Consumer Response to Social Media Advertising: A Neuromarketing Perspective

Table of Contents

Introduction

Over time, social media platforms have been slowly integrated into our daily lives. Many of us spend hours every day scrolling through various platforms and being fed endless content chosen for us by the algorithms. Each platform uses a different algorithm and, therefore, each user should have a different perspective or experience on each platform by subconsciously choosing favorites, and avoiding the platforms that can't hold onto their attention as tightly. Understanding how consumers perceive and engage with these platforms could give companies a competitive advantage and optimize their marketing strategies by more effectively targeting their audiences.

Neuromarketing is a relatively new field, according to Lee et al. (2006) "Neuromarketing as a field of study can simply be defined as the application of neuroscientific methods to analyze and understand human behavior in relation to markets and marketing exchanges." By combining neuroscience and marketing, marketers are able to bridge the gaps left behind by traditional market research techniques. For example, simply recording a consumer's verbal response to a stimulus may not be an accurate representation of what they're experiencing. With some individuals possessing a better ability to self-assess than others, verbal responses alone can leave a lot to be desired. By creating an image of the brain through non-invasive means researchers can examine the consumer's true brain state at the time the stimuli were presented, giving companies invaluable insight into how consumers perceive their products or brand.

There are so many social media platforms to choose from and more are being founded all the time, it creates a challenge for companies to choose which platform will optimize their digital marketing campaign and maximize their return on investment. Understanding how consumers engage and interact with platforms can help companies align marketing strategies with user preferences. For example, if EEG data reveals that Tik Tok users experience low levels of engagement and negative emotional responses then companies can allocate fewer resources to Tik Tok and more to platforms that drive positive emotions and high engagement.

This paper proposes a conceptual neuromarketing study aimed at identifying the most effective social media platform(s) for advertising by analyzing neural responses to various platforms. Drawing upon insights from existing studies, this study seeks to model its design and methodologies to effectively evaluate and compare the neural reactions elicited by different social media platforms, thereby informing marketers on the optimal channels for delivering their marketing messages.

Literature Review

Understanding the cognitive intricacies associated with social media marketing requires a multifaceted approach that integrates principles from psychology, neuroscience, and marketing research. The following theoretical framework aims to provide a conceptual lens through which to interpret the neural responses to

advertisements presented on different social media platforms (Instagram, Facebook, and TikTok) and their implications for consumer behavior.

I. Neuromarketing Techniques

There are multiple neuromarketing techniques including eye tracking, facial expression recognition, galvanic skin response, functional magnetic resonance imaging (FMRI), and electroencephalography (EEG). All of these techniques may be used to track consumer attention in neuromarketing studies and measure an individual's mental state and discover the subconscious motivators that drive social media use. EEG machines are a very popular choice for neuromarketing studies as they are non-invasive, cost-effective, and capable of repetitive, real-time analysis of brain interactions in high temporal resolutions. Yadava et al (2017) emphasize the benefits of EEG-enabled systems by stating, “EEG signals offer high temporal resolution and are cheaper than FMRI. They can access customer brain information during preference generation or observation towards a product. EEG-enabled systems can replace costly setups in neuromarketing.” The biggest advantage they mention is the ability to capture real-time brain activity during preference generation, allowing researchers to connect motivations/emotional states to specific stimuli.

Telpaz et al. (2015) showed that they could predict consumer preferences with EEG based on increased data collection from the N200 component at the mid-frontal electrode site, showing an increase in activity for preferred products. Showing changes in the neural activity in the frontal, parietal, and occipital regions based on consumer preferences.

Hsu et al. (2020) investigated the effect of emojis in subliminal advertising using an EEG machine. They found that “one’s purchase behavior is found to correlate with activating the reward system in the mesolimbic region of the brain triggered by preferred brands." This heightened activity in the mesolimbic region may reflect the brain’s response to anticipation of rewards associated with these brands. The rewards may be feelings of pleasure, satisfaction, or fulfillment. They were also able to determine that “using emojis as subliminal stimuli would reduce consumer psychological pressure, and this finding has implications for marketing research and practice." In other words, this means that when consumers are exposed to emojis in an advertisement without directly recognizing them, they may experience less mental stress in the decision-making process.

II. Frontal Alpha Asymmetry Theory

Frontal alpha asymmetry theory (FAA) is a valuable indirect indicator of positive or negative emotions, rather, FAA theory identifies approach or withdrawal motivations. Approach motivations involve seeking rewards, opportunities, or positive experiences while withdrawal motivations involve avoiding threats, punishments, or negative experiences. This flexible framework allows for a better understanding of emotional responses and recognizes that emotions are complex and can serve different functions based on context. For example, while Instagram may illicit approach motivation in one individual it can also create withdrawal motivation in another, it depends on factors such as personality, past experiences, or situational cues. Research suggests that greater left-sided FAA is generally associated with approach motivation while greater right-sided

FAA is associated with withdrawal motivation. Premnath et al. (2021) states that, "according to psychologists consumers gather a lot of information today. Learning theory states that our behavior is based on our learnings and experiences from the past. The engagement process with a brand involves a lot of psychological elements like perceptions, motivations, and attitudes." suggesting that factors such as perceptions, motivations, and past experiences shape the consumer's behavior and decision-making process.

III. Attention Restoration Theory

The Attention Restoration Theory (ART) is the first lens through which to examine the data, this will serve as a foundational framework for understanding how environmental stimuli influence cognitive processes and facilitate attention restoration. One of the main goals of ART, is to create environments or stimuli that invoke "soft fascination", according to Neilson et al. (2019), soft fascination is elicited by "an environment that promotes effortless attention distributed across aesthetically pleasing features of the environment (e.g., clouds, tree branching moving in the wind)." Neilson et al. (2019) continues to explain that "recent research focusing on gaze behavior found longer gaze times for nature stimuli compared to artificial stimuli when presented at the same time". Attention Restoration Theory (ART) posits that exposure to natural environments replenishes cognitive resources depleted by sustained attention, providing some rest from mental fatigue caused by activities such as prolonged time on social media. In the social media marketing space, consumer attention is often divided, and cognitive resources become strained. The visually appealing aspects of ad content

may trigger the brain's attention restoration processes, this would hopefully create a sense of ease and engagement without requiring conscious effort.

IV. Dual-Process Models

The dual-processing model serves as the second lens through which to analyze the data, providing a theoretical framework and insights into how individuals' motivations and cognitive abilities influence their processing of information and subsequent behavior. Dual - process models propose that advertising effects are driven by two cognitive processes; systematic processing and heuristic processing. Heuristic processing involves quick and relatively effortless decision-making based on mental shortcuts. Instead of consumers analyzing all available information, they rely on simplified decision-making rules to make snap judgements or choices. This decision-making process may be used when cognitive resources are limited or time is constrained. On social media platforms, users commonly engage in fast paced scrolling and rely on actions from other users such as likes, shares, or comments as a shortcut to determine the credibility or popularity of brands or products. Marketers can also take advantage of emotional appeals and persuasive techniques to evoke an immediate reaction from users. In contrast, systematic processing involves a thorough and analytical evaluation of available information to make choices or judgements. Despite the prevalence of heuristic processing, some users engage in more deliberate information processing on social media. Marketers may use attention-grabbing visuals and messaging to capture initial attention, and then incorporate opportunities for deeper engagement and exploration such as polls or discussion in the comments. Using Event-

Related Potentials (ERPs), like the P300 component, is invaluable in assessing the level of cognitive engagement and processing triggered by stimuli, such as advertisements. Higher P300 amplitudes signify heightened attention and deeper information processing. Therefore, by analyzing ERP responses across various social media platforms, this framework can illuminate discrepancies in processing depth and the efficiency of advertisements.

The use of Frontal Alpha Asymmetry will compliment both Attention Restoration Theory and Dual-Process Models, while ART emphasizes the restorative influence of environmental stimuli on attentional resources, FAA Theory offers insights into the inner neural workings of decision making and motivational tendencies. By integrating FAA Theory, marketers can discern how variations in frontal alpha asymmetry change attention restoration processes and influence the balance between systematic and heuristic processing in response to advertising stimuli across different media platforms. This helps deepen the understanding of the relations between environmental cues and cognitive processes.

Methodology

Thirty-five conceptual and empirical papers covering neuromarketing and social media usage were collected and sorted out into seventeen conceptual and eighteen empirical studies. A table as seen in Table 1 below was created based on the empirical papers and sorting the respective content into three columns: study title, study purpose, and findings. However, it's important to note that five of the thirty-five studies, were primarily researched to enhance understanding for the purposes of creating a conceptual study, and are not included in the table as they wouldn't integrate well into

the comparison framework. Based on the findings of the existing literature as outlined in Table 1 below, propositions for future research were made and the rationale for these propositions were explained in the discussion.

Table 1: Summary of Empirical Studies

	Study Title	Study Purpose	Findings
1.)	The application of EEG power for the prediction and interpretation of consumer decision-making: A neuromarketing study	➢ Investigating the potential of EEG spectral power for predicting consumers' preferences and the alteration of consumers' decision-making in shopping behavior when the content of an advertisement is changed, including background color and promotions.	➢ EEG power of the theta band increased in the left frontal region for "Like" preferences and in the right frontal region for "Dislike" preferences. ➢ Similar results were observed for the alpha band, with theta band activity higher in the right hemisphere for "Dislike" preferences. ➢ Comparison of EEG power when participants made decisions about advertisements with a neutral state showed significant differences, indicating altered brain states during decision-making. ➢ ANOVA analysis on EEG features extracted from different brain regions showed statistical differences between "Buy" and

			"Dislike" conditions at specific electrode locations. ➢ Linear discriminant analysis (LDA) and support vector machine (SVM) classifiers achieved high accuracy (> 87%) in predicting consumer decisions based on EEG features. ➢ SVM classifier showed better performance for distinguishing between consumer preferences compared to LDA classifier. ➢ Consumer reaction time decreased significantly when background color was added to advertisements, suggesting an impact on decision-making. ➢ EEG power spectrum features showed potential for predicting consumer preferences and decision-making with high accuracy, offering valuable insights into neural responses to marketing stimuli. ➢ Alterations in EEG power and power ratios were observed in different brain regions during decision-making, highlighting the involvement of frontal

			and parietal lobes.
2.)	Neuromarketing, subliminal advertising, and hotel selection: An EEG study	➢ Investigates how hotel videos embedded with a smiling face emoji as a subliminal message affect consumers' selection of hotels.	➢ Participants' rankings of hotel selection significantly changed with or without subconscious stimulation. ➢ Rankings of hotels with smiling face emojis as subliminal stimuli significantly increased. ➢ Rankings of videos without subliminal stimuli significantly dropped. ➢ Chi-square test results showed a significant effect of subliminal messages on participants' hotel selection ($\chi 2 = 10.21$, $p < .01$). ➢ Bayesian test of association indicated moderately strong evidence for the effect of subliminal stimuli (Bayes Factor = 18.15). ➢ Subliminal messages, even in the form of a simple smiling face emoji, significantly influenced consumers' selection of hotels. ➢ Emojis as subliminal stimuli positively affected consumers' behavior, echoing previous findings on the

			influence of positive emojis.
3.)	The Sample Size Matters: To What Extent the Participant Reduction Affects the Outcomes of a Neuroscientific Research. A Case-Study in Neuromarketing Field	➢ The study aims to investigate how research outcomes change when the sample size is reduced.	➢ Overall, the study suggests that reducing the sample size affects the outcomes of EEG analysis, with a decrease in correlation strength and an increase in MSE and STD values as the sample size decreases. This indicates that larger sample sizes are generally preferred for more reliable results in EEG analysis.
4.)	A comparative analysis of neuromarketing methods for brand purchasing predictions among young adults	➢ This study investigates how psychophysiological reactions, measured through EEG (electroencephalography), EDA (electrodermal activity), and eye-tracking, correlate with responses to a specific type of marketing stimulus - a television advertisement for a retailer.	➢ Correlations between EEG measurements (frontal alpha asymmetry) and the number of chosen products were found, indicating a weak correlation. ➢ However, EEG measurements did not reveal statistically significant relevance in predicting purchase decisions based on dynamic stimuli, suggesting limited utility in this context. ➢ EEG frontal asymmetries correlated with the number of declared chosen products but did not

			reveal statistically significant relevance in predicting a purchase. ➢ Eye-tracking variables (average pupil size, number of fixations) showed significant differences across brands, indicating cognitive processes and attention allocation differences. ➢ Electrodermal activity (EDA) peaks per second correlated with private label purchases, particularly for familiar brands, suggesting that EDA may be linked to the probability of purchasing familiar brands. ➢ Differences in psychophysiological data were observed between familiar and unfamiliar brands, suggesting that brand familiarity influences consumers' decision-making processes.
5.)	The Visual-Digital Identity of Corporate Brands: A Study of Neuromarketing in Young People from Spain and Portugal	➢ Investigates the cognitive processing of young university students in response to traditional brand logos compared to the simplified, flat, and two-dimensional logos commonly used in digital	➢ No significant gender differences were found in the time elapsed from stimulus appearance to first fixation for any AOI. ➢ Significant differences were observed in specific logos, such as

		media.	Juventus' tridimensional logo and Volkswagen's flat logo, with differences in fixation duration between men and women. ➢ Women tended to show greater fixation towards text elements, while men showed greater fixation towards symbol elements in certain logos. ➢ Significant nationality-based differences were observed in fixation times for certain logos, such as Hyundai's tridimensional logo and MEO's complete logo, with Spaniards showing faster fixation in some cases. ➢ Spaniards exhibited significantly greater fixation duration towards certain logos compared to Portuguese participants, particularly for Hyundai's tridimensional logo and Juventus' flat logo. ➢ Portuguese participants showed greater fixation duration towards certain elements of MEO's logos compared to Movistar's logos. ➢ Differences in fixation counts were also

			observed between Spaniards and Portuguese participants for various logos. ➢ Brand Traditions and Positioning: Logos of brands with established communication traditions and perceived status tended to have better fixation and emotional arousal responses, underscoring the importance of brand associations and self-concept alignment in consumer perception. ➢ Sector Affinity: Logos related to sectors with which consumers have a strong affinity (e.g., automotive and telecommunications) tended to receive better fixation responses. ➢ Preference for Flat Logos: In general, flat logos received better fixation responses compared to their tridimensional counterparts, especially for brands with strong positioning like Volkswagen, supporting the trend towards simplicity and digital adaptation in logo design. ➢ Influence of Logo Changes: Even radical

			changes in visual identity, like Juventus' transition to a flat logo, can result in positive fixation responses if the change aligns with the brand's essence and positioning. ➢ Cultural Similarities: Gender and geographical origin did not significantly influence cognitive perception of logos, suggesting socio-cultural affinity among young Spanish and Portuguese university students. However, differences in fixation patterns suggest varying levels of familiarity with flat design trends between Spain and Portugal.
6.)	The Application of Deep Learning and Traditional Machine Learning in EEG Neuromarketing Prediction Tasks	➢ The study aims to explore the effectiveness of deep learning methods in EEG neuromarketing prediction tasks compared to traditional machine learning approaches.	➢ Indicates that both frameworks performed poorly in predicting product choices, but the CNN showed better accuracy in predicting movie ratings. ➢ Suggests that deep learning applications, particularly CNNs, exhibit superiority in certain neuromarketing prediction tasks compared to traditional machine learning approaches.

7.)	Deep Learning for Neuromarketing; Classification of User Preference using EEG Signals	➢ The paper aims to compare the applicability and effectiveness of deep learning methods with traditional machine learning approaches in EEG neuromarketing prediction tasks.	➢ The results indicate that while both models exhibited poor performance in predicting product choices, the CNN demonstrated greater accuracy in predicting movie ratings, suggesting the superiority of deep learning algorithms in certain neuromarketing prediction tasks.
8.)	DeePay: deep learning decodes EEG to predict consumer's willingness to pay for neuromarketing	➢ The study aims to overcome the limitations of EEG data by combining unique techniques of Deep Learning Networks. ➢ The main focus of the study is to develop a DLN to predict subjects' willingness to pay (WTP) based on their EEG data collected while observing product images.	➢ A gradual increase in Willingness to Pay (WTP) was observed across products averaged over subjects. ➢ Products categorized under "Experience" were the most preferred, while those in the "Office" category were least preferred, suggesting varying levels of WTP across product categories. ➢ Limited success in predicting High/Low WTP values based solely on product identity indicates that EEG-based prediction of WTP is not solely mediated by product identity. ➢ Complexity of consumer valuation processes: Highlights the need for advanced analytical

			techniques like deep learning to understand consumer behavior accurately. ➢ DeePay, a Deep Learning Network (DLN) developed in the study, outperformed other DLNs and machine learning models in predicting WTP across different quantiles. ➢ Efficacy of DLNs: Demonstrates the efficacy of DLNs in extracting meaningful patterns from EEG data for predicting consumer behavior accurately
9.)	An Adaptive Machine Learning Methodology Applied to Neuromarketing Analysis: Prediction of Consumer Behavior Regarding the Key Elements of the Packaging Design of an Educational Toy	➢ The research is a response to the question of which aspects of package design are more relevant to consumers, specifically when purchasing educational toys.	➢ Educational toy packaging: Attention was focused on specific areas such as theme specification and recommended age, with less attention on brand or game name. ➢ Diset packaging: Attention was directed towards topics specification and questions/answers, the message "when you hit...", and the product reference, with the product image receiving the most attention in both cases. ➢ Users spent less time

			viewing Diset brand areas compared to Educational, suggesting potentially more easily perceived designs or greater interest in certain areas of Diset packaging.
10.)	Neurophysiological Measurements of Memorization and Pleasantness in Neuromarketing Experiments	➢ The aim of the study is to analyze brain activity during the "naturalistic" observation of commercial ads. ➢ Electroencephalographic (EEG) recordings and high-resolution EEG techniques were employed to measure brain activity and emotional engagement during the experiment.	➢ TV commercials led to increased cortical activity, notably in the theta band in the left hemisphere, particularly when they were both memorized and judged pleasant. ➢ An increase in EEG Power Spectral Density (PSD) at left frontal sites showed a negative correlation with perceived pleasantness. ➢ Conversely, the de-synchronization of left alpha frontal activity exhibited a positive correlation with judgments of high pleasantness. ➢ PSD increased in relation to the observation of unpleasant commercials, indicating a distinct neural response to stimuli perceived as unpleasant.

11.)	Neuromarketing Study: The Effect of Jingle on Consumer Behavior	➢ Investigating the impact of a jingle associated with a top-brand product on consumer behavior, specifically focusing on short-term memory activity in the brain.	➢ Post-test results indicated increased energy levels in the short-term memory area, particularly in the F4 channel, suggesting improved memory retention due to jingles. ➢ Higher accuracy and validation were observed for top brands compared to non-top brands, underscoring the influence of jingles in brand recall. ➢ Jingles emerged as effective marketing tools, facilitating brand memorability and recall among subjects. ➢ Subjects demonstrated higher accuracy in recalling top brand categories compared to non-top brand categories, highlighting the significance of brand status in memory retention. ➢ Active brain signal areas, particularly in the frontal region (F4 channel), indicated enhanced memory processing during jingle exposure. ➢ Top brand categories exhibited higher average energy levels in active channels, emphasizing

			their superior memorability compared to non-top brands.
12.)	Study of neuromarketing: visual influence with decision making on impulse buying	➢ The primary aim of the study is to investigate the application of neuromarketing techniques, specifically utilizing electroencephalography (EEG) signal analysis, to measure consumer responses to marketing stimuli. The study focuses on analyzing how changes in product colors and light intensity affect brain activity and consumer interest.	➢ Light intensity variations can influence impulse purchase decisions. ➢ Respondents exhibited color preferences based on light intensity changes. ➢ Signal pattern recognition accuracy for affected conditions using phase features was 67%, while SVM with RBF kernel achieved 72% accuracy with a combination of features.
13.)	The Neuromarketing Concept in Artificial Neural Networks: A Case of Forecasting and Simulation from the Advertising Industry	➢ The main purpose of this research is to explore the use of neural networks (artificial intelligence) as an alternative model for studying the phenomenon of neuromarketing.	➢ The results suggest that the neural network models effectively predict consumer buying behavior based on various marketing stimuli, with product features consistently emerging as a significant predictor across different applications.
14.)	Processing and analysis of electroencephalography signal to evaluate the effect of sport advertisement on customers	➢ The main purpose of this study was to assess the effect of sports advertisement, specifically focusing on the Nike brand, on customers by analyzing electroencephalography	➢ Results indicate that alpha wave activity increased significantly in the interested group during advertisement viewing, suggesting enhanced attention and

		(EEG) signals.	cognitive processing. ➢ Beta wave activity also showed significant changes, with variations depending on the group's interest in the advertisement. ➢ Delta and theta waves did not show consistent significant differences across all groups, indicating varying responses to the advertisement stimuli. ➢ Overall, the findings suggest that advertisements, particularly those tailored to individuals interested in a specific brand, can influence brainwave activity, affecting attention, cognitive processing, and decision-making.
15.)	Analysis And Evaluation Of Consumers' Cognitive Responses To Visual And Gustatory Stimuli For Neuromarketing Application	➢ The main purpose of the study is to utilize neuroscientific information to understand the brain activity of healthy subjects during visual and gustatory stimuli of different flavors of a beverage brand. Specifically, the study aims to distinguish contrasts between EEG signals of healthy subjects to examine their subconscious responses to stimuli.	➢ The study demonstrated the utility of EEG signals and frequency mapping in assessing consumers' responses to visual and gustatory stimuli. Delta wave dominance, particularly during stimuli associated with preference, suggests its potential as an indicator of consumer liking. The findings align with previous research on brain oscillations and

			emotional appraisal, highlighting the importance of delta and theta bands in evaluating consumer preferences.
16.)	Message framing, non-conscious perception and effectiveness in non-profit advertising. Contribution by neuromarketing research	➢ The main purpose of the study is to investigate the impact of different message framing strategies in television commercials on the effectiveness of advertising campaigns for non-profit organizations, specifically in terms of increasing calls and donations. The study employs neuromarketing techniques to measure cognitive and emotional reactions to the commercials, including electroencephalogram (EEG) to obtain an Approach-Withdrawal Index (AW), heart rate and galvanic skin response sensors to obtain an Emotional Index (EI), and eye tracking to assess visual attention on key visual areas of the ads.	➢ The study observed a considerable change in the trend of cognitive and emotional indexes after modifying the creativity strategy with victim images. Specifically, the AW and EI indexes exhibited significant differences between the LVE and HVE spots after the visualization of war victim images. ➢ The study demonstrated that neuromarketing techniques are effective in identifying weaknesses in advertising campaigns and making strategic modifications to enhance their impact.
17.)	Assessing the Emotional Response in Social Communication: The Role of Neuromarketing	➢ The main purpose of the study is to assess the effectiveness of the Unicef bequest campaign in terms of emotional response, comparing different creative proposals to optimize communication, and	➢ The self-report data did not show significant differences between the two spots and between the two groups in terms of satisfaction, perceived effectiveness, and probability of increasing

		applying neuromarketing tools to the social area. The study aims to understand the emotional and cognitive reactions of individuals to the campaign messages and evaluate their potential to change the behavior of the target audience.	legacies. ➢ Neuroscientific analysis revealed significant differences between the two spots in terms of cognitive involvement (AWI) and emotional activation (SC), with both indicators moving in the same direction. ➢ Participants without children showed more positive cognitive involvement and emotional activation compared to those with children, indicating better performance among the target audience. ➢ The study demonstrated the effectiveness of using a neuroscience approach to assess emotional responses in social advertising, leading to optimized communication strategies.
18.)	Neuromarketing as a strategic tool for predicting how Instagramers have an influence on the personal identity of adolescents and young people in Spain	➢ The main purpose of the study is to investigate the cognitive perception of Spanish adolescents and young people regarding stimuli transmitted by influencers on Instagram, particularly focusing on body image and brand promotion. The study aims to go beyond traditional	➢ Heat maps of subjects' attention revealed that they focused intensely on the attractiveness of influencers' bodies and faces, as well as imperfections deliberately displayed. ➢ Quantitative analysis showed that influencers'

		content analysis of social networks by employing neuromarketing techniques, such as eye tracking and galvanic skin response, to capture unconscious reactions of the audience. Specifically, the study seeks to understand how adolescents and young adults perceive the body image portrayed by influencers and their engagement with the brands promoted by these influencers.	faces attracted attention from all participants, except when the female influencer was seen from behind. ➢ Brands advertised by influencers received less attention compared to influencers' appearance. ➢ Attention was concentrated on attractive body parts of influencers, with buttocks of the female influencer receiving the fastest attention. ➢ There were significant differences in attention between male and female influencers and their respective attractive body parts. ➢ Adolescents showed differences in attention compared to older participants, particularly in their focus on buttocks and faces.

Results

The results of analyzing the findings from the studies in Table 1 above have been summarized into the following:

1. EEG Theta Band Activity:

- Theta band power increased in the left frontal region for “Like” preferences and in the right frontal region for “Dislike” preferences.
- Similar patterns were observed for the alpha band, with theta band activity higher in the right hemisphere for “Dislike” preferences.

2. Decision-Making and Brain States:
    - Comparing EEG power during decision-making to a neutral state revealed significant differences, indicating altered brain states during decision-making.
3. Statistical Differences in EEG Features:
    - ANOVA analysis on EEG features from different brain regions showed statistical differences between “Buy” and “Dislike” conditions at specific electrode locations.
4. Impact of Background Color on Decision-Making:
    - Consumer reaction time decreased significantly when background color was added to advertisements, suggesting an impact on decision-making.
5. Subliminal Stimuli and Hotel Rankings:
    - Participants’ rankings of hotels significantly changed with or without subconscious stimulation.
    - Rankings of hotels with smiling face emojis as subliminal stimuli significantly increased.
    - Rankings of videos without subliminal stimuli significantly dropped.
    - Chi-square test results showed a significant effect of subliminal messages on participants’ hotel selection ($\chi^2 = 10.21$, $p < 0.01$).
    - Bayesian test of association indicated moderately strong evidence for the effect of subliminal stimuli.

These findings provide valuable insights into neural responses to marketing stimuli and consumer decision-making processes.

Discussion

There is a critical importance for marketers to know which social media platform will optimize their marketing campaign and maximize return on investment through commanding audience attention and crafting tailored content strategies. By interpreting the assumed findings in relation to platform-specific neural responses, we can gain invaluable insights into the efficiency of various social media channels for advertising endeavors. Understanding which platforms elicit the most favorable neural engagement patterns can inform marketers on where to allocate resources and deploy content effectively. Moreover, we can refine our understanding of consumer behavior in the digital realm, honing strategies that resonate with target audiences across diverse social media landscapes. This knowledge not only enhances the precision of advertising efforts but also ensures that marketing budgets are allocated efficiently, maximizing the impact of each campaign. However, failing to grasp the nuances of different platforms can pose significant risks to marketers. Without this insight, campaigns may fall flat, failing to capture audience attention or failing to resonate with consumers, leading to wasted resources and missed opportunities. Methodological considerations underscore the need for robust research designs that capture nuanced neural responses, paving the way for more accurate assessments of advertising effectiveness. Ultimately, this discussion not only illuminates the theoretical implications of our findings but also underscores their practical significance for marketers seeking to optimize their social media advertising efforts and achieve maximum impact in an increasingly competitive digital marketplace.

Propositions for Future Research

The findings of the studies outlined in Table 1 above indicates that extant literature has not covered neuromarketing in the social media context. Although extant literature covered many aspects of neuromarketing, from generational and sex differences in attention, through response to influencer marketing and cognitive involvement among many others, these studies have not addressed the neural responses to different social media ads and platforms. Hence, this literature gap creates an opportunity for the research questions posed in this study.

Q1. How do people's perception of an ad vary across the different platforms?

Q2. What is the difference in attention retention across platforms?

Q3. Are different regions of the brain stimulated across different platforms?

Q4. What are the moderating effects of age?

Conclusion

In closing, this study underscores the importance of bridging theoretical frameworks with empirical research to inform marketing practices in the digital realm. As social media continues to evolve, there remains ample opportunity for future research to expand upon our theoretical groundwork. Through EEG data analysis, we expect to uncover patterns of attention, emotional response, and cognitive processing across different social media platforms. For instance, we hypothesis that TikTok may elicit the highest level of attention due to its engaging algorithm, followed by Instagram and then Facebook, reflecting shifts in platform popularity and user engagement. Understanding which platform draws the most attention or elicits a negative response helps marketers

optimize their campaigns and allocate their social media marketing budget efficiently, ensuring maximum impact and return on investment.

References

Abed Hosseini, S., & Moushmand , M. (2022). *Analysis of the EEG Signal Using Higher-Order Spectra (HOS) in the Neuro-marketing Application*. https://www.sid.ir/fileserver/jf/4002914014402.pdf

Ahmed, R. R., Streimikiene, D., Channar, Z. A., Soomro, H. A., Streimikis, J., & Kyriakopoulos, G. L. (2022, July 12). *The neuromarketing concept in artificial neural networks: A case of forecasting and simulation from the advertising industry*. MDPI. https://www.mdpi.com/2071-1050/14/14/8546

Aldayel, M., Ykhlef, M., & Al-Nafjan, A. (2020, February 24). *Deep learning for EEG-based preference classification in neuromarketing*. MDPI. https://www.mdpi.com/2076-3417/10/4/1525

Alimardani, M., & Kaba, M. (2021, May 1). *Deep learning for neuromarketing; classification of user preference using EEG signals: 12th Augmented Human International Conference*. ACM Other conferences. https://dl.acm.org/doi/abs/10.1145/3460881.3460930

Antoniak, M. (2020). *BENEFITS AND THREATS OF NEUROMARKETING: THEORETICAL BACKGROUND AND PRACTICAL USE*. S I L E S I A N U N I V E R S I T Y O F T E C H N O L O G Y P U B L I S H I N G H O U S E. file:///C:/Users/amand/Downloads/Benefits_and_threats_of_neuromarket-1.pdf

Byrne, A., Bonfiglio, E., Rigby, C., & Edelstyn, N. (2022, November 14). *A systematic review of the prediction of consumer preference using EEG measures and machine-learning in neuromarketing research - brain informatics*. SpringerLink. https://link.springer.com/article/10.1186/s40708-022-00175-3

Cardoso, L., Chen, M.-M., Araújo, A., de Almeida, G. G. F., Dias, F., & Moutinho, L. (2022, February 21). *Accessing neuromarketing scientific performance: Research gaps and emerging topics*. MDPI. https://www.mdpi.com/2076-328X/12/2/55

Constantinescu, M., Orindaru, A., Pachitanu, A., Rosca, L., Caescu, S.-C., & Orzan, M. C. (2019, December 11). *Attitude Evaluation on using the neuromarketing approach in social media: Matching company's purposes and consumer's benefits for sustainable business growth*. MDPI. https://www.mdpi.com/2071-1050/11/24/7094

Costa Rozan Fortunato, V., de Moura Engracia Giraldi, J., & Henrique Caldeira de Oliveira, J. (2014, April). *A Review of Studies on Neuromarketing: Practical Results, Techniques, Contributions and Limitations*. Macrothink Institute. https://d1wqtxts1xzle7.cloudfront.net/87629174/29a7bf9e1a91b41582d3e5e5cd47

53ca93f8-libre.pdf?1655436592=&response-content-disposition=inline%3B+filename%3DA_Review_of_Studies_on_Neuromarketing_Pr.pdf&Expires=1712722258&Signature=UzW2coc5O5XdysLd2pJgY05YuODspnGGfIbgJng2vfsCijkT6IWIeKYZpt8~NcjIUunIyMjiGsueqIKoFt7VYuQ2SJE7~45GAqh~9KlKtWfj7JNj1YAA20TtEkz0brV6-QMTH6nQPyhsbeYU5HSvT-wydUAlgsa0XNDB-3-IPy-xPAxo6iedeEff614x7MxJvVBLk3Qqh0OFPkJ0IdLmQkPZmBy~X937lPkbB6uB0pcEcjShDpcXk29-SDgUvGJ5dnXMF2x~2D6weKTw8Vqaz469Khdcq0LRrA4UJFfA8eSOO~U~iAnNF4y5y0Uk7pJQioF7GdCjcQfMQkQHQIg9fA__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

Darabi, M., Azizian, N., Moharramzadeh, M., & Nobakht, F. (2018, July 1). *Processing and analysis of electroencephalography signal to evaluate the effect of sport advertisement on customers*. Journal of Advanced Sport Technology. https://jast.uma.ac.ir/article_611.html

Ercan, Ö., & Kabakçı, A. C. (2019, March 30). *Subliminal advertising applications in sport: Neuromarketing*. International Journal of Sport Culture and Science. https://dergipark.org.tr/en/pub/intjscs/issue/45916/582724

Fauzi, H., Rizqullah, R., Ariyanti, M., & Hadyningtyas, I. A. (2022). *Neuromarketing study: The effect of jingle on consumer behavior*. UI Scholars Hub. https://scholarhub.ui.ac.id/amj/vol14/iss2/4/

Garczarek-Bąk, U., Szymkowiak, A., Gaczek, P., & Disterheft, A. (2021, January 12). *A comparative analysis of neuromarketing methods for brand purchasing predictions among Young Adults - Journal of Brand Management*. SpringerLink. https://link.springer.com/article/10.1057/s41262-020-00221-7

Golnar-Nik, P., Farashi, S., & Safari, M.-S. (2019, April 29). *The application of EEG power for the prediction and interpretation of consumer decision-making: A neuromarketing study*. Physiology & Behavior. https://www.sciencedirect.com/science/article/pii/S0031938418306723?casa_token=16CDEZruH7AAAAAA%3Ath-FfbRO5Jq0JsJc0CGvICEnlJ5mpr2lXhOgLBZ6J7y-RAaW3y4a-JVYfw-DnRgpcFvzl-FrVw

Gupta, A. (2022, May 1). *Consumer preference detection in neuromarketing using EEG*. DSpace @ Delhi Technological University: CONSUMER PREFERENCE DETECTION IN NEUROMARKETING USING EEG. http://dspace.dtu.ac.in:8080/jspui/handle/repository/19226

Hakim, A., Golan, I., Yefet, S., & Levy, D. J. (2023, May 16). *DeePay: Deep learning decodes EEG to predict consumer's willingness to pay for*

neuromarketing. Frontiers. https://www.frontiersin.org/articles/10.3389/fnhum.2023.1153413/full

Hsu, L., & Chen, Y.-J. (2020). *Neuromarketing, Subliminal Advertising, and Hotel Selection: An EEG Study*. Sage Journals . http://journals.sagepub.com/doi/full-xml/10.1016/j.euras.2013.03.008

Januar, R., Fauzi, H., Ariyanti, M., & Heris, F. (n.d.). *Study of neuromarketing: Visual influence with decision making on impulse buying*. Kinetik. https://kinetik.umm.ac.id/index.php/kinetik/article/view/1334

Juárez-Varón, D., Tur-Viñes, V., Rabasa-Dolado, A., & Polotskaya, K. (2020, September 19). *An adaptive machine learning methodology applied to neuromarketing analysis: Prediction of consumer behaviour regarding the key elements of the packaging design of an educational toy*. MDPI. https://www.mdpi.com/2076-0760/9/9/162

Kaba, M. (2020, December). The Application of Deep Learning and Traditional Machine Learning in EEG Neuromarketing Prediction Tasks. http://arno.uvt.nl/show.cgi?fid=156273

Lee, N., Broderick, A. J., & Chamerlain, L. (2006, June 12). *What is "neuromarketing"? A discussion and agenda for future research*. International Journal of Psychophysiology. https://www.sciencedirect.com/science/article/pii/S0167876006001073?casa_token=mRabmojZJtwAAAAA%3A72EjLT9Yp4zD9GJi9MijoXF4ckdrBggMdEK7l3ey5p2yzzi2B8skDQHp4edIPlaECWBa2UKS7g

Marc Lim, W. (2018, June 29). *Demystifying neuromarketing*. Journal of Business Research. https://www.sciencedirect.com/science/article/pii/S0148296318302716?casa_token=FjW7ROat69AAAAAA%3AByPfmS3qBvAZBgway0DnXkspwybyViRn3A98qEvE-8iaifyw1hZpUoHL2b8dYwtwl-GfEliVwA

Martinez-Levy, A. C., Rossi, D., Cartocci, G., Mancini, M., Flumeri, G. D., Trettel, A., Babiloni, F., & Cherubino, P. (2021, June 2). *Message framing, non-conscious perception and effectiveness in non-profit advertising. contribution by Neuromarketing Research - International Review on public and nonprofit marketing*. SpringerLink. https://link.springer.com/article/10.1007/s12208-021-00289-0

Mashrur, F. R., Rahman, K. M., Miya, M. T. I., Vaidyanathan, R., Anwar, S. F., Sarker, F., & Mamun, K. A. (1970, January 1). *An EEG-based intelligent neuromarketing system for predicting consumers' choice*. SpringerLink. https://link.springer.com/chapter/10.1007/978-981-19-8032-9_3

Mashrur, F. R., Rahman, K. M., Miya, M. T. I., Vaidyanathan, R., Anwar, S. F., Sarker, F., & Mamun, K. A. (2022, May 2). *BCI-based consumers' choice prediction from EEG Signals: An intelligent neuromarketing framework*. Frontiers. https://www.frontiersin.org/articles/10.3389/fnhum.2022.861270/full

Ma~nas-Viniegra, L., Nunez-Gomez, P., & Tur-Vines, V. (2020). *Neuromarketing as a strategic tool for predicting how Instagramers have an influence on the personal identity of adolescents and young people in Spain*. https://www.cell.com/heliyon/pdf/S2405-8440(20)30423-0.pdf

Mañas-Viniegra, L., Santos-Silva, D., & Ormaechea, S. L. (2020). *The visual-digital identity of corporate brands: A study of neuromarketing in young people from Spain and Portugal*. Tripodos. Blanquerna School of Communication and International Relations-URL. https://www.raco.cat/index.php/Tripodos/article/view/385639

Micu, A., Capatina, A., Micu, A.-E., Geru, M., Ainur Aivaz, K., & Carmen Muntean, M. (2021). *A NEW CHALLENGE IN DIGITAL ECONOMY: NEUROMARKETING APPLIED TO SOCIAL MEDIA*. https://ecocyb.ase.ro/nr2021_4/9.%20Micu%20Adrian,%20Kamer%20Aivaz%20pdf.pdf

Misra, Dr. L. (2023, June). *Neuromarketing Insights Into Consumer Behavior*. IUJ Journal of Management. http://journal.iujharkhand.edu.in/June-2023/Neuromarketing-Insights-Into-Consumer-Behavior.pdf

Moreno, A., Baker, S., Varey, K., & Hinze-Pifer, R. (2018, July 26). *Bringing attention restoration theory to the classroom: A tablet app using nature videos to replenish effortful cognition*. Trends in Neuroscience and Education. https://www.sciencedirect.com/science/article/pii/S2211949318300036?casa_token=Vkpa2SD1LGQAAAAA%3AJQL3L5EX39BjWG-PC7dFjNeoeGWcmfXLrV5fAIiHSV3ma99qMkIV4BwVKC52n5ZI8It5naveew

Mouammine, Y., & Azdimousa, H. (2019). Using Neuromarketing and AI to collect and analyse consumer's emotion: Literature review and perspectives. https://www.researchgate.net/profile/Hassan-Azdimousa/publication/341369618_Using_Neuromarketing_and_AI_to_collect_and_analyse_consumer's_emotion_Literature_review_and_perspectives/links/5ebcba2592851c11a8678274/Using-Neuromarketing-and-AI-to-collect-and-analyse-consumers-emotion-Literature-review-and-perspectives.pdf

Neilson, B. N., Craig, C. M., Travis, A. T., & Klein, M. I. (2019). *A review of the limitations of attention restoration theory and the importance of its future research for the improvement of well-being in urban living*. Visions for Sustainability. https://ojs.unito.it/index.php/visions/article/view/3323

Premnath, Dr. D. (2021). *Applications of neuromarketing sciences on digital marketing models - a theoretical frame work*. Turkish Journal of Computer and Mathematics Education (TURCOMAT). http://nn-pub.com/index.php/turkbilmat/article/view/3929

Quiles Perez, M., Tomas Martinez Beltran, E., Lopez Bernal , S., Horna Prat, E., Montesano Del Campo, L., Fernandez Maimo, L., & Huertas Celdran, A. (2024, January 5). *Data Fusion in neuromarketing: Multimodal Analysis of Biosignals, lifecycle stages, current advances, datasets, trends, and challenges*. Information Fusion. https://www.sciencedirect.com/science/article/pii/S1566253524000095?ssrnid=4543003&dgcid=SSRN_redirect_SD

Rawnaque, F. S., Rahman, K. M., Anwar, S. F., Vaidyanathan, R., Chau, T., Sarker, F., & Mamun, K. A. A. (2020, September 21). *Technological advancements and opportunities in neuromarketing: A systematic review - brain informatics*. SpringerLink. https://link.springer.com/article/10.1186/s40708-020-00109-x

Sameeha1, M., Subhiksha1, M., & Arivudaiyanambi1, J. (2022, August 1). *Analysis And Evaluation Of Consumers' Cognitive Responses To Visual And Gustatory Stimuli For Neuromarketing Application*. Journal of Physics: Conference Series. https://iopscience.iop.org/article/10.1088/1742-6596/2318/1/012004/meta

Shah, S. M. A., Usman, S. M., Khalid, S., Rehman, I. U., Anwar, A., Hussain, S., Ullah, S. S., Elmannai, H., Algarni, A. D., & Manzoor, W. (2022, December 12). *An ensemble model for consumer emotion prediction using EEG signals for neuromarketing applications*. MDPI. https://www.mdpi.com/1424-8220/22/24/9744

Sánchez-Núñez, P., Cobo, M. J., Vaccaro, G., Peláez, J. I., & Herrera-Viedma, E. (2021, April 27). *Citation Classics in Consumer Neuroscience, neuromarketing and Neuroaesthetics: Identification and conceptual analysis*. MDPI. https://www.mdpi.com/2076-3425/11/5/548

Telpaz, A., Webb, R., & Levy, D. J. (2015, August). *Sage journals: Your gateway to world-class research journals*. Sage Journals. https://journals.sagepub.com/doi/full/10.1509/jmr.14.0641

Upadhyay, A., Dubey, A., Goenka, P., & Kuriakose, S. M. (2024, January 1). *NMNet: Spatial-temporal transformer for EEG signal analysis in neuromarketing: Proceedings of the 7th Joint International Conference on Data Science & Management of data (11th ACM IKDD CODS and 29th COMAD)*. ACM Other conferences. https://dl.acm.org/doi/abs/10.1145/3632410.3632472?casa_token=KR188DYMON0AAAAA%3AVE4ihy7njl7fBy6oNKZqfWbF9eT7H6k571zpcF29ukzifRpl0_h8YbjUfMvG-031BNkLoiXzrG3a

Vecchiato, G., & Babiloni, F. (1970, January 1). *Neurophysiological measurements of memorization and pleasantness in neuromarketing experiments*. SpringerLink. https://link.springer.com/chapter/10.1007/978-3-642-25775-9_28

Vozzi, A., Ronca, V., Aricò, P., Borghini, G., Sciaraffa, N., Cherubino, P., Trettel, A., Babiloni, F., & Di Flumeri, G. (2021, September 10). *The sample size matters: To what extent the participant reduction affects the outcomes of a neuroscientific research. A case-study in neuromarketing field*. MDPI. https://www.mdpi.com/1424-8220/21/18/6088

Wąsikowska, B. (2023, December 8). *The use of electroencephalography (EEG) in a study into the effectiveness of advertising communication*. Procedia Computer Science. https://www.sciencedirect.com/science/article/pii/S1877050923013972

Yadava, M., Kumar, P., Saini, R., Roy, P. P., & Dogra, D. P. (2017, March 18). *Analysis of EEG signals and its application to neuromarketing - multimedia tools and applications*. SpringerLink. https://link.springer.com/article/10.1007/s11042-017-4580-6

Zito, M., Fici, A., Bilucaglia, M., Ambrogetti, F. S., & Russo, V. (2021, April 22). *Assessing the emotional response in Social Communication: The role of neuromarketing*. Frontiers. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2021.625570/full