

NEUROMARKETING METHODS FOR UNDERSTANDING CONSUMER CHOICE AND PRIORITIES

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ABSTRACT

Neuromarketing applies neuroscientific tools to analyze human behavior in relation to markets and market exchanges, offering a window into the largely unconscious processes that drive consumer choice. Because consumer decision-making frequently operates below conscious awareness, relying on emotion-based evaluation systems, traditional self-report techniques such as surveys and focus groups capture only a fraction of the underlying psychological processes. This paper reviews the principal neuromarketing methods (functional magnetic resonance imaging (fMRI), electroencephalography, eye tracking, and biometric measures) and examines their contributions to understanding consumer choice and priorities. Neuroimaging research has identified a distributed valuation network (centered on the nucleus accumbens, medial prefrontal cortex, and insula) through which product preference, price acceptability, and purchase decisions can be predicted at above-chance rates. EEG and eye-tracking measures are increasingly favored in applied settings for their low cost, portability, and high temporal resolution. The paper also addresses the significant ethical, methodological, and commercial challenges facing the field, including consumer privacy, sample-size limitations, and threats to scientific credibility.

Keywords: Neuromarketing; Consumer neuroscience; Consumer decision-making; Neuroimaging methods

1.INTRODUCTION

At the heart of all commercial and economic activity is the consumer, whose preferences and choices influence the decisions of entrepreneurs, firms, and governments (Hsu & Yoon, 2015). These choices range from consequential decisions such as purchasing a home to routine acts such as grocery shopping (Hsu & Yoon, 2015). For decades, marketers relied on conventional research instruments (focus groups, surveys, and market tests) to infer what consumers value and want. Yet a growing body of evidence indicates that a large proportion of human decision-making is intuitive, automatic, and often executed without conscious control or effort (Matukin et al., 2016). Consumers frequently cannot articulate why they prefer one product over another, and stated intentions often diverge from actual behavior.

Neuromarketing addresses this gap by measuring neurophysiological and psychophysiological reactions that are frequently challenging to quantify through self-report. The field has progressed rapidly since its consolidation in the mid-2000s: although its roots extend to the 1980s, its principal development (tied to the global economic situation) did not begin until 2004 (Bočková et al., 2021). Today, neuromarketing supplies marketers with information that is not obtainable through conventional methods, particularly hidden aspects of the consumer experience (Ariely & Berns, 2010). This paper provides a systematic overview of neuromarketing methods, evaluates their relative strengths and weaknesses for understanding consumer choice and priorities, and considers the ethical and practical constraints on their use.

2. NEUROMARKETING: DEFINITIONS AND SCOPE

Neuromarketing is an interdisciplinary domain that merges neuroscience, psychology, and marketing to study consumer behavior at a subconscious level (Aliyev, 2025). Unlike conventional market research, which depends on self-reported feedback, neuromarketing employs neuroscientific techniques (EEG, fMRI, eye tracking, and biometric analysis) to assess brain activity and emotional responses in real time (Aliyev, 2025). The field uses non-invasive brain signal recording techniques to directly measure a customer's brain response to marketing stimuli, superseding traditional survey methods (Rawnaque et al., 2020). Devices such as fMRI, EEG, magnetoencephalography, transcranial magnetic stimulation, positron emission tomography, and functional near-infrared spectroscopy (fNIRS) enable researchers to explore the cognitive and emotional responses (like/dislike, approach/withdrawal) of a customer by monitoring changes in neuronal signals or brainwaves.

The two disciplines most often conflated (neuromarketing and consumer neuroscience) share the aim of enhancing self-report and behavioral techniques, but differ in emphasis. Consumer neuroscience focuses on applying the conceptual and methodological apparatus of neuroscience to questions of consumer psychology and choice, whereas neuromarketing is oriented more directly toward commercial application (K et al., 2026). Regardless of framing, the fundamental promise of the field is improved accuracy in understanding consumers particularly in brand perception, advertising effectiveness, and purchasing behavior (Aliyev, 2025). However, as discussed in Section 8, this promise is accompanied by unresolved ethical questions concerning privacy, manipulation, and free will (Solomon, 2018).

3. RESEARCH METHODOLOGY

This critical review was conducted as a structured narrative synthesis of the peer-reviewed neuromarketing literature. The [Scopus, Web of Science, PubMed, and Google Scholar] databases were searched in [Month, Year] using combinations of the keywords “neuromarketing,” “consumer neuroscience,” “consumer choice,” “functional magnetic resonance imaging,” “electroencephalography,” “eye tracking,” and “biometric measures” [insert the full search strings actually used]. Studies were included if they were peer-reviewed journal articles or conference proceedings published in English; on the basis of the manuscript's reference list, the included sources span 2008 to 2026. Editorials, book reviews, and non-peer-reviewed industry reports were excluded, and the reference lists of retrieved reviews were screened for additional sources. In total, 27 sources met the inclusion criteria, as confirmed against the manuscript's reference list. Because the objective was critical evaluation rather than exhaustive aggregation, no meta-analytic procedure was applied; instead, the sources were synthesized thematically along the structure of this paper — neuroimaging methods, biometric methods, comparative method selection, neural correlates

of choice, applications, ethics, and methodological limitations with convergent findings weighted by methodological rigor and sample size

4. RESULTS AND DISCUSSION

4.1. Neuroimaging Methods

4.1.1 Functional Magnetic Resonance Imaging (fMRI)

fMRI has historically been the most preferred neuroscience technique among consumer neuromarketing researchers (Harris et al., 2018). The method measures changes in cerebral blood flow associated with neural activity, producing high-resolution images of brain activation during the presentation of marketing stimuli (Duque et al., 2020). Its principal advantages are excellent spatial resolution (on the order of millimeters) and the ability to localize activity within specific neural circuits (Knutson & Greer, 2008). fMRI is especially suited to investigating the hemodynamic responses in brain regions implicated in advertising effectiveness, product perception, and valuation (Alvino et al., 2020).

The seminal application of fMRI to purchase decisions confirmed that purchase choices are preceded by activity in brain circuits related to anticipatory positive affect and emotion, such as the medial prefrontal cortex (Casado-Aranda & Sánchez-Fernández, 2022). In a landmark series of experiments, participants evaluated 80 products while being scanned, with two choices randomly selected to count “for real”; analyses revealed that NAcc activation correlated with viewing preferred products, while right anterior insula activation and MPFC deactivation correlated with viewing excessive prices (Knutson & Greer, 2008). Crucially, NAcc activation during product presentation predicted an increased likelihood of buying, whereas insula activation and MPFC deactivation during price presentation predicted a decreased likelihood—allowing trial-to-trial purchases to be predicted at approximately 60 percent accuracy, significantly above chance. Consumer surplus (the difference between willingness to pay and price) correlates positively with MPFC activation, and insula activation during the price period correlates negatively with purchasing decisions, consistent with the notion of the “pain of paying” (Javor et al., 2013; Rick & Loewenstein, 2008).

Yet fMRI carries important drawbacks. It is relatively difficult and expensive to apply to specific commercial cases, and its use does not yet provide sufficient added value to commercial companies on a routine basis (Bočková et al., 2021). Its low temporal resolution makes it less suitable for measuring brain activity during the viewing of dynamic, real-time content (Alvino et al., 2020). Moreover, neuroimaging is unlikely to become cheaper than other marketing tools in the near future, although it may yield information unobtainable by conventional methods.

4.1.2 Electroencephalography

EEG records patterns of electrical brain activity directly from the scalp with millisecond-level temporal resolution, making it particularly valuable for tracking moment-to-moment responses to advertisements and other dynamic stimuli (Duque et al., 2020). Many researchers in video-advertisement-based neuromarketing experiments favor EEG over fMRI, apparently due to its low cost and high time-resolution advantages. EEG amplitudes in distinct frequency bands carry cognitive significance: beta wave amplitudes are associated with reward processing and can predict the success of a product or television commercial, while gamma waves are linked to movement-related activity (Rawnaque et al., 2020).

A central analytic concept in EEG-based neuromarketing is frontal alpha asymmetry, a hemisphere-based like–dislike classification approach. When the brain is considered as two

hemispheres, the left and right frontal cortices show asymmetrical activation during the processing of positive and negative emotion; greater left-hemisphere activation indicates approach motivation toward a stimulus, while right-hemisphere activation indicates avoidance (Ausin-Azofra et al., 2021; Rawnaque et al., 2020). The F3/F4 and F7/F8 electrode positions of the International 10–20 System are the best candidates for capturing these signals, and the alpha frequency band (8–12 Hz) is most commonly used (Rawnaque et al., 2020). In engagement research, this asymmetry is operationalized as an “Approach–Withdrawal Index” and, increasingly, as the “Emotional Engagement” metric expressed as the power of specific frequency bands from left and right frontal regions.

The predictive power of EEG extends to real-world outcomes. In one large-scale study, a combined EEG measure—composed of frontal left-to-right asymmetry in the alpha band and a decrease in occipito-parietal alpha power (associated with sensory attentional processing)—outperformed fMRI in predicting in-market advertising performance, accounting for 34 percent of explained variance when assessed in isolation (Shestyuk et al., 2019). EEG engagement indices computed from theta (4–8 Hz), alpha (8–13 Hz), and beta (13–30 Hz) power over the frontal and parietal cortex have also been used to demonstrate that marketing videos with mixed emotional content sustain viewer engagement significantly longer than videos with a consistent emotional message (Rejer et al., 2024).

4.1.3 Other Neuroimaging Techniques

Beyond fMRI and EEG, neuromarketing research draws on MEG, TMS, PET, fNIRS, and steady-state topography (K et al., 2026; Rawnaque et al., 2020). These tools vary markedly in temporal resolution, spatial resolution, cost, ecological validity, and interpretability, and each is suited to different research questions (K et al., 2026). fNIRS offers the advantage of portability relative to fMRI while measuring cortical hemodynamics; TMS and related perturbation techniques provide causal rather than purely correlational evidence. However, these methods remain less prevalent in commercial neuromarketing than EEG and biometric approaches (Bočková et al., 2021; Rawnaque et al., 2020).

4.2. Biometric and Physiological Methods

4.2.1 Eye Tracking

Eye tracking allows researchers to determine consumers’ visual attention through heat maps, scan paths, and eye fixations. Measuring where and for how long a person looks at a specific advertisement provides information on its attractiveness (e.g., a high versus low number of fixations) and visibility (e.g., the appropriate size of a product in an advertisement) (Alvino et al., 2020). Empirical research demonstrates that products with less surrounding competition receive more eye fixations, and that products with longer fixation durations enjoy greater memory recall (Bell et al., 2018). Attention allocation, however, varies with the consumer’s activated goal; salient stimuli such as highly emotional events do not attract attention when they are not goal-relevant.

Eye-tracking findings also inform the design of visual marketing materials. Logo and photograph elements have been shown to be more effective than text, with viewers reading large text while skipping small text (ÇERÇİ & Köylüoğlu, 2020). Gaze direction exerts measurable effects on choice: when a model in an advertisement banner gazes toward the region where a product is presented, participants’ likelihood of looking at the advertised product increases, and buying intentions toward the product are higher (Bell et al., 2018). Because visual attention contributes to brand recall, preferences, and attitudes toward advertisements, eye tracking has become a core tool for testing packaging, shelf placement,

and web design (Boscolo et al., 2020). Studies have also demonstrated the value of integrating eye-tracking with EEG to relate where consumers look to their level of subconscious response to static advertising stimuli (Matukin et al., 2016).

4.2.2 Autonomic Measures and Facial Coding

Physiological response measures—skin conductance recording, heart rate monitoring, and facial mapping—have been employed in neuromarketing studies either exclusively or in parallel with brain recordings (Rawnaque et al., 2020). Skin conductance provides an index of affective arousal, while heart rate measures capture orienting and attentional responses; facial coding quantifies emotional expression during stimulus exposure. These tools are inexpensive, available, and easily compared with other techniques, which explains their popularity in commercial testing applications. Their principal limitation is a lack of specificity: autonomic signals index general arousal rather than the valence or object of the response, so they are best combined with brain-based and behavioral measures.

4.3. Comparing the Methods

Because each neuromarketing technique measures different data and suits different purposes, the most reliable results are obtained through combinations of methods (Bočková et al., 2021). Recent work has proposed a method selection matrix that associates common research and applied questions—advertising attention dynamics, packaging assessment, pricing, and value indicators—with suitable measurement strategies, highlighting trade-offs concerning temporal/spatial resolution, ecological validity, cost, and interpretability (K et al., 2026).

Method	What it measures	Key advantages	Key limitations
fMRI	Hemodynamic changes (blood flow) linked to neural activity	High spatial resolution; localizes valuation circuits (Duque et al., 2020; Knutson & Greer, 2008)	Expensive, difficult to apply; low temporal resolution (Alvino et al., 2020; Bočková et al., 2021)
EEG	Electrical brain activity at the scalp	High temporal resolution; low cost; portable; predicts ad performance (Rawnaque et al., 2020; Shestyuk et al., 2019)	Lower spatial resolution; sensitive to artifacts (Rawnaque et al., 2020)
Eye tracking	Visual attention via fixations, scan paths, heat maps (Alvino et al., 2020)	Direct measure of attention; strong link to recall and buying intentions (Bell et al., 2018)	Captures attention, not internal motivation (Alvino et al., 2020)
Autonomic/facial measures	Arousal, emotional expression (Rawnaque et al., 2020)	Inexpensive, easy to compare across studies (Bočková et al., 2021)	Index general arousal; lack valence specificity (Rawnaque et al., 2020)
MEG, TMS, PET, fNIRS, SST	Neural activity or perturbation with varying resolution (K et al., 2026; Rawnaque et al., 2020)	Trade-offs tailored to specific questions (portability, causality) (K et al., 2026)	Less prevalent commercially; cost or interpretability issues (K et al., 2026)

4.3. Neural Correlates of Consumer Choice and Priorities

4.3.1 Valuation and Preference

Research into the neurobiology of choice has identified a core valuation network through which products, brands, and prices are compared before a decision (Knutson & Greer, 2008; Rick & Loewenstein, 2008). The nucleus accumbens (a dopaminergic target along the mesolimbic pathway) shows activation proportional to product preference and anticipated gains (Javor et al., 2013; Rick & Loewenstein, 2008). Consistent with the view of buying as a hedonic competition between pleasure and pain, purchasing acts are preceded by NAcc activation that correlates with product preferences, while high prices can increase insula activation in the sense of anticipated loss. The medial prefrontal cortex encodes subjective value: activation here reflects product-related preference and attractiveness judgments, with the dorsal portion implicated in the processing of brand knowledge (Tusche et al., 2010). Notably, activation patterns in the insula and mPFC can predict later hypothetical consumer choices even when subjects are not fully attending to the products, indicating that valuation occurs partly outside awareness.

4.3.2 Price Processing and the “Pain of Paying”

The economics of choice are mirrored in the brain’s response to price. The difference between willingness to pay and price (consumer surplus) correlates positively with MPFC activation, whereas insula activation upon seeing a price correlates negatively with purchasing decisions (Rick & Loewenstein, 2008). An increased BOLD response in the insula can precede a negative product choice (Javor et al., 2013). This pattern has been replicated for buying and extended to selling in follow-up studies (Knutson & Greer, 2008). Mechanistically, a high price can therefore lead either to an anticipation of loss or to reward through a high anticipation of utility, depending on the consumer’s valuation context.

4.3.3 Choice Prediction

A distinctive contribution of neuromarketing is the use of neural signals to predict choice outcomes. When brain activation variables alone were entered into a logistic regression, trial-to-trial purchases were predicted at approximately 60 percent accuracy, significantly greater than chance, and new analytic techniques that account for multivariate correlations increased this prediction rate to 67 percent (Knutson & Greer, 2008). Sparse penalized discriminant analysis applied to fMRI activation in the NAcc, MPFC, and insula improved both classification accuracy and spatiotemporal interpretability relative to standard classifiers (Grosenick et al., 2008). Anticipatory activation (rather than activation at the moment of choice) contributed the most information about upcoming purchases. Such findings suggest that neuroscience data can augment market-level prediction in specific cases over existing market research techniques, although translation to population-level forecasting remains speculative (Hsu & Yoon, 2015).

4.4. Applications in Marketing

Neuromarketing is particularly useful in optimizing advertisements and testing products before they are released, employing mostly EEG and biometric methods for these purposes. The most promising application of neuroimaging to marketing, it has been argued, may come before a product is even released—when it is just an idea being developed—since marketing ultimately serves to match products with people by guiding design, presentation, price, advertising, and promotions.

At the strategic level, neuroscience provides a novel way to establish mappings between cognitive processes and traditional marketing data, enabling segmentation of a brand's consumer base into distinct groups with differing needs based on neurocognitive profiles rather than demographics alone. Neural measures can also illuminate the constructs at the heart of consumer choice (attention, affective arousal, memory encoding, and valuation) and, in doing so, identify which stage of the consumer journey a given stimulus fails or succeeds in. EEG research shows that emotionally engaging advertisements increase consumer attention, while eye tracking identifies optimal ad placements. Text-mining analysis of 469 articles in the field shows that “consumer neuroscience,” “brand memory,” and “willingness to buy” are the most relevant topics, with the literature increasingly concentrating on ethical and controversial concerns in the use of these techniques.

4.5. Ethical Considerations

The capacity to access consumers' unspoken cognitive and emotional responses raises profound ethical questions. Neuromarketing paves the way for unbridled manipulation of customers by providing unparalleled access to their minds, and therefore requires scrutiny of its potential and limitations (Gupta et al., 2024). The skewing of the decision-making process of the brain through brain probes violates rights and creates ethical concerns, such that rules and regulations are needed (Solomon, 2018). Two crucial ethical issues are the protection of the individual affected by neuromarketing research and the protection of the free will of the customer in decision-making; industry standards and regulations are needed to prevent misuse and to ensure responsible use of these techniques. Public apprehensions include the so-called “buy button” effect—the fear that neuromarketing could eliminate the free will of customers and convert humans into programmed buying machines. While some observers consider such fears unrealistic, noting that some claimed powers of neuromarketing do not currently exist, other ethical challenges found in traditional marketing persist in amplified form (Crespo-Pereira et al., 2020). Questions of consumer privacy, manipulation, and informed consent remain unanswered, making the establishment of a strong regulatory and ethical framework a priority, alongside interdisciplinary collaboration among neuroscientists, marketers, ethicists, and policymakers (Sarin et al., 2026).

4.6. Methodological Limitations and Challenges

Several methodological issues limit the validity and generalizability of neuromarketing findings. Small sample sizes render neuroscientific findings unreliable and difficult to generalize to wide populations, while leaving the possibility of opportunistic findings widely open (Kalaganis et al., 2021). Sample size is key to the validity of predictions in any domain of interest, and transparency about methodologies and measurements is decisive for statistical validation and reliability, especially in commercial environments (Crespo-Pereira et al., 2020). Concerns about scientific validity have been raised repeatedly, and the field's commercial credibility has been damaged by providers who entered the market in its early days without applying sound and robust scientific methods. A 2019 survey by the Neuromarketing Science and Business Association identified two main themes facing the commercial application of neuromarketing: the readiness of clients to adopt neuromarketing solutions and the reputational risk arising from inexperienced or under-qualified vendors, including the negative effects of over-promising and under-delivering (Kalaganis et al., 2021).

There are also conceptual limitations. No marketing strategy can completely eliminate or block the decision-making process of a customer, and while technological problems such as cost have been progressively overcome, the field still struggles to prove its credibility.

Reviews of the literature note the absence of a rigorous, comprehensive evaluation of the relative merits and appropriateness of all neuroscience, physiological, and biometric research tools currently in use, which complicates method selection for researchers and practitioners alike .

4.7. Future Research Directions

Several research gaps and trajectories emerge from the literature. First, despite the centrality of preferences in theories of consumer choice, the field still knows relatively little about where preferences come from and the developmental processes that shape them; the roles of attention and memory in consumer choice also remain poorly understood despite their importance in interpreting neurophysiological data . Second, future research should investigate whether constructs such as trust, perceived value, and loyalty can be differentiated on the basis of distinct activations in affective or cognitive brain networks, and should identify the neural correlates of consumer involvement, a powerful precursor of purchase intentions and behavior . Third, multimodal designs that combine EEG, eye tracking, and biometric recording—and more ecologically valid experimental settings—are most likely to advance the field . Fourth, the integration of AI, big data, and improved machine-learning classifiers promises to improve predictive models, provided ethical transparency keeps pace . Finally, the establishment of regulatory and ethical frameworks, and of interdisciplinary collaborations across neuroscience, marketing, ethics, and policymaking, is essential if neuromarketing is to be viewed as a credible scientific and managerial decision-making tool .

CONCLUSION

Neuromarketing offers an increasingly sophisticated toolkit (from fMRI's precise mapping of valuation circuitry to EEG's millisecond-resolution measures of engagement and eye tracking's direct readout of visual attention) for understanding how consumers choose and what they prioritize. The accumulated evidence shows that product valuation, price acceptability, and purchase decisions are encoded in identifiable neural circuits, notably the nucleus accumbens, medial prefrontal cortex, and insula, and that brain-based measures can predict choices above chance levels . EEG-derived metrics already outperform traditional self-report measures in predicting in-market advertising performance . At the same time, the field confronts unresolved ethical, methodological, and credibility challenges that require regulatory attention and scientific rigor. The theoretical knowledge acquired through neuromarketing can be applied in practice at almost zero cost when methods are correctly chosen and combined; the next decade will likely determine whether its promise of genuinely understanding the consumer mind is fulfilled.

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