



“Optimizing Digital Marketing Through Neuromarketing: Consumer Insights, Engagement, and Ethics”

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ABSTRACT:

This paper investigates the role of neuromarketing in understanding consumer decision-making processes within digital environments. As online platforms and e-commerce continue to dominate the marketplace, marketers face the challenge of decoding how digital stimuli influence consumer behaviour. Neuromarketing bridges neuroscience and marketing by utilizing tools such as functional magnetic resonance imaging (fMRI), electroencephalography (EEG), eye tracking, and galvanic skin response (GSR) to study subconscious reactions to marketing content. Unlike traditional methods, these techniques allow researchers to access real-time, non-verbal indicators of consumer attention, engagement, and emotion. In digital environments—characterized by rapid information flow, algorithmic personalization, and interactive interfaces—these insights are especially valuable. This paper explores how website design, user experience (UX), emotional branding, and personalized advertising impact decision-making. Furthermore, it examines how neuromarketing applications can optimize digital strategies to enhance user engagement and conversion rates. Ethical concerns surrounding manipulation, consent, and data privacy are also addressed, highlighting the need for responsible practices in the field. By integrating neuroscience insights into digital marketing, businesses can develop more effective, user-centric approaches while maintaining transparency and consumer trust. The paper concludes by outlining future research directions that emphasize cross-cultural studies, long-term effects, and real-time neuromarketing technologies.

Keywords: Neuromarketing, Consumer Decision-Making, Digital Marketing, EEG, fMRI, Eye Tracking, Galvanic Skin Response, User Experience, Emotional Branding, Biometric Feedback, Marketing Ethics, Neurotechnology

1. Introduction

The rapid evolution of digital technologies has significantly altered the landscape of consumer behaviour and marketing strategies. In today’s hyper-connected world, consumers interact with brands through multiple digital touchpoints—websites, social media, mobile apps, and e-commerce platforms. These virtual interactions generate an overwhelming number of stimuli, making the consumer decision-making process more complex and nuanced than ever before. Traditional marketing research methods, such as surveys, focus groups, and interviews, often fail to capture the full spectrum of human emotion and subconscious thought that drives these decisions. This limitation has given rise to **neuromarketing**—an interdisciplinary field that blends neuroscience, psychology, and marketing to understand how consumers’ brains respond to marketing stimuli at a biological level.

The term “neuromarketing” was first introduced in 2002 by Ale Smidts, a Dutch professor of marketing research, who recognized the untapped potential of using neuroscience tools to investigate consumer preferences and choices. Although relatively new as a formal discipline, the foundation of neuromarketing is deeply rooted in earlier studies from cognitive psychology, behavioural economics, and neuroscience, which sought to understand how humans process information and make decisions. Early experiments using functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) allowed researchers to observe which brain regions were activated during specific marketing tasks, such as viewing advertisements or choosing between brands. These insights revealed that many consumer decisions are not entirely rational but are influenced heavily by emotions, memory, and subconscious biases.

Over the past two decades, neuromarketing has grown in sophistication and popularity, particularly with the integration of wearable biometric devices and more accessible neuroimaging technologies. Major corporations like Coca-Cola, Google, and Procter & Gamble have invested in neuromarketing research to fine-tune their branding, advertising, and product design strategies. In digital environments, neuromarketing has found especially fertile ground. The ability to test and track consumer responses to online interfaces, content, and advertisements in real-time offers marketers a powerful toolkit for optimizing user experiences.

Moreover, the digital space presents unique challenges and opportunities for marketers. Unlike traditional settings, online environments demand rapid attention capture and seamless engagement, as users are bombarded with endless choices and distractions. Understanding how visual cues, layout design, personalization, and social validation affect the consumer brain is crucial for driving conversions and brand loyalty. Neuromarketing offers data-driven insights into these dynamics, enabling businesses to craft more intuitive and emotionally resonant digital experiences.

As digital marketing continues to evolve, the role of neuromarketing is poised to become even more central. By bridging the gap between brain science and consumer behaviour, it promises to reshape not only how companies engage with their audiences but also how consumers experience brands in the digital world.

2. Objectives of the Study:

1. To explore the role of neuromarketing in understanding consumer decision-making in digital environments.
2. To investigate how key elements of digital platforms (e.g., website design, UX, emotional branding, and personalization) influence consumer behaviour through neurological and biometric responses.
3. To analyse real-world applications of neuromarketing techniques across industries and evaluate their effectiveness in optimizing digital marketing strategies.
4. To assess how neuromarketing can be used to enhance user engagement, improve ad effectiveness, and increase conversion rates in online environments.
5. To evaluate the ethical implications of neuromarketing practices, particularly in relation to data privacy, informed consent, consumer autonomy, and accessibility.

Neuro marketing techniques:

Neuromarketing employs a variety of neuroscientific and biometric tools to decode consumers' unconscious reactions to marketing stimuli. These tools provide objective insights into cognitive and emotional processes that often go undetected by conventional self-report methods. Below is an overview of the most commonly used neuromarketing techniques and their applications in real-world marketing scenarios:

- a) **Functional Magnetic Resonance Imaging (fMRI):** fMRI measures brain activity by detecting changes in blood flow, offering high spatial resolution of neural activity. It helps identify which areas of the brain are involved in processes such as decision-making, emotion, and memory when exposed to marketing content.

Applications:

- i) **Brand Evaluation:** Companies use fMRI to test brand associations and loyalty. For example, a well-known study by Read Montague compared the brain's response to Coca-Cola vs. Pepsi, revealing that branding can influence preference at a neural level—even when taste was constant.
- ii) **Advertising Pre-testing:** Marketers use fMRI to analyse how viewers respond to different ad formats and storylines, helping them choose the most neurologically engaging content.

- b) **Electroencephalography (EEG):** EEG records electrical activity in the brain via sensors placed on the scalp. It provides high temporal resolution, making it ideal for tracking moment-to-moment engagement and attention.

Applications:

- i. **Content Optimization:** Media companies and advertisers use EEG to evaluate commercials, movie trailers, or product demos to see which moments capture or lose attention.
- ii. **User Experience (UX) Testing:** EEG helps identify which elements of a website or app interface cause cognitive overload or disengagement, guiding redesign efforts.

- c) **Eye Tracking:** Eye tracking uses infrared cameras and software to monitor where, how long, and in what sequence a person looks at visual elements. It provides insights into attention, navigation, and visual hierarchy.

Applications:

- i. **Website and App Design:** Eye-tracking data helps optimize webpage layouts by highlighting which sections users focus on, where they skip, and how they scan content. Brands like Amazon and eBay have used this technique to improve the usability and conversion rates of their digital platforms.
- ii. **Packaging Design:** Companies test how quickly consumers notice products on shelves or digital listings, leading to more attention-grabbing packaging and placement.

- d) **Galvanic Skin Response (GSR) / Skin Conductance:** GSR measures changes in skin conductivity that occur with emotional arousal. When people experience excitement, fear, or stress, sweat gland activity increases, which GSR detects.

Applications:

- i. **Emotional Testing of Ads:** Marketers assess emotional peaks and valleys in a viewer's response to advertising to understand which scenes resonate or fall flat.
- ii. **In-store or Online Shopping Reactions:** By combining GSR with eye tracking, researchers can identify which products or offers elicit emotional engagement.

- e) **Facial Expression Analysis:** This technique uses computer vision to analyse micro-expressions on a person's face, detecting emotions such as happiness, surprise, anger, or confusion.

Applications:

- i. **Customer Feedback Analysis:** Brands analyse customer responses to ads, videos, or presentations in real time to determine emotional alignment with brand messaging.

- ii. **Retail Testing:** Facial coding can be used in stores or online to evaluate satisfaction, interest, or frustration during a shopping experience.
- f) **Implicit Association Tests (IAT):** IATs measure the strength of associations between concepts (e.g., brand and quality) by analyzing reaction times in categorization tasks. Faster responses imply stronger subconscious associations.
 - Applications:**
 - i. **Brand Positioning:** Marketers assess how closely a brand is associated with key traits such as trustworthiness, luxury, or innovation.
 - ii. **Campaign Effectiveness:** Companies measure how well an ad shifts consumer associations before and after exposure.

Real-World Industry Applications:

- a) **Real-Time Emotional Optimization of Advertisements:** Neuromarketing now enables real-time emotional analysis of digital advertisements using facial coding and EEG. Marketers can dynamically adjust ad content based on audience reactions to enhance engagement. For example, a study published in the *Journal of Advertising Research* (Venkatraman et al., 2015) found that ads eliciting strong emotional responses, as measured by EEG and biometric sensors, led to higher recall and brand preference. Companies like Unilever and Coca-Cola are using real-time feedback loops during ad development to fine-tune narratives, visuals, and music for maximum emotional impact before launch.
- b) **AI-Driven Personalization Based on Neurometric Profiles:** Advanced AI algorithms now integrate neuromarketing data (e.g., EEG patterns, eye tracking) to create personalized content recommendations. Neurometric profiles—based on an individual's attention, emotional response, and decision-making tendencies—allow marketers to serve content that matches users' subconscious preferences. A study by Plassmann et al. (2012) showed that tailoring digital content to match neural responses significantly increased user engagement and purchase intent. Netflix and Spotify have explored neuromarketing insights to enhance their recommendation engines, improving both user satisfaction and retention.
- c) **Neuromarketing-Driven Website and App UX Optimization:** Neuromarketing is being applied to optimize digital interfaces by analysing users' neural and physiological responses to various UX elements. Eye tracking and EEG are used to evaluate visual attention, ease of navigation, and emotional friction points on websites and mobile apps. According to research by Reimann et al. (2010), websites that generated positive emotional responses and clear visual hierarchies increased user satisfaction and trust. E-commerce giants like Amazon and Zalando use neuromarketing tools to streamline layouts and drive higher conversion rates.
- d) **Emotional AI in Chatbots and Virtual Assistants:** Emotionally intelligent AI, trained using neuromarketing data, is being used to enhance digital customer service experiences. These systems detect emotional cues from language, tone, and facial expressions to tailor responses empathetically. A 2021 MIT study showed that users were 31% more satisfied with emotionally adaptive chatbots than with traditional ones. Neuromarketing inputs help these systems understand user frustration or enthusiasm, enabling brands like Sephora and H&M to build deeper emotional connections through virtual assistants.
- e) **Neuromarketing in Virtual and Augmented Reality Experiences:** VR and AR marketing campaigns now incorporate neuromarketing to evaluate user immersion and emotional engagement. By measuring EEG and biometric feedback during immersive experiences, marketers can fine-tune product visualizations and storytelling techniques. For instance, a neuromarketing study by Neurons Inc. for IKEA's AR app showed increased purchase intent and emotional attachment when users could "see" furniture in their homes. This application is especially valuable in real estate, automotive, and luxury retail sectors, where emotional visualization enhances decision-making.
- f) **Google and Media Companies:** Google and major media companies have integrated neuromarketing techniques such as EEG and eye tracking to evaluate and enhance user engagement with YouTube advertisements. By monitoring neural and visual responses, they identify which ad elements capture attention, trigger emotional responses, and lead to higher viewer retention. This data helps optimize ad length, placement, and creative content to align better with viewer preferences. The goal is to create more compelling, personalized advertising experiences that resonate on a subconscious level—leading to improved ad performance and reduced viewer drop-off rates, ultimately maximizing return on ad spend for digital platforms.
- g) **Frito-Lay:** Frito-Lay employed EEG and Galvanic Skin Response (GSR) sensors to study consumer reactions to different packaging designs. Their research revealed that shiny, reflective packaging often evoked negative emotional responses, associated with guilt or un-healthiness—especially for female consumers. In contrast, matte-finished bags featuring wholesome ingredients and natural imagery elicited more positive emotional engagement. This insight led the brand to redesign its packaging to appear healthier and more appealing at a subconscious level. The findings demonstrated the power of neuromarketing to influence purchasing decisions by aligning visual packaging cues with desired emotional outcomes in the consumer mind.
- h) **Hyundai:** Hyundai utilized functional magnetic resonance imaging (fMRI) technology to explore how consumers' brains respond to different vehicle design concepts. By observing brain activity during exposure to various car aesthetics, the company identified which features triggered emotional and reward-related responses. This allowed Hyundai to design vehicles that not only appealed to consumers visually but also stimulated positive emotional engagement at a neurological level. The study emphasized the role of design in evoking desire and attachment, influencing buyers beyond rational specifications like performance or price. The findings helped Hyundai enhance both its product development and branding strategies through brain-based insights.
- i) **NBC and ESPN:** NBC and ESPN applied neuromarketing techniques—including facial expression analysis, EEG, and eye tracking—to optimize their promotional content, show intros, and advertisements. These tools helped them determine which visual elements and narrative sequences elicited strong emotional responses, maintained attention, and improved content recall. For example, intros that sparked excitement or nostalgia led to longer viewer engagement and stronger brand association. By fine-tuning visual pacing, music, and storyline elements based on subconscious viewer reactions, the networks successfully enhanced audience retention and connection. This approach illustrates how media companies can leverage neuroscience to elevate storytelling and maximize viewer satisfaction.

These techniques collectively offer marketers a more precise, real-time understanding of how consumers perceive, process, and emotionally react to digital and physical marketing efforts. By leveraging neuromarketing tools, companies can make informed, data-backed decisions to enhance user experience, brand perception, and campaign performance—often leading to significant improvements in ROI.

Consumer Decision-Making in Digital Environments:

Consumer decision-making in digital environments is shaped by a combination of cognitive, emotional, and contextual factors unique to online platforms. Unlike traditional retail, digital settings present users with an abundance of choices, dynamic content, and personalized experiences—all of which influence how decisions are made. Visual design, ease of navigation, loading speed, and trust signals (such as reviews and security badges) can significantly impact consumer behaviour. Moreover, digital platforms leverage algorithms to deliver targeted advertisements and product recommendations, subtly guiding consumers toward specific actions. Social proof, such as user ratings and influencer endorsements, plays a crucial role in building confidence and reducing decision-making uncertainty. Mobile accessibility, instant gratification, and seamless checkout processes further shape purchasing behaviours. In these fast-paced, attention-fragmented environments, consumers often rely on heuristics and emotional triggers rather than rational deliberation, making it vital for marketers to create intuitive, emotionally resonant, and frictionless user experiences.

Ethical Considerations in Neuromarketing:

As neuromarketing becomes more integrated into digital marketing strategies, ethical concerns surrounding its use have intensified. While the technology offers powerful insights into consumer behaviour, it also raises questions about autonomy, privacy, consent, and potential manipulation. Unlike traditional marketing, neuromarketing taps into subconscious processes, potentially influencing consumer behaviour without their explicit awareness. This has led to fears that marketers could exploit neural vulnerabilities to drive decisions that are not in the consumers' best interests.

A) **Privacy and Informed Consent:** The collection of neurophysiological data such as brain scans, eye movements, and emotional responses involves sensitive personal information. Ensuring informed consent is a foundational ethical principle, yet many consumers may not fully understand how their data is collected or used in neuromarketing research. *Case Study – Facebook's Emotional Contagion Experiment (2014):* Facebook conducted an experiment by manipulating the emotional content in users' news feeds to measure its effect on user emotions. While not strictly a neuromarketing study, it raised serious ethical concerns due to the lack of informed consent. Users were unaware they were part of an experiment influencing their emotional state. The backlash from this study highlighted the importance of transparency and ethical oversight in research involving psychological and emotional manipulation.

B) **Manipulation and Autonomy:** Neuromarketing can be used to design ads and interfaces that subtly push users toward certain choices by triggering emotional responses. Critics argue that this could infringe on consumer autonomy, especially when the techniques are so effective that individuals make decisions they might not consciously support. *Case Study – PepsiCo and EEG Packaging Study:* PepsiCo used EEG and biometric sensors to test consumer responses to different packaging designs. Results showed that certain designs evoked less guilt and more positive emotional responses, leading the company to change its packaging. While seemingly harmless, critics argue that such techniques could manipulate consumers into making unhealthy or irrational choices, raising ethical questions about using emotional responses to influence purchasing decisions, particularly for potentially harmful products (e.g., sugary snacks or alcohol).

C) **Accessibility and Inequality:** As neuromarketing tools are expensive and technologically advanced, their benefits are often available only to large corporations. This creates a knowledge and power asymmetry between corporations and consumers, potentially leading to unethical use in hyper-targeted advertising or manipulative persuasion strategies.

D) **Regulatory and Ethical Frameworks:** Currently, neuromarketing operates in a gray area with limited regulation. Ethical frameworks such as those from the American Marketing Association (AMA) and International Chamber of Commerce (ICC) stress transparency, consumer well-being, and voluntary participation, but enforcement is inconsistent. There's a growing call for industry-wide ethical standards tailored specifically to neuromarketing.

Conclusion:

The intersection of neuroscience and marketing—neuromarketing—has emerged as a revolutionary paradigm in decoding consumer decision-making, especially within digital environments characterized by complexity, interactivity, and sensory overload. As digital platforms become the primary mode of brand-consumer interaction, understanding how the brain processes online stimuli has moved from an academic curiosity to a commercial necessity. Neuromarketing fills a critical gap left by traditional methods, offering direct access to non-conscious processes such as emotional engagement, attention patterns, and memory recall—core elements that heavily influence consumer decisions.

This paper has outlined the origins and evolution of neuromarketing, tracing its roots from foundational cognitive neuroscience to its current applications in digital strategy. Tools such as fMRI, EEG, eye tracking, facial expression analysis, and GSR have enabled researchers and marketers to develop a richer understanding of how consumers perceive, interact with, and respond to marketing content in real time. These techniques offer not just data, but context—allowing businesses to refine product designs, craft emotionally resonant narratives, and personalize digital experiences with scientific precision.

In the context of digital marketing, neuromarketing has found particularly fertile ground. Online environments demand rapid attention capture, intuitive navigation, and emotionally engaging content. The ability to measure neural and physiological responses to digital stimuli empowers companies to optimize user experience (UX), enhance content personalization, and improve ad effectiveness. For instance, platforms like Netflix and Spotify use

neurometric data to refine recommendation engines, while companies like Unilever and IKEA apply real-time biometric feedback to optimize advertising and augmented reality tools. These applications not only increase consumer satisfaction and engagement but also contribute to more efficient allocation of marketing budgets.

However, the power of neuromarketing raises substantial ethical considerations. The ability to influence consumer behaviour at a subconscious level challenges traditional notions of autonomy and informed consent. High-profile controversies, such as Facebook's emotional contagion study, have underscored the importance of transparency and ethical safeguards. As neuromarketing technologies become more advanced and accessible, it is imperative for companies and researchers to prioritize user privacy, voluntary participation, and non-manipulative practices. The potential for misuse—whether in targeting vulnerable populations, promoting harmful products, or exaggerating claims—must be carefully monitored and addressed through clear regulatory frameworks and industry codes of conduct.

Looking ahead, the future of neuromarketing lies in real-time analytics, cross-cultural research, and the integration of artificial intelligence. Wearable neurotechnology, combined with machine learning, may allow for moment-to-moment personalization of digital content based on live neural feedback. Cross-cultural neuromarketing studies could reveal how cultural norms and values shape emotional and cognitive responses to digital stimuli, paving the way for more globally resonant campaigns. Additionally, interdisciplinary collaboration among neuroscientists, data scientists, designers, and ethicists will be essential in developing marketing strategies that are not only effective but also respectful of human cognition and dignity.

In summary, neuromarketing offers a profound opportunity to elevate digital marketing from a data-driven to a brain-driven discipline. When used responsibly, it can help brands create more meaningful, engaging, and ethical consumer experiences—redefining the future of marketing in a way that respects both business goals and human agency.

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