AI-Powered Neuromarketing in Digital Commerce: Legal and Ethical Concerns

Authors

[1]Ms. Simran Bharti, [2]Ms. Basabi Pandey, [3]Ms. Priya Tyagi, [4]Mr. Sanjay Singh Rawat

[1]Assistant Professor, Innovative Institute of Law, Greater Noida (U.P.),

[2] Assistant Professor, Innovative Institute of Law, Greater Noida (U.P.),

[3] Assistant Professor, Royal College of Law, Ghaziabad (U.P.),

[4] Assistant Professor, Jigyasa University, Dehradun (U.K.)

Abstract

Neuromarketing refers to the application of neuroscientific tools such as electroencephalography (EEG), functional magnetic resonance imaging (fMRI), eye tracking and biometric sensing to study consumers' subconscious responses to marketing stimuli, and, increasingly, to optimise digital advertising and interface design in real time. When combined with artificial intelligence (AI) techniques particularly machine learning, deep learning and generative models—neuromarketing enables highly granular profiling and personalised persuasion in digital commerce environments, from e-commerce platforms and social media marketplaces to immersive retail experiences. This convergence promises efficiency gains for firms and more tailored consumer experiences but simultaneously raises significant legal and ethical concerns around privacy, autonomy, cognitive manipulation, discrimination and accountability.

This paper examines AI-powered neuromarketing as an emerging phenomenon in digital commerce, analyses its ethical risks through the lenses of autonomy, cognitive liberty, informed consent and fairness, and evaluates how existing legal frameworks such as data protection law, consumer protection and advertising regulation, and nascent AI-specific instruments address or fail to address these challenges. It adopts a doctrinal and analytical methodology, drawing on European Union law (notably the General Data Protection Regulation, the Unfair Commercial Practices Directive and the AI Act), comparative perspectives from the United States, and the evolving Indian regime under the Digital Personal Data Protection Act 2023 and consumer-protection law, with a focus on digital marketing and targeted advertising. The paper argues that although general data-protection and consumer-law principles provide an initial regulatory foundation, the opacity, behavioural targeting power and cross-border nature of AI-driven neuromarketing call for clearer rules and enforcement strategies, including safeguards for vulnerable consumers and recognition of cognitive liberty as an emerging normative benchmark.

Keywords: Neuromarketing, Artificial Intelligence, Data Protection, Consumer law, Privacy, Liberty

1.0 Introduction

Neuromarketing, initially developed as an application of consumer neuroscience in laboratory settings, has moved rapidly into commercial practice as digital commerce platforms have acquired the technical capacity and data resources to deploy neuro-inspired metrics at scale. Where early neuromarketing relied on small-scale fMRI or EEG studies of advertising stimuli, contemporary practice is increasingly mediated by AI systems that infer attention, emotion and preference states from biometric signals and behavioural traces such as gaze patterns, click-streams and micro-interactions. These systems are used to optimise product placement, pricing, advertising creatives and user-interface design in real time, with the aim of nudging consumers towards desired choices.[4][5][6][1]

In parallel, digital commerce has become a primary locus of economic and social life, with e-commerce, app-based marketplaces and social-media commerce intermediating a substantial share of retail activity worldwide. AI-powered personalisation and recommender systems are already recognised as raising distinct consumer-protection and data-protection issues, including opacity, filter bubbles and profiling based on sensitive attributes. Neuromarketing techniques intensify these concerns by explicitly targeting pre-reflective cognitive and affective mechanisms, fuelling debates about manipulation, exploitation of vulnerability and threats to mental self-determination.[3][9][^6]

This paper situates AI-powered neuromarketing within this broader legal and ethical landscape. It first clarifies the concept and technological foundations of neuromarketing in digital commerce; then maps key ethical concerns; next analyses relevant legal regimes in the European Union, United States and India; and finally identifies regulatory gaps and proposes normative and policy recommendations. The study is limited to consumer-facing neuromarketing applications in digital commerce and does not address political neuromarketing or purely clinical research.

1.1 Research Methodology

This paper adopts a doctrinal and analytical research methodology, supplemented by comparative and interdisciplinary perspectives. The doctrinal component involves close reading and interpretation of legal texts, including data-protection statutes (such as the GDPR and the DPDP Act), consumer-protection and advertising-law instruments (such as the UCPD and the Consumer Protection Act 2019), and emerging AI-specific regulations and policy guidelines. Judicial decisions and regulatory enforcement actions relating to targeted advertising, biometric data and manipulative design are analysed to infer how existing principles might apply to neuromarketing scenarios, even where the term “neuromarketing” is not explicitly used.

1.2 Scope and Limitations of the Study

The scope of this paper is limited to neuromarketing practices deployed in digital commerce contexts, broadly understood to include e-commerce platforms, app-based marketplaces, social-media commerce and immersive retail environments. It focuses on consumer-facing applications where neuro-physiological or closely related biometric and behavioural data are used, in combination with AI techniques, to design, target or optimise marketing interventions. Political neuromarketing, electoral campaigning, clinical neuro-research and purely offline retail settings fall outside the primary scope, except where they inform conceptual or legal analogies.

Geographically, the paper emphasises the European Union, India and, to a lesser extent, the United States and other jurisdictions that have adopted GDPR-inspired data-protection frameworks. This selection reflects both the prominence of these jurisdictions in shaping global data-protection and consumer-protection norms and the availability of relevant legal and policy materials. The analysis does not attempt a systematic survey of all national regulatory regimes and thus may omit important developments in other regions.

Substantively, the paper is constrained by the fast-moving nature of AI and digital-commerce regulation. Legislative and regulatory initiatives, particularly in India and in relation to AI-specific rules, are in flux, and some proposals discussed here may be amended or superseded. Furthermore, the actual technical capabilities and commercial deployment of AI-powered neuromarketing are difficult to assess due to proprietary practices, trade-secret protections and marketing hype. The paper therefore adopts a cautious stance, distinguishing between demonstrated capabilities and speculative claims and highlighting areas where further empirical research is needed.

1.3 Literature Review

Neuromarketing techniques and efficacy

Empirical research on neuromarketing has grown rapidly, with numerous studies exploring the use of EEG, fMRI and eye-tracking to predict consumer preferences and evaluate marketing stimuli. Systematic reviews of EEG-based neuromarketing find that EEG measures such as frontal asymmetry and event-related potentials can correlate with self-reported preferences and purchase intentions, although methodological heterogeneity and small sample sizes limit generalisability. Eye-tracking research shows that fixation duration and gaze paths provide valuable information about visual attention in advertising and web-page design, and can complement traditional self-report measures in understanding consumer behaviour.[4][5]

Some scholars argue that neuromarketing offers incremental rather than revolutionary gains over conventional marketing research, and caution against over-interpreting neuro-metrics as direct indicators of purchase decisions. Others highlight the potential of neuromarketing to reveal implicit attitudes and biases

that respondents may be unwilling or unable to articulate, especially in socially sensitive domains. This debate informs ethical assessments by challenging simplistic narratives about mind-reading and emphasising the need for realistic appraisal of what AI-enhanced neuromarketing can and cannot do.[12][5][^4]

Ethical analyses of neuromarketing

Ethical discussions of neuromarketing typically centre on manipulation, autonomy and the legitimacy of targeting consumers' non-conscious processes. Early critics warned that neuromarketing could enable advertisers to exploit "hidden persuaders" by identifying brain responses associated with reward and using them to craft highly persuasive messages. More recent analyses adopt a nuanced view, recognising that all marketing involves some degree of influence and that neuromarketing, if used transparently and with proper safeguards, could improve relevance and reduce waste.[14][12]

At the same time, scholars emphasise that neuromarketing raises particular concerns where vulnerable populations are targeted or where techniques cross the line from influence to manipulation by deliberately exploiting cognitive limitations. The notion of cognitive liberty has been proposed as a guiding principle, with some authors calling for constitutional or human-rights recognition of a right to mental self-determination that would constrain intrusive neuromarketing and other neurotechnologies. Industry-oriented writings stress the importance of ethical codes, informed consent and adherence to medical-ethics-style standards in neuromarketing practice.[1][14][5][2]

AI, consumer protection and personalised advertising

The broader literature on AI in marketing and personalised advertising provides essential context for understanding neuromarketing's legal and ethical implications. Studies of generative AI in marketing examine risks of deception, bias and opacity in AI-generated advertising copy and images, and assess whether instruments such as the UCPD, the AI Act and the Digital Services Act are fit to address these risks. Consumer-protection scholars argue that AI-driven personalised marketing can undermine traditional assumptions about rational, informed consumers and may require a shift towards a more vulnerability-sensitive model of regulation.[9][3]

Policy analyses by organisations such as UNCTAD highlight the benefits and risks of AI in e-commerce, noting that AI can enhance price transparency, product matching and dispute-resolution mechanisms, while also enabling manipulation, discriminatory pricing and opaque decision-making. In the Indian context, legal commentary has focused on targeted and behavioural advertising, examining how the DPDP Act and existing IT-law rules intersect with consumer-protection concerns and recent European case law on Meta's advertising practices. These discussions underscore the relevance of AI-specific and data-protection norms for neuromarketing regulation.[8][6][^10]

2.0 Conceptualising AI-Powered Neuromarketing

2.1 Defining neuromarketing and its tools

Scholarly and industry definitions converge on neuromarketing as the application of neuroscientific methods and insights to marketing problems, typically by measuring brain and physiological responses to advertising, branding and product stimuli. Common tools include fMRI, which measures changes in blood-oxygen levels to infer regional brain activity; EEG, which records electrical activity along the scalp with high temporal resolution; and peripheral biometric sensors that track heart rate, galvanic skin response, facial expression and eye movements. These techniques are complemented by eye-tracking technologies that record gaze fixation and saccades to infer attention distribution across a visual scene such as a web page, advertisement or product shelf.[5][1][^4]

In digital commerce, these tools are deployed both in experimental settings—to test the effectiveness of particular designs or messages—and, increasingly, in operational environments where lightweight sensors and computer-vision systems can be integrated into consumer devices or interfaces. The resulting data sets, often comprising high-dimensional temporal signals, are well-suited to analysis with machine-learning methods that detect subtle patterns relating stimulus features to neural or biometric responses. [^5]

2.2 The role of AI in neuromarketing

AI amplifies neuromarketing in at least three ways. First, supervised learning models can be trained on labelled neuro-physiological data to predict constructs such as emotional valence, arousal or purchase intent from new data, enabling automated scoring of marketing stimuli. Second, reinforcement-learning and multi-armed bandit algorithms can be combined with these scores and behavioural outcomes (such as click-through and conversion rates) to iteratively optimise content presentation in real time. Third, generative AI models can create customised advertising copy, images or interactive experiences that are tailored to inferred psychological profiles, thereby closing the loop between measurement, prediction and content generation.[6][3][4][5]

This integration of measurement and optimisation is particularly pronounced in digital commerce, where platforms already use AI-driven recommendation and pricing systems and have constant access to behavioural data. When neuro-metrics are layered on top of conventional behavioural profiling, firms may gain unprecedented insight into, and leverage over, consumers' subconscious preferences and susceptibilities, raising concerns that go beyond traditional persuasive advertising.[9][6]

2.3 Distinguishing neuromarketing from adjacent practices

Not all AI-driven personalisation or behavioural targeting constitutes neuromarketing. Conventional targeted advertising relies primarily on click-stream data, demographic attributes and inferred interests, without direct measurement of neuro-physiological states. Neuromarketing is distinguished by its use of brain or biometric data to directly probe and model neural and affective processes relevant to decision-making, even if in operational settings this may be approximated through AI models trained on smaller neuro-data sets. The line between neuromarketing and non-neuro behavioural targeting is nevertheless porous, especially where computer-vision systems infer emotional responses from facial micro-expressions or where gaze tracking is embedded in consumer hardware.[10][11][4][5]

This fluid boundary complicates legal classification. From a data-protection perspective, many neuromarketing data streams fall within the category of biometric or health-related data and thus attract heightened protection, whereas other behavioural signals may be treated as ordinary personal data. From a consumer-protection standpoint, however, what matters are the effects on autonomy, fairness and vulnerability, which may be similar regardless of whether the underlying signals are strictly "neuro" in a medical sense.[7][6]

3.0 Ethical Concerns in AI-Powered Neuromarketing

3.1 Autonomy, manipulation and cognitive liberty

A central ethical concern is that AI-powered neuromarketing can threaten consumer autonomy by targeting subconscious processes in ways that bypass or undermine rational deliberation. Critics argue that by identifying stimuli that trigger reward-related brain activity or heightened arousal, marketers can craft "hyper-persuasive" messages that exploit cognitive biases and impulsive tendencies, particularly in digital environments engineered for constant engagement. When AI systems continuously adapt these messages in response to neural or biometric feedback, the boundary between persuasion and manipulation becomes blurred.[12][2][^5]

The emerging concept of cognitive liberty—understood as the right to mental self-determination and protection against unwanted interference with one's thought processes—has been invoked in debates about neurotechnology and neuromarketing. While not yet widely codified in binding legal instruments, cognitive liberty resonates with existing human-rights guarantees of freedom of thought and privacy, and suggests that systematic efforts to influence neural processes without meaningful consent may be ethically impermissible even where they comply with formal data-protection rules.[2][6][^5]

3.2 Informed consent and transparency

Neuromarketing methods raise complex questions about informed consent and transparency, particularly when deployed in everyday digital commerce rather than controlled research settings. Traditional neuromarketing studies emphasise voluntary participation, written consent and non-invasive methods analogous to routine medical diagnostics. In operational digital environments, however, consumers may be unaware that their biometric or quasi-biometric signals are being collected and analysed for marketing optimisation, especially where such collection is embedded in interface design or bundled into lengthy privacy notices.[1][7][10][5]

AI further complicates meaningful consent because model inferences often go beyond the data explicitly provided by users, generating sensitive profiles about emotional states, vulnerabilities or impulsive tendencies. Even where users nominally consent to data processing for "personalisation", they are unlikely to grasp the extent to which neuro-informed AI systems can infer and exploit subconscious traits. This raises questions about the validity of consent and the need for heightened disclosure obligations, opt-out mechanisms and default protective settings in neuromarketing contexts.[13][6]

3.3 Privacy, data protection and security

Neuromarketing data sets typically involve sensitive physiological and behavioural information that can reveal intimate aspects of personality, health status and cognitive functioning. Under frameworks like the EU's General Data Protection Regulation, biometric and health data are subject to stricter processing conditions, including requirements of explicit consent and limitations on profiling. In India, the Digital Personal Data Protection Act 2023 requires consent-based processing and recognises certain "sensitive" use cases, and earlier rules under the Information Technology Act treated biometric data as "sensitive personal data".[8][11][7][10][^5]

AI-powered neuromarketing multiplies privacy risks by enabling large-scale aggregation and cross-contextual profiling. Neuro-physiological data collected in one setting (e.g., a VR shopping app) may be combined with behavioural data from other services to build comprehensive profiles for targeted advertising, dynamic pricing or credit scoring. These practices raise concerns about function creep, data minimisation and the risk of data breaches exposing inherently sensitive information. Ensuring robust security safeguards, purpose limitation and strict retention policies is thus critical to any ethical neuromarketing deployment.[6][10]

3.4 Vulnerable consumers and discrimination

AI-powered neuromarketing may disproportionately affect vulnerable consumer groups, including children and adolescents, persons with cognitive impairments, and individuals in situations of economic or emotional vulnerability. These groups may be less able to recognise or resist sophisticated persuasive techniques, and

may be particularly susceptible to impulse purchasing, addictive design patterns or exploitative pricing strategies amplified by neuro-informed AI systems.[3][9][13][6]

There is also a risk of discriminatory outcomes where AI models trained on neuro-physiological data reproduce or exacerbate bias, for example by differentially targeting or excluding certain demographic groups based on inferred responsiveness. While neuromarketing is generally framed as a tool for increasing conversion rates rather than explicit exclusion, the combination of granular profiling and algorithmic optimisation can lead to opaque forms of segmentation with distributive implications, calling for fairness-oriented design and impact assessment.[9][13]

3.5 Professional ethics and research integrity

Beyond consumer-facing concerns, neuromarketing raises issues of professional ethics for marketers, neuroscientists and data scientists involved in designing and deploying AI-driven systems. Industry bodies and academic commentators have called for codes of conduct that limit the use of neuroscientific methods for manipulative purposes and require transparency when research is sponsored by commercial entities. Questions arise about the appropriate boundary between academic consumer-neuroscience research and proprietary neuromarketing, and about potential conflicts of interest when scientific tools are repurposed for persuasive applications.[14][1]

Research integrity issues also surface where claims about neuromarketing efficacy are exaggerated or where neuro-data are collected without adequate ethical review. Some commentators note that neuromarketing's practical impact may be more modest than feared, and warn against overstating its predictive power in ways that mislead clients or justify intrusive data-collection. A balanced ethical assessment must therefore consider both the actual capabilities of AI-driven neuromarketing and the reputational and trust risks created by unrealistic promises.[12][4]

4.0 Legal Frameworks Governing AI-Powered Neuromarketing

4.1 Data protection and privacy law

4.1.1 European Union: GDPR and related instruments

In the European Union, neuromarketing practices involving identifiable individuals fall within the scope of the General Data Protection Regulation (GDPR), which treats biometric and health-related data as "special categories" subject to heightened safeguards. Processing such data generally requires explicit consent or another limited ground, and is subject to principles of purpose limitation, data minimisation and storage limitation. Profiling that produces legal or similarly significant effects—such as dynamic pricing or credit

decisions—triggers additional protections, including the right not to be subject to solely automated decisions and requirements of human oversight.[7][10][^3]

Neuromarketing that uses AI to infer emotional states or psychological traits from biometric or behavioural data may also fall under emerging rules on "emotion recognition" and "biometric categorisation" in the EU's Artificial Intelligence Act, which restricts such practices in certain contexts and imposes transparency and risk-management obligations in others. Combined with the Digital Services Act and the e-Privacy framework, these instruments create a layered regime governing tracking, profiling and targeting in digital services.[3][9]

4.1.2 India: DPDP Act and ancillary rules

India's Digital Personal Data Protection Act 2023 adopts a consent-centric model, requiring notice and consent for most personal-data processing, subject to limited legitimate uses. While it does not enumerate special categories of data in the same way as the GDPR, prior rules under the Information Technology Act—which remain relevant until fully replaced—explicitly classify biometric data as "sensitive personal data or information" and subject it to stricter conditions. For AI-powered neuromarketing, this suggests that collection and use of biometric or neuro-physiological signals for targeted advertising would need clear, specific consent and robust security safeguards.[15][11][^8]

In addition, India's evolving jurisprudence on informational privacy following the Supreme Court's decision in *K.S. Puttaswamy v. Union of India* has underscored the constitutional significance of data protection and autonomy, which can inform interpretation of statutory obligations in marketing contexts. Commentators analysing targeted and behavioural advertising in India note that the DPDP Act, read with consumer-protection law, will require marketers and platforms to reassess their data-processing practices, adopt privacy-by-design measures and provide meaningful opt-out mechanisms for personalised advertising.[8][15][^10]

4.1.3 United States and other jurisdictions

In the United States, there is no comprehensive federal data-protection statute analogous to the GDPR, but sectoral laws (such as health-privacy rules and children's privacy legislation) and state-level data-protection acts, along with Federal Trade Commission (FTC) authority over unfair and deceptive practices, shape neuromarketing regulation. The FTC has issued guidance and enforcement actions relating to biometric data and dark-pattern design, signalling that undisclosed or manipulative neuromarketing could be challenged as unfair or deceptive.[11][7]

Other jurisdictions, including Brazil, South Africa and several Asia-Pacific countries, have enacted data-protection laws modelled partly on the GDPR, which treat biometric data as sensitive and restrict profiling for behavioural advertising. These regimes contribute to a patchwork of national approaches that global digital-commerce platforms must navigate when deploying AI-powered neuromarketing.[7][6]

4.2 Consumer protection and advertising law

Consumer-protection and advertising-law regimes provide another critical layer of regulation. In the EU, the Unfair Commercial Practices Directive (UCPD) prohibits unfair and aggressive commercial practices, including those that materially distort the economic behaviour of consumers by impairing their freedom of choice. Academic analysis of AI-generated advertising and personalised marketing argues that UCPD concepts can be applied to AI-driven neuromarketing, particularly where practices involve covert manipulation or exploitation of vulnerable consumers.[9][3]

The EU's Digital Markets, Competition and Consumers Act in the UK and related legislation also address manipulative design and unfair commercial practices in digital markets, including certain forms of dark patterns and exploitative targeting. In the United States, the FTC Act's prohibition of unfair or deceptive acts or practices has been used to challenge deceptive neuromarketing claims and undisclosed data-collection, while state consumer-protection laws may apply to specific advertising practices.[11][2][^12]

In India, the Consumer Protection Act 2019 and accompanying e-commerce rules regulate unfair trade practices, misleading advertisements and obligations of online marketplaces, including requirements of transparency and due diligence for sellers and platforms. Although there is no explicit reference to neuromarketing, commentators emphasise that practices which covertly manipulate consumer choices or exploit behavioural biases could be challenged under provisions on unfair or deceptive practices, especially where vulnerable consumers are affected.[10][11][^7]

4.3 Emerging AI-specific regulation

The EU's Artificial Intelligence Act represents the most developed attempt to create a cross-sectoral regulatory framework for AI systems, including those used in marketing and consumer-facing applications. The Act adopts a risk-based approach, prohibiting certain AI practices deemed unacceptable—such as systems that manipulate persons through subliminal techniques in ways likely to cause significant harm—and imposing obligations on providers and deployers of high-risk and limited-risk AI systems. Emotion-recognition and biometric-categorisation systems are subject to specific transparency and risk-management requirements, which may be directly relevant to AI-powered neuromarketing using such techniques.[3][9]

International bodies such as UNCTAD and the OECD have highlighted the need for consumer-protection frameworks to adapt to AI, including the risks of manipulation, opacity and unequal bargaining power in e-commerce. Soft-law instruments—such as ethical guidelines for trustworthy AI and sector-specific codes—are increasingly referenced by regulators and courts when assessing AI-mediated marketing practices.[6][9]

India has not yet enacted comprehensive AI-specific legislation, but government policy papers and expert reports emphasise responsible AI principles and the need to ensure that AI-driven consumer applications respect privacy, transparency and fairness. As Indian authorities consider sectoral AI guidelines, neuromarketing in digital commerce represents a test case for articulating boundaries between legitimate personalisation and impermissible manipulation.[15][8]

5.0 AI-Powered Neuromarketing in Digital Commerce: Use Cases and Risks

5.1 Dynamic personalisation and A/B testing at scale

In digital commerce, AI-driven neuromarketing builds on existing practices of A/B testing and personalisation by incorporating neuro-informed metrics into optimisation loops. Platforms can test multiple variants of product-detail pages, banner ads or push notifications, using facial-expression analysis and gaze tracking to estimate emotional engagement and attention in addition to click-through rates. Machine-learning algorithms then identify patterns linking specific design features or messages to positive neuro-behavioural responses, and automatically allocate traffic to higher-performing variants.[4][5]

While such techniques can improve user experience by highlighting content that users find genuinely engaging, they also create incentives to converge on design patterns that maximise short-term engagement or conversion, potentially at the expense of long-term welfare—for example by amplifying scarcity cues, social-proof signals or emotionally charged imagery. When neuro-metrics become part of the optimisation objective, the risk of pushing consumers towards impulsive or addictive behaviours increases, particularly in segments like online gambling, in-app purchases and fast-fashion e-commerce.[13][12]

5.2 Neuromarketing in immersive and social commerce

The rise of augmented-reality (AR) and virtual-reality (VR) shopping environments, as well as social-media commerce, expands the scope for neuromarketing by enabling continuous collection of multi-modal behavioural and physiological signals. VR headsets and AR-enabled devices can track head movement, gaze, gesture and sometimes physiological responses, which AI models can analyse to infer attention and affective states in real-time, feeding into dynamic product placement and pricing strategies.[5][6]

Social-commerce platforms already use sophisticated engagement-maximisation algorithms based on interaction metrics; the addition of neuromarketing elements—such as camera-based emotion recognition or affect-sensitive filters—could deepen their ability to shape consumer moods and choices. These developments accentuate concerns about constant surveillance, mental privacy and the potential normalization of neuro-profiling as a standard feature of digital commerce.[13][3]

5.3 Cross-device tracking and data aggregation

AI-powered neuromarketing often relies on cross-device tracking and data aggregation, linking physiological and behavioural data collected in one context to identifiers used across multiple services. For example, eye-tracking data from a mobile shopping app might be combined with browsing histories and social-media interaction data to refine user profiles and predict responsiveness to specific product categories or price points.[10][6]

Such cross-context profiling may undermine context-specific expectations of privacy and heighten the risk of re-identification even from ostensibly anonymised neuro-data, given the uniqueness of some biometric patterns. It also raises questions about the applicability of purpose-limitation principles and the need for interoperable consent and preference-management mechanisms that can track users' choices across platforms and devices.[7][5]

5.4 Regulatory frameworks for neuromarketing

Dedicated analyses of neuromarketing regulation point out that few jurisdictions have neuromarketing-specific statutes, and that the field is largely governed by general data-protection, consumer-protection and advertising-standards regimes. Commentators surveying global frameworks emphasise the role of the GDPR in Europe, FTC advertising guidelines in the United States and consumer-protection acts in jurisdictions like India as the primary legal instruments constraining neuromarketing. These frameworks stress transparency, consent, fairness and accountability but rarely address neuro-specific issues such as cognitive liberty or the distinct sensitivity of brain-derived data.[14][7]

Some authors argue for neuromarketing-specific guidelines or codes of conduct, potentially modelled on medical-research ethics, to bridge this gap and clarify expectations for practitioners. Others caution that creating technology-specific legal categories may lead to fragmentation and suggest instead that existing principles, if interpreted in a technologically informed manner, can adequately govern neuromarketing without new legislation.[1][14][^9]

5.5 Indian perspectives on digital advertising and data protection

Indian scholarship and practitioner commentary on digital advertising and data protection, while not yet focused specifically on neuromarketing, address issues directly relevant to AI-powered neuromarketing in digital commerce. Analyses of personalised and behavioural advertising argue that processing of personal data for targeted ads must comply with consent, purpose-limitation and transparency requirements, and that the forthcoming implementation of the DPDP Act will necessitate significant changes in AdTech practices.[10][8]

Other commentary on data protection in the advertising industry notes that, in the absence of sector-specific advertising regulation, existing IT-law rules and consumer-protection provisions form the basic legal framework, with self-regulatory codes and Advertising Standards Council of India (ASCI) guidelines playing a complementary role. As Indian e-commerce and digital-marketing ecosystems mature, these discussions suggest that neuromarketing practices using biometric or neuro-physiological data will need to navigate both data-protection obligations and consumer-protection expectations regarding fairness and non-manipulation.[^11]

6.0 Analysis: Legal and Ethical Challenges

6.1 Tensions between consent, autonomy and behavioural targeting

A key challenge in regulating AI-powered neuromarketing is reconciling consent-based data-protection models with substantive concerns about autonomy and manipulation. Even where neuromarketing data are collected with explicit consent and processed in compliance with data-protection principles, the use of AI-driven neuro-profiling to optimise persuasive messages may still undermine consumers' practical capacity for self-determination. Consent mechanisms are ill-equipped to address such concerns because they focus on informational control rather than on the fairness or legitimacy of the influence exerted.[5][2]

Consumer-protection and AI-specific regulations offer complementary tools by focusing on the effects of practices on consumer autonomy. Provisions prohibiting unfair or aggressive commercial practices and AI techniques that manipulate behaviour through subliminal or exploitative means can address neuromarketing practices that materially distort decision-making, regardless of formal consent. However, applying these standards in practice requires regulators and courts to develop criteria for distinguishing legitimate influence from manipulation, which is conceptually and evidentially challenging.[3][9]

6.2 Governance of biometric and neuro-physiological data

Another challenge concerns the governance of biometric and neuro-physiological data used in neuromarketing. While the GDPR and similar frameworks recognise biometric data as sensitive, the categorisation of derived features and inferences, such as emotion scores or attention metrics, is often unclear. If such inferences are not treated as sensitive or as personal data, they may fall outside the strictest protections, even though they can be highly revealing and persistent.[7][10]

Moreover, anonymisation of neuro-data is technically difficult, as some brain or biometric patterns may be uniquely identifying or re-identifiable when combined with other data sources. This complicates reliance on anonymisation as a privacy-preserving strategy in neuromarketing research and commercial deployment. Data-protection regimes may need to clarify the status of neuro-derived inferences and impose stricter controls on their creation, sharing and use, including prohibitions on secondary uses incompatible with the original neuromarketing purpose.[^5]

6.3 Cross-border enforcement and platform governance

AI-powered neuromarketing in digital commerce is often conducted by global platforms operating across jurisdictions, which complicates enforcement of national data-protection, consumer-protection and advertising laws. Even within the EU, where the GDPR provides a harmonised framework, cross-border enforcement has faced delays and coordination challenges; in India and other countries, resource constraints and limited technical expertise may further hamper effective oversight of complex AI-driven marketing systems.[6][8]

Platform governance mechanisms, including app-store policies, advertising-network standards and self-regulatory codes, thus play an important role in shaping neuromarketing practices. However, self-regulation alone is unlikely to suffice, given conflicts of interest and the competitive incentives to deploy ever more effective persuasive techniques. Public-law enforcement, international cooperation and potentially ex ante approval or registration of certain high-risk neuromarketing systems may be needed to ensure accountability.[9][6]

6.4 Protecting vulnerable and child consumers

Existing legal frameworks often recognise heightened protections for children and other vulnerable consumers, but applying these protections to AI-powered neuromarketing remains underdeveloped. The EU's consumer-protection instruments and the AI Act give particular attention to children as a vulnerable group, and some national laws (such as the US Children's Online Privacy Protection Act) restrict data-driven advertising to minors. Nevertheless, neuromarketing techniques targeting children's subconscious responses raise distinct concerns about exploitation and long-term developmental effects that go beyond data-protection issues.[3][9]

In India, child-specific digital-rights and advertising-standards discussions are nascent, though broader debates on child-centric AI and digital products emphasise the need for age-appropriate design, limitations on profiling and enhanced transparency for child users. Incorporating neuromarketing into these debates will require explicit recognition that neuro-physiological data from children are particularly sensitive and should not be used for persuasive commercial targeting, or only under stringent conditions and with demonstrable benefits.[8][11]

6.5 Accountability and explainability of AI neuromarketing systems

AI-powered neuromarketing systems often involve complex, opaque models that integrate multiple data sources and optimisation criteria, making it difficult to explain how specific marketing interventions are generated and to attribute responsibility for harmful outcomes. Data-protection and AI-governance frameworks increasingly emphasise explainability, auditability and human oversight, but operationalising these requirements in high-velocity digital-marketing environments is challenging.[13][3]

Accountability mechanisms may include internal governance structures within firms, such as AI-ethics committees and impact-assessment processes, as well as external oversight through audits, certifications and regulatory reporting. For neuromarketing, such mechanisms should specifically address the sourcing and handling of neuro-physiological data, the design of optimisation objectives (e.g., balancing engagement with well-being), and the monitoring of potential harms to vulnerable users.[6][9]

7.0 Suggestions and Policy Recommendations

Recognising cognitive liberty and mental privacy

First, legal and policy frameworks should recognise cognitive liberty and mental privacy as guiding principles for regulating neuromarketing and related neurotechnologies. While wholesale creation of new rights may not be necessary in all jurisdictions, existing constitutional guarantees of privacy and freedom of thought can be interpreted to encompass protection against intrusive neuromarketing practices that seek to manipulate neural processes without meaningful consent. Soft-law instruments and regulatory guidance can explicitly reference cognitive liberty as a normative benchmark, signalling that certain neuromarketing techniques—especially those involving subliminal or coercive influence—are incompatible with respect for mental autonomy.[2][6]

Strengthening consent, transparency and choice

Second, data-protection and consumer-protection regimes should require heightened consent and transparency standards for neuromarketing, including clear labelling of neuromarketing experiments, concise explanations of the types of data collected and inferences made, and user-friendly mechanisms to opt out of neuro-profiling. Privacy notices should avoid bundling neuromarketing-related processing into

generic "personalisation" clauses, and regulators should treat opaque neuromarketing disclosures as potentially unfair or deceptive.[10][7]

In digital-commerce interfaces, default settings should prioritise privacy and autonomy, with neuromarketing features disabled by default and activated only with explicit, informed user choice. Consent should be revocable at any time, and systems should be designed to respect withdrawal of consent promptly across all linked services.[15][6]

Special protections for children and vulnerable consumers

Third, jurisdictions should introduce or clarify special protections for children and other vulnerable groups in relation to AI-powered neuromarketing. This could include outright prohibitions on using neuro-physiological or affect-recognition data from minors for commercial targeting, or strict conditions requiring demonstrable educational or therapeutic benefit and independent ethical oversight. Age-appropriate design codes and child-rights-based AI guidelines can explicitly address neuromarketing, specifying that persuasive techniques exploiting children's cognitive immaturity are unacceptable.[9][3]

For other vulnerable consumers, regulators and industry bodies can develop guidance on avoiding exploitative neuromarketing in contexts such as high-interest credit, gambling or addictive digital services, and encourage firms to conduct vulnerability-sensitive impact assessments of their AI-driven marketing systems.[6][9]

Clarifying the legal status of neuro-data and inferences

Fourth, data-protection laws should clarify the status of neuro-physiological data and neuro-derived inferences, treating them as sensitive data deserving of heightened protection even where they are not strictly medical in nature. This would entail restricting secondary uses, imposing stricter conditions on sharing with third parties and requiring robust security and governance measures.[7][5]

Guidance should also address the limits of anonymisation and pseudonymisation in neuromarketing contexts and encourage privacy-enhancing technologies—such as on-device processing, federated learning and differential privacy—to reduce the risks associated with centralised storage of neuro-data.[5][6]

Enhancing accountability, audits and impact assessments

Fifth, regulators should require firms deploying AI-powered neuromarketing in digital commerce to implement comprehensive accountability frameworks, including AI-specific governance structures, documentation and regular audits. Mandatory algorithmic impact assessments for certain high-risk neuromarketing systems could evaluate effects on privacy, autonomy, discrimination and vulnerable users, and require mitigation plans where significant risks are identified.[9][6]

Independent audits and certifications—potentially overseen by accredited bodies—can help verify compliance with legal and ethical standards and provide assurance to regulators and the public. Platforms and large digital-commerce intermediaries should be subject to particular scrutiny given their central role in shaping online markets and their capacity to set de facto industry norms for neuromarketing.[13][3]

Fostering interdisciplinary ethics and professional standards

Finally, professional bodies in marketing, neuroscience and data science should collaborate to develop and enforce ethical codes specifically addressing AI-powered neuromarketing. Such codes can adapt principles from medical research ethics—respect for persons, beneficence and justice—to the commercial context, emphasising informed consent, minimisation of harm and attention to vulnerable groups.[14][1]

Educational programmes for marketers and data scientists should include training on ethical issues in neuromarketing and AI, and firms should embed ethics review processes into the design and deployment of neuromarketing initiatives. Public engagement and transparency about neuromarketing practices can help build trust and enable informed societal debate about acceptable boundaries.

8.0 Conclusion

AI-powered neuromarketing in digital commerce sits at the intersection of cutting-edge neuroscience, machine learning and pervasive digital marketing, offering powerful tools for understanding and influencing consumer behaviour while simultaneously challenging existing legal and ethical frameworks. By integrating neuro-physiological data into AI-driven optimisation loops, neuromarketing magnifies longstanding concerns about privacy, manipulation and exploitation of vulnerability, and raises new questions about cognitive liberty and mental privacy.

Current legal regimes—centred on data protection, consumer protection and emerging AI-specific regulation—provide important but incomplete safeguards. Data-protection law addresses the sensitivity of biometric and neuro-physiological data but struggles with the governance of inferences and the substantive fairness of influence; consumer-protection and advertising law focus on unfair and manipulative practices but require further doctrinal development to tackle AI-mediated neuro-profiling; and AI-specific instruments like the EU AI Act begin to identify unacceptable manipulative practices but leave much to interpretation in commercial contexts.

To ensure that AI-powered neuromarketing evolves in ways compatible with respect for human dignity and autonomy, regulators and industry actors must move beyond a narrow focus on data-collection consent towards a more holistic approach that integrates cognitive-liberty considerations, vulnerability-sensitive consumer protection, robust governance of neuro-data and strong accountability mechanisms for AI systems. This paper has outlined key elements of such an approach, including recognition of mental privacy,

enhanced transparency and choice, special protections for children, clarification of neuro-data's legal status, and interdisciplinary ethical standards.

As digital commerce continues to expand and AI-enabled marketing techniques become ever more sophisticated, the normative choices made today about neuromarketing will shape not only consumer welfare but also broader societal understandings of acceptable influence in marketplace relationships. Regulatory and ethical frameworks that safeguard autonomy while permitting responsible innovation can help ensure that neuromarketing serves genuine consumer interests rather than eroding the conditions for meaningful choice in an increasingly data-driven economy.

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