure to exhilarating music generates substantial positive stimuli, leading to increased neuronal activity levels that can elicit emotional responses such as excitement and exhilaration. Furthermore, the interplay of melody and rhythm with the on-screen actions and emotions intricately influences the audience’s brain, producing complex neural activity patterns. The process of audience emotional responses under dual visual and auditory stimulation is depicted in Figure 3.

Figure 3 Neural activity and emotional response processes in audiences under visual and auditory stimulation (see online version for colours)



The portrayal of heroic figures sacrificing themselves for their country evokes intense positive stimuli within the emotional centres of the brain, generating feelings of admiration and deep emotional resonance (Wang, 2022; Miao, 2020; Jackson and Du, 2022). This empathetic engagement fosters a richer understanding of the narrative and character arcs while enabling a profound connection to the essence of national spirit and mainstream values. Themes of self-sacrifice and a strong sense of patriotism encapsulated

by these figures resonate powerfully with audiences, activating the brain's emotional centres (Kawamura and Iwabuchi, 2022; Stepchenkova et al., 2020).

During the viewing of patriotic-themed films, the brain regulates neurotransmitter release in direct response to the film's stimuli and narrative impact, subsequently modulating neuronal activity levels. Observing the courageous actions of heroes prompts the release of neurotransmitters such as dopamine, reinforcing the audiences' identification with and admiration for these characters (Huang, 2022). In contrast, exposure to the brutality and violence of war scenes triggers the release of norepinephrine, which serves to adjust emotional responses to this negative stimulus. Faced with fear or tension, audiences may instinctively engage in deep breathing and muscle relaxation techniques to mitigate these emotional states.

4 Experimental design and performance evaluation

4.1 Experimental materials

The experimental design seeks to explore the capacity of contemporary patriotic-themed films to evoke or reinforce patriotic feelings among audiences, examining the mechanisms behind the elicitation and intensification of these emotions. A dual approach to data collection is employed, integrating questionnaire surveys with physiological measurements to achieve a comprehensive assessment of the influence of patriotic-themed films on audience emotions. To control irrelevant variables as much as possible, 30 independent judges (who do not participate in the formal experiment) are recruited before the formal experiment to evaluate the candidate films from multiple dimensions.

In the context of culture tourism integration, the film *My People, My Country* is chosen as the primary experimental material due to its representation of the main melody genre. This film comprises seven independent narrative segments that illustrate significant historical moments from the 70-year development of the People's Republic of China, highlighting the intertwined fates of individuals and the nation. In contrast, *Operation Mekong*, a non-patriotic action crime film, serves as the control to account for differences in film genre and emotional intensity. By reconstructing iconic scenes from these films or creating related tourism routes, audiences can engage with the film narratives during on-site experiences, thereby enhancing emotional involvement. Preliminary evaluation data show no significant difference between the two films in overall emotional arousal, production quality, and preference level ($p > 0.05$). However, there is a remarkable difference in the distinctiveness and directness of the patriotic theme ($p < 0.001$). Additionally, the films represent two different types: feature and action films. Both demonstrate potential for culture tourism communication; however, *My People, My Country* aligns more closely with the content requirements of red tourism and patriotic education, making it more suitable for examining the emotional impact of main melody films within the framework of culture tourism integration.

4.2 Experimental environment

To scientifically evaluate audiences' patriotic sentiments, the study uses a combination of questionnaires and physiological measurements in the experimental environment. This study defines patriotism as an individual's sense of identity and emotional attachment to

the country, as well as the attitude and behavioural tendency to promote national development through positive actions. This definition covers three aspects: emotion (sense of pride), cognition (national identity), and behaviour (sense of responsibility, rational criticism, and positive action). The basic questionnaire encompasses several key components:

- 1 Demographic information questionnaire: This section gathers essential participant details, including age, gender, and educational background.
- 2 Patriotic emotion questionnaire: A patriotic sentiment questionnaire is designed by combining the national identity scale (Baydhowi et al., 2023) and the constructive patriotism scale (Elban and Aslan, 2023).

This questionnaire is used to systematically evaluate audiences' patriotic sentiments and attitudes before and after watching the film. The questionnaire includes the following five dimensions.

- 1 The national identity dimension assesses an individual's sense of belonging and identity to the country; for example, "I am proud of being a citizen of this country".
- 2 The national pride dimension reflects an individual's positive emotions towards the country's achievements and history, such as "I am proud of the country's development achievements".
- 3 The sense of responsibility dimension measures an individual's attitude towards caring about national and social issues and taking responsibility; for instance, "I care about the improvement of national policies and am willing to put forward suggestions for this purpose".
- 4 The rational criticism dimension assesses an individual's ability to rationally point out national problems and seek improvements on the premise of patriotism; for example, "Pointing out national problems and seeking improvements is a patriotic act".
- 5 The positive action dimension measures an individual's tendency to participate in national construction or improve social issues through actions, such as "I am willing to participate in social activities to promote national development".

The questionnaire consists of 18 items, scored using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Pre-experiment results show that the overall internal consistency of the questionnaire is good. The Cronbach's α coefficient is 0.87, and the Kaiser-Meyer-Olkin (KMO) value is 0.82, indicating that the questionnaire has good reliability and construct validity.

In the physiological measurement aspect, this study tracks changes in participants' heart rates throughout the film viewing process and monitors brainwave activity. EEG facilitates the capture of brain activity patterns during the film screening, with a particular emphasis on fluctuations in the intensity of activity within brain regions linked to emotional processing. Before the commencement of the experiment, all participants received a comprehensive overview of the study's objectives, procedures, and precautions, followed by the signing of an informed consent form.

4.3 Parameters setting

This study focuses on Chinese adults aged 18 to 60 years, aiming to enhance the diversity and representativeness of the participant sample. A total of 160 individuals were recruited, evenly split into an experimental group and a control group, with 80 participants in each. The experimental group engaged with a typical patriotic-themed film, while the control group viewed a non-patriotic-themed film. Throughout the research process, strict adherence to ethical standards was maintained to safeguard participant safety and privacy. All collected data were exclusively utilised for scientific research purposes.

Statistical analysis of the questionnaire data employed SPSS software, facilitating a descriptive analysis of the fundamental statistical characteristics of all variables, including means and standard deviations. Comparisons were made regarding differences in patriotic emotion scores before and after viewing between the experimental and control groups, as well as changes in physiological indicators across the two groups.

4.4 Performance evaluation

1 Descriptive statistics of basic information

The participant composition reveals 42 males and 38 females in the experimental group, contrasted with 40 males and 40 females in the control group. Figures 4 and 5 depict the age distribution and educational background of the two participant groups, respectively. Age distribution appears relatively uniform across both groups, predominantly clustered within the 26-35 and 36-45 age ranges. A substantial proportion of participants possess a bachelor's degree or higher, while individuals with a middle school education or less are notably underrepresented. Statistical analysis indicates no significant differences in gender, age, or educational background between the two groups ($p > 0.05$), affirming comparability.

Figure 4 Age distribution of participants in both groups (see online version for colours)

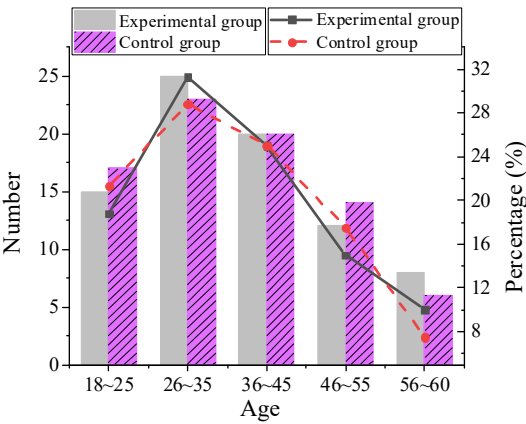
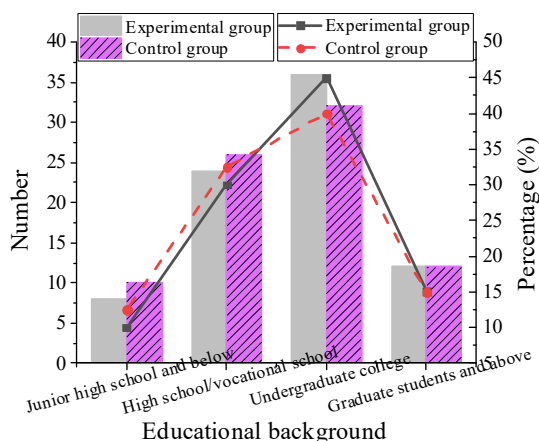


Figure 5 Educational background distribution of participants in both groups (see online version for colours)



2 Results of audience patriotism and physiological changes

Figure 6 shows the comparison of patriotism scores between the two groups. Paired-samples t-tests for pre-test and post-test are conducted for the experimental and control groups, respectively. Bonferroni correction is applied for multiple comparisons to control Type I errors. The results are outlined in Table 2. Combining Figure 6 and Table 2, after watching patriotic-themed films, the experimental group shows a remarkable increase in patriotic sentiments across all five dimensions. This indicates that the films have a significant stimulating effect on the audience's patriotic emotions. Specifically, national identity increases from 3.5 to 4.2 ($t = 4.12$, $p < 0.001$); national pride rises from 3.6 to 4.3 ($t = 4.35$, $p < 0.001$); sense of responsibility improves from 3.4 to 4.1 ($t = 4.01$, $p < 0.001$); rational criticism adds from 3.2 to 3.8 ($t = 3.55$, $p = 0.001$); positive action increases from 3.1 to 3.7 ($t = 3.68$, $p < 0.001$). These data indicate that patriotic-themed films can significantly enhance audiences' sense of pride, national identity, as well as sense of responsibility, rational criticism, and positive action tendency related to constructive patriotism. In contrast, the control group shows no significant changes in patriotic sentiments across all dimensions before and after watching the non-patriotic film ($p > 0.05$). Moreover, Cohen's d value is extremely small, which means the audience's patriotic sentiments remain stable under the control condition. In addition, the comparison between the experimental and control groups at the post-test also shows substantial differences. The p -values of all five dimensions are less than 0.01, and Cohen's d ranges from 0.73 to 0.90. This further verifies the significant effect of patriotic-themed films on enhancing audiences' patriotic sentiments. These findings suggest that the narrative and character arcs in patriotic-themed films effectively evoke feelings of belonging and connection to the nation among audiences. The depiction of historical events and heroic figures amplifies national pride, while the film's storyline promotes a heightened sense of duty to contribute to national development. Conversely, the control group exhibited no significant changes in patriotic sentiments after viewing the non-patriotic film, indicating stability in pre-viewing emotions.

Figure 6 Comparison of patriotism between two groups of participants (see online version for colours)

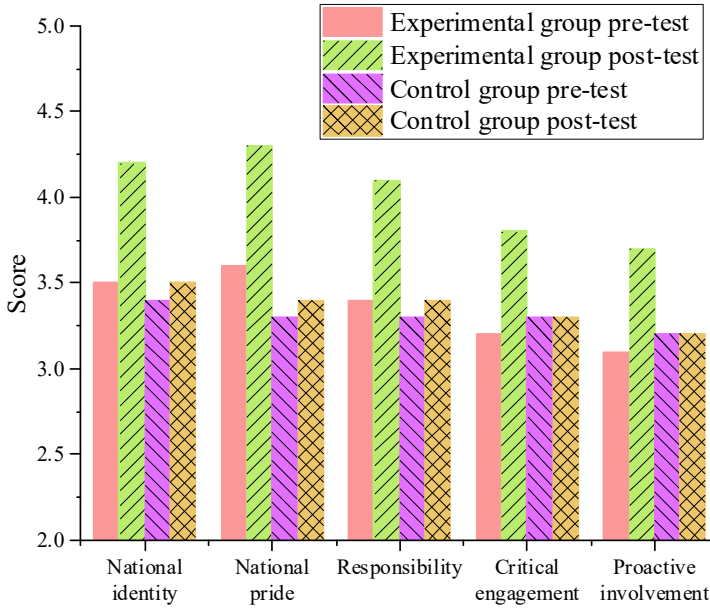
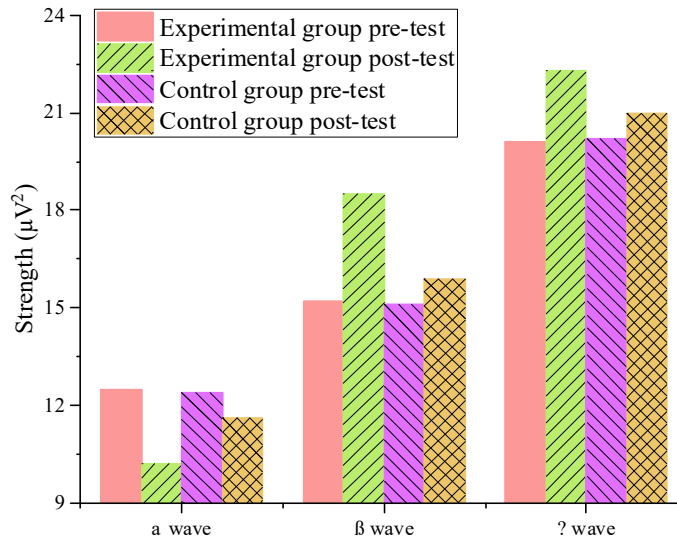


Table 2 Statistical analysis of the results of two groups of patriotic sentiments pre- and post-test

	Dimension	t-value	p-value	Cohen's d	95% confidence interval
Pre-test and post-test of the experimental group	National identity	4.12	<0.001	0.85	[0.45, 1.25]
	National pride	4.35	<0.001	0.9	[0.50, 1.30]
	Sense of pride	4.01	<0.001	0.82	[0.42, 1.22]
	Rational criticism	3.55	0.001	0.73	[0.33, 1.13]
	Positive action	3.68	<0.001	0.75	[0.35, 1.15]
Pre-test and post-test of the control group	National identity	0.98	0.33	0.12	[-0.10, 0.34]
	National pride	1.05	0.3	0.14	[-0.08, 0.36]
	Sense of pride	0.97	0.34	0.12	[-0.09, 0.33]
	Rational criticism	0.12	0.91	0.02	[-0.19, 0.23]
	Positive action	0.15	0.88	0.02	[-0.20, 0.22]
Post-test of the experimental and control groups	National identity	4.12	<0.001	0.85	[0.45, 1.25]
	National pride	4.35	<0.001	0.9	[0.50, 1.30]
	Sense of pride	4.01	<0.001	0.82	[0.42, 1.22]
	Rational criticism	3.55	0.001	0.73	[0.33, 1.13]
	Positive action	3.68	<0.001	0.75	[0.35, 1.15]

Figure 7 Comparison of EEG activity between two groups of participants (see online version for colours)**Table 3** Statistical analysis of EEG results of the two groups pre- and post-test

	EEG wave band	t-value	p-value	Cohen's d	95% confidence interval
Pre-test and post-test of the experimental group	α wave	-3.45	<0.001	0.78	[-3.4, -1.2]
	β wave	3.21	0.002	0.71	[1.1, 4.0]
	γ wave	3.56	<0.001	0.75	[0.8, 2.0]
Pre-test and post-test of the control group	α wave	-1.12	0.27	0.15	[-0.8, 0.3]
	β wave	1.05	0.3	0.14	[-0.5, 1.0]
	γ wave	0.95	0.35	0.13	[-0.6, 1.0]
Post-test of the experimental and control groups	α wave	-3.45	<0.001	0.78	[-3.4, -1.2]
	β wave	3.21	0.002	0.71	[1.1, 4.0]
	γ wave	3.56	<0.001	0.75	[0.8, 2.0]

α waves typically signify relaxation and distraction, while β waves indicate alertness and cognitive engagement. γ waves are often linked to high-level cognitive processing and emotional management. Figure 7 demonstrates the comparison of brain waves between the two groups. Paired-samples t-tests for pre-test and post-test are conducted for the experimental and control groups, respectively, and Bonferroni correction is used to control Type I errors. The results are listed in Table 3. Combining Figure 7 and Table 3, after watching patriotic-themed films, the experimental group shows prominent changes in EEG indicators between the pre-test and post-test. The α wave decreases markedly ($t = -3.45$, $p < 0.001$, Cohen's $d = 0.78$), which suggests an increase in the audience's attention level and cognitive engagement; the β and γ waves increase significantly ($p < 0.01$), with Cohen's d values of 0.71 and 0.75, reflecting an improvement in alertness and the level of general cognitive and emotional activation. In contrast, the control group

has small and insignificant EEG changes between the pre-test and post-test ($p > 0.05$), indicating that non-patriotic films have a limited regulatory effect on audiences' attention and cognitive engagement. The overall results reveal that, within the context of culture tourism integration, main melody films enhance audiences' attentional engagement, alertness, and overall cognitive-emotional involvement.

4.5 Discussion

This study reveals that the neural activation and enhancement of patriotic sentiment triggered by main melody films can be maintained and intensified in offline settings, such as red tourism sites, immersive experiences, and themed educational bases, from the perspective of culture tourism integration. This finding goes beyond mere observation of emotional shifts, revealing underlying mechanisms by which patriotic-themed films modulate emotional responses. Positive elements, such as depictions of heroic deeds and significant national achievements, serve as focal points, channelling audiences' attention away from negative stimuli and thus reducing the likelihood of negative emotional responses. This form of emotional redirection aligns closely with principles in psychological therapy, where individuals are encouraged to concentrate on positive stimuli to mitigate the effects of negative emotions. In patriotic-themed films, emotional elements evoke a profound resonance with audiences, triggering positive affective responses. This resonance transcends the narrative and character portrayals, interweaving with audiences' personal experiences and values. Such an immersive engagement amplifies the overall positive emotional impact, fostering a deeper emotional connection that reflects admiration for the depicted figures and reinforces collective ideals.

The survey conducted by Ni and Coupé (2023) explored the emotional impact of patriotic-themed films on audiences, revealing a marked increase in positive emotions post-viewing. The present study advances these findings by incorporating physiological data, such as heart rate and EEG measurements, thereby offering a more robust foundation of evidence. Through the analysis of physiological changes, this research substantiates the uplifting emotional effects of patriotic-themed films on audiences at a biological level. Schaar and Chang (2023) examined the emotional impact of various film genres and found that patriotic-themed films notably enhance positive emotions. Expanding on this conclusion, the present study delves further into the effects of patriotic-themed films on sentiments of patriotism, enhancing this analysis through physiological data. Bhat (2023) identified significant increases in patriotic sentiments following the viewing of patriotic-themed films. By integrating physiological measurements, this study reinforces Bhat's findings, delivering well-rounded evidence to support these conclusions. By contrasting the emotional impacts of different film genres, this research contributes to a broader theoretical framework in emotional psychology and media studies. The influence of emotional elements in film on audience affect adds empirical support to investigations in emotional psychology, underlining the substantial role of media in shaping audience emotions.

In the culture tourism industry, an integrated monitoring and optimisation system that connects "film, culture, tourism scenarios, and audience emotion" can be developed by leveraging the IoB and GAI. By analysing audiences' EEG signals and behavioural data, personalised culture tourism routes for patriotic education, immersive experience programs, and derivative culture tourism products inspired by main melody films can be designed and optimised. With the continuous maturity and popularisation of these

technologies, the film industry will gradually develop from traditional narrative art to a more intelligent and personalised direction. In this process, the integration of neuroscience and the film industry will become an inevitable trend. The film production team will need to know more about the audience's neural activity mechanism and social interaction behaviour to integrate more elements that meet the audience's needs into the film creation. Meantime, the film industry also needs to constantly introduce new technical means and methods to improve the film production efficiency and viewing experience. Combining IoB and GAI technology, the film industry can provide more personalised and customised services for the audience. By analysing the audience's neural activity data and social interaction behaviour, the film industry can identify the audience's interest preferences and emotional needs, and accordingly recommend film content and viewing methods that meet their needs. For the audience who like exciting plots, the film industry can recommend theme films with strong visual impact and tense atmosphere. For the audience who like deep thinking and emotional resonance, they can recommend films with profound themes and rich emotional connotations. This personalised service can enhance the audience's viewing experience, loyalty, and satisfaction with the film industry.

5 Conclusion

5.1 Research contribution

In the context of deep culture tourism integration, this study systematically investigates the impact of main melody films on audiences' patriotic sentiment using neuroscientific methods. The results show that audiences' positive emotions and patriotic sentiment significantly increase after viewing the films, while negative emotional responses decrease. Physiological data, such as heart rate variations and EEG activity patterns observed during the film viewing, further substantiate the film's capacity to evoke emotional responses. These findings validate the positive emotional effects of main melody films and provide robust physiological evidence, offering scientifically grounded implications for filmmakers and culture tourism practitioners. Such evidence supports the production of emotionally compelling patriotic films and contributes to the development of main melody film IP-driven culture tourism projects and patriotic education-oriented tourism programs. This, in turn, promotes the deep integration of film and culture tourism in value communication and the dissemination of national spirit. By integrating IoB and GAI methodologies, it becomes possible to further interpret audiences' neural activity patterns and the underlying mechanisms of social interaction when viewing main melody films in culture tourism contexts. This integration also enhances film production quality and the effectiveness of marketing strategies while enabling more personalised and customised audience service experiences.

5.2 Future works and research limitations

This study employs survey questionnaires and physiological measurements as primary methods. Future investigations might enhance this framework by integrating in-depth interviews and content analysis, aiming to capture a more nuanced understanding of emotional responses elicited by patriotic-themed films. There is a difference in genre

between the control film and the target patriotic film used in the experiment, which may introduce a confounding effect of film genre on emotions and attention. Therefore, the observed differences in the results may stem from the theme content, film genre, or the interaction between the two. Regarding data interpretation, the α , β , and γ wave EEG indicators used in this study reflect the overall cognitive arousal and attention state, rather than being specific to ‘patriotic emotions’. It is emphasised that these physiological signals should not be directly equated with specific emotions or neurochemical activities. Additionally, this study does not account for the moderating effects of offline culture tourism contexts or on-site immersive experiences on audiences’ neural activity and patriotic sentiment. Thus, future work can be deepened in two aspects. First, it is necessary to select film materials with more matched genres to separate the theme effect. Second, multi-modal physiological sensing is combined to build a more robust emotion computing framework, to capture the audience’s responses more comprehensively. Future studies could design multi-modal experiments that combine film viewing with immersive red tourism experiences, thereby exploring how culture tourism scenarios enhance patriotic sentiment and forming more practice-oriented conclusions aligned with culture tourism integration.

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Declarations

Data will be made available on request.

All authors declare that they have no conflicts of interest.

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