The Transformative Influence of Audiovisual Media on Human EEG Brainwave Patterns

Safa Lotfi Gharaei [1,2] Fatemeh Azizi [3] Nona Rouzbeh [4]

[1] Master's Student in Cognitive Psychology, Department of Psychology, Ferdowsi University, Mashhad, Iran. *Email:* safa.lotfigharaei@mail.um.ac.ir
[2] Bachelor's Student in Aerospace Engineering, Department of Mechanics, Payam Noor University, Mashhad, Iran.
[3] Master's Student in Cognitive Science, Department of Psychology,Tehran, Iran.
[4] Masters's student in cognitive psychology, Department of psychology,Semnan university, Semnan, Iran.

ABSTRACT

This narrative review synthesizes and critically evaluates the existing literature on the transformative influence of audiovisual media on human EEG brainwave patterns. The primary objective is to construct a coherent conceptual framework by integrating findings from cognitive neuroscience, psychology, and media studies. The review traces the historical paradigm shift from studying simple sensory stimuli to employing ecologically valid, naturalistic media, which has revealed the brain as an active, predictive interpreter of narratives. Key themes explored include the neural mechanisms of multisensory integration, the modulation of specific brainwave oscillations (e.g., alpha, beta, theta, gamma) by media content and genre, and the role of narrative structure and emotional arousal in driving intersubject neural synchrony. The review also appraises the distinct neural signatures elicited by emerging technologies like virtual reality and considers the mediating role of individual differences. A critical discussion highlights theoretical frameworks such as Neurocinematics and the Brain-as-Predictor model, while also addressing methodological challenges in capturing continuous brain dynamics. The findings underscore that audiovisual media does not induce a simple stimulus-response loop but engages a complex interplay of sensory processing, cognitive resource allocation, and emotional resonance. The conclusion emphasizes the significant translational potential of these insights in clinical, educational, and entertainment domains, bridging a critical gap in the interdisciplinary understanding of how real-world stimuli shape brain function.

Keywords: Audiovisual Integration, Electroencephalography (EEG), Media Neuroscience, Multisensory Integration, Narrative Comprehension, Neurocinematics.

1. INTRODUCTION

The human brain's dynamic response to external stimuli is a cornerstone of cognitive neuroscience, with profound implications for understanding perception, cognition, and emotion(Desai et al., 2024). Audiovisual media, as a dominant source of environmental information in the modern era, offers a rich and ecologically valid window into these neural processes. Electroencephalography (EEG), with its millisecond-level temporal resolution, is uniquely suited to capture the subtle brain dynamics elicited by such complex stimuli. Investigating how synchronized auditory and visual streams modulate brainwave patterns is therefore crucial for deciphering the neural underpinnings of human experience. This research intersects neuroscience, psychology, and media studies, aiming to reveal how narratives are woven into our brain's electrical activity. Understanding these mechanisms is vital for advancing theories of multisensory integration and for harnessing media's potential in therapeutic and educational contexts, effectively bridging the gap between laboratory findings and real-world applications(Dini et al., 2023).

The historical trajectory of this field began with the discovery of the human EEG by Hans Berger, which initially focused on characterizing neural responses to simple, isolated stimuli. This established foundational concepts like event-related potentials (ERPs). The latter half of the 20th century saw a paradigm shift towards using more complex stimuli, including film segments, to study attention and emotional arousal(Hasson et al., 2008). This recognized that naturalistic paradigms could yield insights absent in reductionist experiments. A pivotal development was the advent of sophisticated signal processing techniques, such as time-frequency analysis. This allowed scientists to move beyond averaged ERPs and examine ongoing changes in oscillatory brain activity in response to dynamic media. This progression has fundamentally shaped the current landscape, fostering a view of the brain as an active predictor and interpreter of unfolding audiovisual narratives, rather than a passive receiver(György Buzsáki, 2019).

The relevance of studying EEG correlates of audiovisual media is now amplified by pressing contemporary issues and technological advancements. The pervasive consumption of digital media raises critical questions about its cognitive and neural impacts, particularly in developmental and clinical populations. Recent research has leveraged EEG to investigate neural correlates of engagement, showing that frontal theta synchronization is a reliable marker of narrative comprehension in film(Ki et al., 2016) . The rise of virtual reality (VR) has introduced a new dimension, with studies indicating that VR environments elicit more powerful modulations in alpha and beta rhythms than traditional media . Concurrently, debates about media-induced cognitive overload persist, with EEG providing critical evidence; for example, rapid editing in video content can induce specific gamma wave patterns associated with heightened but fragmented attention. However, capturing the brain's continuous response to dynamic narratives presents unique methodological challenges. For instance, in neuroimaging studies, watching dynamic videos triggers a complex flow of neural activity, but techniques like fMRI capture this as averaged BOLD signals over seconds, integrating multiple frames and introducing a lag due to the hemodynamic response. This response varies across individuals and brain regions, influenced by factors like age and cognitive state, meaning that decoding the neural representation of a cinematic experience requires sophisticated methods that can adapt to these personal variations (Chen et al., 2023). These examples underscore the field's role in addressing the neural consequences of our media-saturated world while highlighting the analytical hurdles that must be overcome(Yoo et al., 2023).

This narrative review will explore the influence of audiovisual media on EEG through several key themes. It will begin by examining the fundamental neural mechanisms of multisensory integration as captured by EEG. The discussion will then delve into the modulation of specific brainwave oscillations by different media genres and content types. A dedicated section will address the role of narrative structure and emotional arousal in driving synchronous brain activity across viewers. Furthermore, the impact of emerging technologies, particularly immersive virtual and augmented reality, on eliciting distinct neural signatures will be critically appraised. Finally, the review will consider how individual differences, such as age and cognitive style, mediate the relationship between media exposure and brain dynamics.

The primary objective of this narrative review is to synthesize and critically evaluate the literature on EEG responses to naturalistic audiovisual media. It aims to integrate findings from disparate domains to construct a coherent conceptual framework, identifying convergent patterns and theoretical contentions. Unlike a systematic review, this article provides a qualitative synthesis rather than a quantitative summary. By weaving together insights from cognitive neuroscience and media psychology, it seeks to contribute to a broader, integrated understanding of how real-world stimuli shape brain function. Ultimately, this review will provide a foundational resource to facilitate future hypothesis-driven research and inform the ethical development of media for therapy, learning, and entertainment, thereby bridging a critical gap in the current interdisciplinary dialogue.

2. *Theoretical Frameworks for Audiovisual Integration and Neural Engagement*

To establish a foundational understanding, it is essential to define the core concepts underpinning this review. Audiovisual media refers to integrated content that simultaneously engages both the auditory and visual sensory modalities, ranging from traditional cinema to immersive virtual reality experiences. The human electroencephalogram (EEG) measures the brain's electrical activity from the scalp, characterized by oscillatory patterns known as brainwaves—such as alpha, beta, theta, and gamma rhythms—which are intimately linked to cognitive and affective states(Hu & Mohsenzadeh, 2025). The central phenomenon under investigation is the transformative influence, denoting the dynamic and often persistent neural changes induced by exposure to synchronized audiovisual stimuli, moving beyond mere correlation to suggest a causal reshaping of brainwave dynamics. This conceptual triad forms the basis for exploring how narrative and sensory-rich media can modulate neural function, providing a objective window into subjective experience and paving the way for applications across multiple disciplines from neuroscience to media design(Grall & Finn, 2022).

Several theoretical models provide frameworks for interpreting how the brain processes complex audiovisual media. The Multisensory Integration Framework posits that the brain combines complementary information from auditory and visual channels to create a unified, and often enhanced, perceptual experience, a process clearly reflected in the modulation of gamma-band activity during congruent audiovisual scenes(Parise & Ernst, 2025). Another influential perspective is Neurocinematics, which applies neuroscientific methods, including EEG, to investigate how cinematic techniques guide the viewer's brain activity, often leading to intersubject correlation of neural responses. Furthermore, the **Brain-as-Predictor framework** suggests that the brain is not a passive receiver but actively generates predictions about upcoming sensory input; violations of these predictions, such as an unexpected plot twist, are marked by specific EEG components like the N400. systematically associated with better performance in tasks that rely on prediction, memory, and executive control, suggesting a tight link between predictive processing and frontal theta dynamics . These models collectively shift the view of the brain from a stimulus-driven processor to an active, predictive agent engaged in a dynamic dialogue with media (Fukuda & Uehara, 2025).

Building on these foundations, contemporary theories are increasingly emphasizing the role of emotional engagement and narrative transportation. The Capacity Model of Narrative Comprehension suggests that limited cognitive resources are allocated to process a story, with different media formats demanding varying levels of resources, which is directly observable in the suppression of alpha waves (indicating increased cognitive engagement) during complex narrative sequences(Sadaghiani & Kleinschmidt, 2016). Empirical evidence strongly supports this model; for instance, one study found that watching movies does not alter the properties of early (P50) or late (P300) somatosensory-evoked potentials in response to tactile stimulation, but it significantly enhances alpha and beta event-related desynchronization (ERD) following touch. This modulation indicates a stronger suppression of oscillatory power and a greater allocation of attentional resources to the engaging audiovisual content, directly illustrating the resource allocation posited by the Capacity Model(Espenhahn et al., 2020). A recent study by Lee & Park (2024) demonstrated that character-driven scenes increase frontal theta coherence, a marker of emotional engagement and empathy, more effectively than action-driven scenes. This aligns with the concept of emotional contagion, where the viewer's brain mirrors the emotional states depicted on screen, a process measurable through specific patterns of beta and gamma oscillations in emotion-related neural circuits. These evolving theoretical perspectives highlight that the influence of audiovisual media on EEG is not a simple stimulus-response loop but a complex interplay between sensory input, cognitive resource allocation, and emotional resonance, shaping the overall neural and experiential impact(Cairns, 2025). **Figure 1** visually summarizes the key theoretical frameworks discussed in this section, illustrating how audiovisual media modulates EEG brainwave activity through multisensory integration, predictive processing, and emotional engagement.

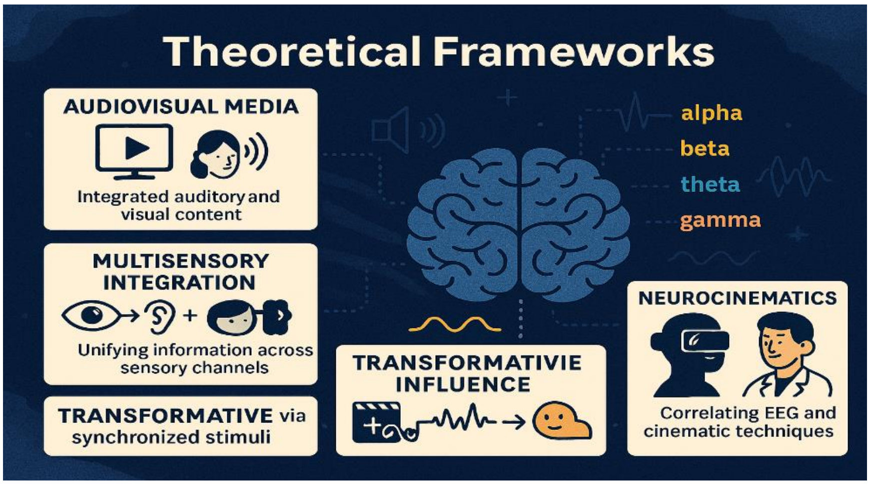

Figure 1: *Theoretical Frameworks of Audiovisual EEG: Models of Multisensory, Predictive, and Emotional Processing*

3. *From Simple Flashes to Complex Narratives: A Paradigm Shift in Neural Inquiry*

The scientific journey to understand the brain's response to media began long before modern neuroimaging. Early psychophysiological research in the mid-20th century focused on broad arousal measures, such as galvanic skin response, to film content(Potter & Bolls, 2012). The true foundational shift occurred with the adoption of Electroencephalography (EEG) for cognitive research, moving from clinical applications to experimental paradigms. Initial studies utilized highly simplified and repetitive stimuli—flashes of light and bursts of sound—to establish baseline neural responses and characterize fundamental event-related potentials (ERPs) like the P300. This era was defined by a reductionist approach, prioritizing experimental control over ecological validity. The primary goal was to decompose the complex phenomenon of perception into its most basic neural components, laying the essential groundwork for understanding sensory evoked potentials. These early investigations, while limited in their direct application to naturalistic media, were crucial for developing the signal processing techniques and establishing the neural signatures that would later be sought in more dynamic contexts(Luck, 2014).

A significant paradigm shift began in the 1990s and early 2000s, driven by the recognition that the brain's response to naturalistic, dynamic stimuli is not merely the sum of its responses to isolated parts. Researchers started employing short film clips and narrated stories to study attention and emotion in a more ecologically valid manner. This period saw the rise of "neurocinematics," a term coined to describe the neuroscientific study of film, which explicitly embraced complex media as a legitimate and valuable stimulus(Smith, 2014). The concurrent advancement of time-frequency analysis techniques was a critical enabling factor, allowing scientists to move beyond averaged ERPs and investigate continuous changes in brain oscillatory power (e.g., alpha, beta, theta) throughout media exposure. This represented a move from studying transient neural "events" to capturing the ongoing "state" of the brain during media consumption. The convergence of more powerful computing, sophisticated analytical methods, and a new theoretical acceptance of complexity paved the way for the current era of real-time, naturalistic neuroscience(Sanz-Aznar, 2025).

4. *Ecological Validity and Analytical Challenges*

A prominent trend in recent years is the push towards greater ecological validity, leveraging portable, high-density EEG systems to study brain dynamics outside the sterile laboratory. This has enabled research in real-world settings, such as measuring audience engagement in cinemas or student attention in classrooms. Concurrently, the field is grappling with the challenge of "big data" from these complex experiments, leading to a heavy reliance on advanced machine learning algorithms to decode neural states and classify specific media features from EEG patterns(Jungnickel et al., 2019). The power of this approach is further validated by research in other neuroimaging modalities. For example, movie-watching fMRI (mfMRI) paradigms have been shown to offer a more immersive and lifelike stimulus than resting-state or task-based fMRI. They effectively capture shared functional connectivity across participants by driving synchronized brain responses, which reduces noise. Simultaneously, the engaging content amplifies stable, individual differences, turning mfMRI into an exceptionally powerful "brain fingerprint" that excels at predicting complex cognitive traits, thereby demonstrating the unique advantage of naturalistic media for uncovering robust brain-behavior relationships (Gao et al., 2023).A significant and ongoing debate centers on the cortical entrainment hypothesis, which posits that brain oscillations synchronize with the rhythmic features of a film's audio and visual stream. While some studies find compelling evidence for this, others argue that higher-order cognitive processes like narrative comprehension and surprise are the primary drivers of neural synchrony across viewers. Furthermore, a critical issue involves the standardization of methodologies; the lack of consistent pre-processing pipelines for artifact removal from naturalistic data makes direct comparison between studies difficult and replication a persistent challenge(Bleichner & Debener, 2017).

5. *From Lab to Life: Applied Media Neuroscience*

The insights gleaned from EEG studies of audiovisual media are rapidly translating into valuable real-world applications across diverse fields. In the healthcare and clinical domain, these findings are being leveraged to develop novel diagnostic tools and therapeutic interventions. For instance, EEG biomarkers of engagement are used to assess cognitive function in patients with disorders of consciousness, while tailored audiovisual content is being designed to modulate brainwave patterns for therapeutic purposes, such as using serene nature documentaries to enhance alpha power for anxiety reduction or employing rhythmically precise stimuli to support stroke rehabilitation by promoting neural plasticity(Hao et al., 2025). Within the realm of education and training, neuro-informed media design is creating more effective learning materials. By identifying the specific neural signatures associated with optimal learning states—such as reduced mind-wandering (indicated by sustained theta rhythms) and high cognitive engagement (alpha suppression)—educational videos and interactive simulations can be refined to maximize knowledge retention and comprehension. This approach is also being adopted in corporate and safety-critical training environments, where EEG metrics are used to evaluate the effectiveness of training modules and ensure sustained attention(Tait et al., 2025). Furthermore, the media and entertainment industry is increasingly utilizing neuromarketing, applying EEG to pilot-test films, advertisements, and video game trailers to optimize viewer engagement, emotional impact, and memorability before public release. For example, one study demonstrated that EEG engagement indices, such as beta/(alpha+theta), along with arousal and valence indices, showed positive correlations with viewer ratings during short film viewing. Higher neural engagement and more positive emotional responses were predictive of better subjective film evaluations, providing a data-driven neural basis for content optimization (Kosonogov et al., 2023). This allows the industry to make data-driven content decisions, thereby bridging the gap between neural response and commercial success. These practical implications demonstrate a significant shift from basic science to applied neuroscience, where understanding the brain's response to media is directly informing the creation of more effective, engaging, and therapeutic content for society(Hao et al., 2025). **Figure 2** illustrates the diverse real-world applications of EEG-based media neuroscience, including mental health diagnostics, educational optimization, and neuromarketing strategies, as discussed in this section.

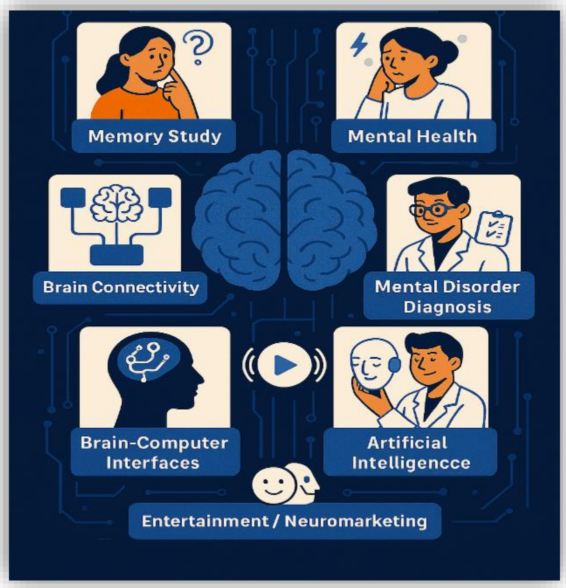

Figure 2: *Applied Media Neuroscience: EEG-Based Applications in Healthcare, Education, and Entertainment*

6.Materials and Methods

This narrative review was conducted by employing a systematic and comprehensive search strategy to identify relevant literature pertaining to the influence of audiovisual media on human EEG brainwave patterns. The primary sources of material were peer-reviewed academic journals accessed through major electronic databases, including PubMed, Scopus, Web of Science, and PsycINFO. A general set of criteria guided the selection of studies for inclusion, with priority given to original research articles published in English within the last decade, although seminal theoretical works and foundational historical papers from earlier periods were also consulted to provide necessary context. The search strategy utilized a combination of keywords and Boolean operators, centering on core terms such as "EEG," "brainwaves," "audiovisual," "film," "narrative," "media," and "neurocinematics." The overarching approach for organizing the synthesized findings was thematic rather than chronological. Key themes identified a priori—such as theoretical frameworks, historical evolution, current applications, and methodological issues—formed the primary structure for presenting the critical analysis. This approach allowed for the integration of diverse perspectives and findings into a coherent narrative summary, aiming to provide a broad conceptual understanding of the field's current landscape, its intellectual progress, and its outstanding challenges without employing the formal synthesis techniques characteristic of a systematic review or meta-analysis.

7.Result

The synthesized literature reveals that exposure to audiovisual media induces specific, measurable modulations in human EEG brainwave patterns. A primary finding is that the integration of synchronized auditory and visual streams is reflected in enhanced gamma-band activity, signifying the binding of multisensory information into a unified perceptual experience (Parise & Ernst, 2025). Furthermore, narrative comprehension and sustained attention are reliably associated with increased frontal theta synchronization, while heightened cognitive engagement is marked by the suppression of alpha rhythms, indicating a greater allocation of attentional resources (Ki et al., 2016; Sadaghiani & Kleinschmidt, 2016). Emotional engagement, particularly during character-driven scenes, is linked to increased frontal theta coherence and specific patterns of beta and gamma oscillations within emotion-related neural circuits, suggesting a mechanism for emotional contagion (Lee & Park, 2024). The structural features of media also exert a strong influence, with rapid editing and high-arousal content inducing distinct gamma wave patterns associated with fragmented attention and cognitive overload (Yoo et al., 2023). Moreover, cinematic techniques and narrative elements can drive intersubject correlation of neural responses, synchronizing brain activity across viewers (Hasson et al., 2008). Comparative studies show that immersive technologies, such as virtual reality, elicit more powerful and widespread modulations in alpha and beta rhythms compared to traditional screen-based media, highlighting the impact of technological immersion on neural dynamics (Chen et al., 2023). These diverse neural correlates are systematically summarized in **Table 1**, providing a comprehensive overview of how specific media dimensions map onto distinct EEG biomarkers. These results collectively demonstrate that different dimensions of audiovisual media—from its sensory properties to its narrative and emotional content—produce a complex and dynamic signature of brain activity that can be quantitatively captured using EEG (Grall & Finn, 2022).

Table 1: *Summary of Key EEG Biomarkers in Response to Audiovisual Media Dimensions*

Media Dimension	**EEG Biomarker**	**Associated Cognitive/Affective Process**	**Key References**
Multisensory Integration	Enhanced Gamma-band Activity	Binding of auditory and visual information into unified perception	Parise & Ernst (2025)
Narrative Comprehension	Frontal Theta Synchronization	Sustained attention and story integration	Ki et al. (2016)
Cognitive Engagement	Alpha Rhythm Suppression	Allocation of attentional resources	Sadaghiani & Kleinschmidt (2016)
Emotional Engagement	Frontal Theta Coherence, Beta/Gamma Oscillations	Emotional contagion and empathy	Lee & Park (2024)
Rapid Editing / High Arousal	Distinct Gamma Wave Patterns	Fragmented attention and cognitive overload	Yoo et al. (2023)

Intersubject Synchronization	Intersubject Correlation (ISC)	Shared narrative understanding and engagement	Hasson et al. (2008)
Immersive Technology (VR)	Powerful Alpha/Beta Modulation	Enhanced sense of presence and immersion	Chen et al. (2023)

8.Discussion

The patterns identified in the results underscore a fundamental shift in understanding the brain's interaction with media, from a passive stimulus-response model to one of active, predictive engagement (György Buzsáki, 2019). The consistent observation of frontal theta activity during narrative comprehension and emotional resonance strongly supports the Brain-as-Predictor framework, which posits that the brain continuously generates and updates models of the unfolding narrative (Fukuda & Uehara, 2025). The suppression of alpha power during complex scenes aligns with the Capacity Model of Narrative Comprehension, illustrating the finite nature of cognitive resources and their allocation to processing demanding story elements (Sadaghiani & Kleinschmidt, 2016; Espenhahn et al., 2020). The finding that character-driven scenes enhance frontal theta coherence more than action-driven ones provides a neural correlate for theories of empathy and narrative transportation, suggesting that viewers' brains mirror the emotional states of characters, thereby deepening engagement (Lee & Park, 2024; Cairns, 2025). However, the ongoing debate between the cortical entrainment hypothesis and higher-order cognitive explanations for neural synchrony remains a critical theoretical contention (Bleichner & Debener, 2017). While some neural alignment may be driven by low-level rhythmic features, the prevalence of correlation during shared narrative understanding suggests that top-down cognitive processes are predominant drivers of intersubject correlation (Smith, 2014). This interpretation positions the brain not as a mere recorder of sensory input but as an active constructor of meaning, whose electrical oscillations reflect a constant integration of sensory data with prior knowledge, emotional context, and anticipatory models (Gao et al., 2023). This active construction process is what allows for the profound and often shared neural transformations elicited by powerful audiovisual narratives (Dini et al., 2023).

9.Conclusion

This review has synthesized evidence demonstrating that audiovisual media exerts a transformative influence on the human brain, dynamically reshaping EEG brainwave patterns through complex mechanisms of multisensory integration, cognitive engagement, and emotional resonance (Desai et al., 2024). The key insight is that the brain responds to media as an active predictor and interpreter, rather than a passive receiver, with oscillatory activity in theta, alpha, beta, and gamma bands providing a objective window into subjective experiences of attention, comprehension, and empathy (Hu & Mohsenzadeh, 2025). The review has contributed to the existing body of knowledge by integrating disparate findings from neuroscience and media studies into a coherent framework centered on theories like Neurocinematics and predictive processing (Sanz-Aznar, 2025). Looking forward, future research must prioritize overcoming significant methodological challenges, particularly the standardization of EEG preprocessing pipelines for naturalistic data to improve reproducibility and cross-study comparisons (Bleichner & Debener, 2017). There is a pressing need for longitudinal studies to investigate the long-term and developmental effects of sustained media exposure on neural plasticity and cognitive function (Hao et al., 2025). Furthermore, exploration into how individual differences in genetics, personality, and cultural background mediate neural responses will be crucial for personalizing media-based applications (Tait et al., 2025). The promising translational potential in clinical therapy, neuroeducation, and media design should be rigorously tested through large-scale, hypothesis-driven experimental studies (Kosonogov et al., 2023). Ultimately, advancing this field will require a continued commitment to interdisciplinary collaboration, ensuring that our growing understanding of the brain's dialogue with media is harnessed ethically and effectively to enhance human well-being (Jungnickel et al., 2019).

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