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Dr. S Dinesh Kumar
Associate Professor,
Sri Sairam Institute of Management Studies, Sri Sairam Engineering College, Chennai, Tamil Nadu, India

M Monisha
Scholar, Sri Sairam Institute of Management Studies, Sri Sairam Engineering College, Chennai, Tamil Nadu, India

Corresponding Author:
Dr. S Dinesh Kumar
Associate Professor,
Sri Sairam Institute of Management Studies, Sri Sairam Engineering College, Chennai, Tamil Nadu, India

Impact on understanding consumer decision-making through brain imaging

S Dinesh Kumar and M Monisha

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Abstract
Both marketing and neuroscience have focused very much on understanding consumer decision-making. With recent advances in imaging techniques, including functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and near-infrared spectroscopy (NIRS), researchers have been able to tap further into how consumers really process information to make a purchase. These techniques go beyond surveys and focus groups; these would yield real-time data on what goes on in the brain in making a decision. This paper discusses the ability of brain imaging technologies to identify interactions between emotional and cognitive processes in consumer choice decisions. Some central brain regions, including the PFC, which is responsible for rational, logical decision-making, and the amgydala, which is essential for responses to emotion, have been found in various studies to be more generally tied to both rational analysis and emotional influences when evaluating products or services. Besides, such research also makes available discussions by the researcher that relate to the implications of findings from such studies on marketing strategies. Factors inducing positive neural responses could be used as better grounds for advertisers and marketers to modify advertising and products to suit such consumers on a more profound neurological basis.

Keywords: Decision making, brain imaging, neuroscience, electroencephalography, neural response

1. Introduction
Consumer decision-making is such a complex process and very much dictated by psychological, social, and emotional factors. Researchers over the years pursued the understanding of cognitive processes underlying those decisions to improve marketing strategies, product design, and consumer satisfaction. Among the most promising approaches to this date is the utilization of brain imaging techniques-the field of which is called neuromarketing. What neuromarketing refers to is the use of tools of neuroscience for marketing in conjunction with what it learns from such imaging devices as fMRI, EEG, or other neural activity measurement methods to view consumers' unconscious preferences, desires, and decision-making processes.

What distinguishes traditional consumer research from new ones-the survey and the focus group-is self-reporting. More often than not, such data are likely affected by social desirability bias or the inability of individuals to clearly elicit their own thoughts. Through a comparison of brain images, the researchers avoid this limitation by directly looking into neural responses connected with emotions, attention, or memory-things most affecting the consumer choice. For instance, fMRI captures changes in blood flow to different regions of the brain, implying which areas become activated by interaction with specific stimuli, such as advertisements or products. Therefore, it may thereby indicate which marketing elements induce positive emotions or which product features activate the reward pathways in the brain.

Another widely used tool is EEG, recording the electrical activity of the brain, with the ability to assess a response in real time to stimuli and hence ideally suited to study how consumers respond to fast-moving or dynamic content like advertising. Such methods enable marketers to know where their campaign is going to have a better possibility of working and which might not cut it and thus enable marketers to be better targeted and more effective in their efforts.

2. Review of literature

Ahmed H Alsharif, et al. (2021) [3] researched about the advancement of neuroscience technology has caught the attention of various companiresearchers. So, the neuromarketing studies have been increased from about one article in 2004 to over 570 articles in 2020 based on the Web of Science database. The aim of this study is to point out the neuroimaging tools, the neuroanatomy of the brain, and analyzes the related literature and investigates the influence of emotion on decision making via the neuromarketing approach.

Sami Alsmadi & Khaled Hailat (2021) [4] researched about the past thirty years have seen a growing interest in the study of direct consumer behavior through a non-conventional, brain-based approach using fundamental knowledge of human neuroscience. It has evolved into a new marketing branch known as Neuromarketing, a multidisciplinary approach, which goes inside the human brain to improve our knowledge of consumer behavior. Traditionally, marketers trace neural circuit activities inside the brain, applying MRI technology.

Emily Glaenzer (2021) [5] researched about Applying brain-imaging technology - namely, electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) machines - neuromarketing measures consumers' neurological responses to marketing stimuli. In this paper, I show how neuromarketing connects with the history of subliminal messaging and our current neuro-obsessed culture, or neuroculture. These aspects influence the way critics view neuromarketing and the implications involved for the future of this study.

Constantinos Halkiopoulos, et al. (2022) [6] researched about Neuromarketing is a multidisciplinary field that combines consumer behavior, neuroscience, and economics to provide the tourism industry with new approaches that are far more effective than traditional marketing methodologies at responding to shifting market conditions. Moreover, the variables of motivation, perception, learning, beliefs, and attitudes impact human behavior rules in tourist activities, tourism consumer behavior, and consumer psychology inclinations of the decision-making process while choosing a vacation location.

Alexander Genevsky & Carolyn Yoon (2022) [7] researched about this chapter provides a selective review of prior research findings on the neural processes behind decision making. It reflects how these insights about neural processes have served as a basis for advancing research incorporating neural measures to enhance within-individual predictions of preferences, choice, and decision-making in consumer domains. The chapter then addresses emerging research findings in neuroforecasting involving the use of neural data to forecast the aggregate behavior of a separate and independent group.

H Arora & Pooja Jain (2020) [8] researched about Consumer mind is a complex black box and it is hard to understand what he thinks, says, does and feels. Feelings of consumers have gained strategic importance for marketers rather than only focusing on need identification and satisfaction. Neuromarketing has emerged as a strategic tool that tries to map brain activity, consumer sensorimotor and emotional responses of consumers toward understanding their responses to different marketing activities carried out by organizations (Kumar & Singh).

John A Clithero, et al. (2024) [9] researched about the past decades have seen quite a burst of neuroscience research investigating mental and physiological processes that are central to consumer behavior, such as sensory perception, memory, and decision making. Nonetheless, few of the publications that include neural and physiological measures or conceptual frameworks developed around neuroscience principles have appeared in the field of consumer psychology. As such, it is quite clear that "consumer neuroscience" has thus far not lived up to its promises in the marketing literature. Three reasons basically account for this. First, by default, neural and other biological markers are mistaken to be the same as the overlaying psychological constructs of the traditional consumer psychology work. Second, somewhat surprisingly, there has been an overly narrow utilization of neural data.

3. Need for study

Consumer decision-making through brain imaging is perhaps one of the biggest steps taken in marketing research. Surveys and focus groups are based on self-reported data, a premise intrinsically laced with the biases of the reportee and inaccuracies. Techniques such as fMRI and EEG capture the real-time neural responses to different stimuli such as advertisements or product placements, thereby providing marketing with an objective view. This would give researchers the chance to study unconscious motivators and emotions that lead people to consume. Marketers can know which part of the product encourages consumers through studying brain activity. Preferences and aversions that have not been articulated will be revealed through a marketer's analysis of his brain activity. For instance, through brain imaging, areas activated in emotional responses can be highlighted, which can then assist brands to craft messages that are aligned with the psychological triggers of consumers. These insights will be useful in product design, positioning, and overall marketing strategies to ensure more effective campaigns.

4. Objectives

- To Improve marketing campaigns
- To Improve product design
- To Test packaging
- To Predict consumer behavior
- To Create personalized experiences

5. Scope of study

It focuses on the identification of which brain regions respond to marketing stimuli while a decision is being made in a consumer. Such interdisciplinary research arises from the nexus of neuroscience, psychology, and marketing, due to its striving for an understanding of how consumers evaluate products, make purchasing decisions, and form brand preferences. Techniques such as fMRI, EEG, and other neuroimaging techniques allow scientists to observe live neural activity. The study aims to discern the various brain area patterns-like that of the prefrontal cortex that is known to influence rational thinking and the limbic system where emotions are spawned-for the investigation of how the human mind uses logic alongside emotion in the marketplace. It also explores whether extrinsic factors like the price of the product, brand, social influence, or perceived value trigger cognitive processes and how these lead to the eventual outcome of a buying decision. Practical applications of this research can be observed in the

marketing campaigns designed by companies in order to better resonate with unconscious consumer preferences or biases.

6. Research methodology

The study employs a descriptive research design. The respondents were sampled through convenience sampling. Research Instrument: Questionnaire was used in the data gathering process. Sample size: Responses from 75 members have been utilized. Questionnaire has demographic detail of age category and 5 point rating scale statements default, Question 3,4,5 describes familiarity of the concept of Consumer Decision-Making, benefits has Brain imaging with emotional response, brand loyalty in marketing, Where 6,7,8,9 describes satisfaction with risk assessment, shopping environment, opinion based question, Where 10 are descriptive type question related with decision making of consumer.

7. Data analysis and interpretation

Pie chart

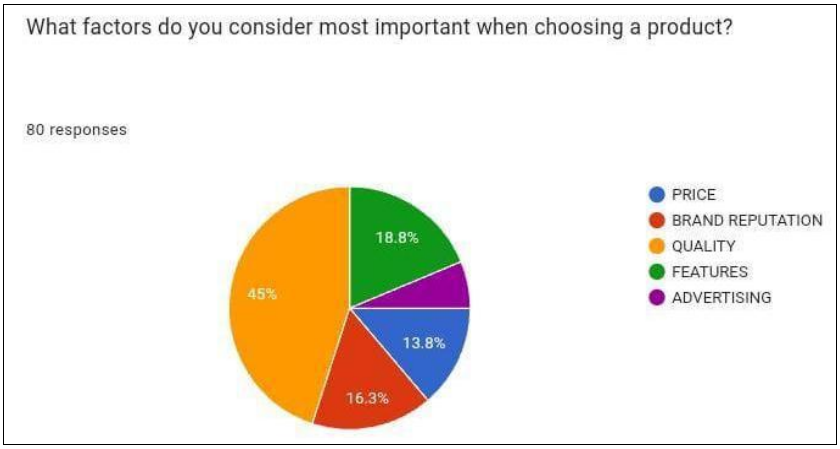

Chart 1: Showing important factors of product by consumer

Table 1: Showing important factors of product by consumer

Source	Respondent	Percentage
Price	11	13.8%
Brand reputation	13	16.3%
Quality	36	45%
Features	15	18.8%
Advertising	5	6.3%

Interpretation

As shown in the table above, out of 80 people, 36 people chose quality as an important factor for the product, 15 people are chosen features as important factors of a product, 13 people chosen brand reputation as important factors of a product, 11 people chosen price as important factors of a product, and 5 of them chose advertising as important factors of a product.

Rating

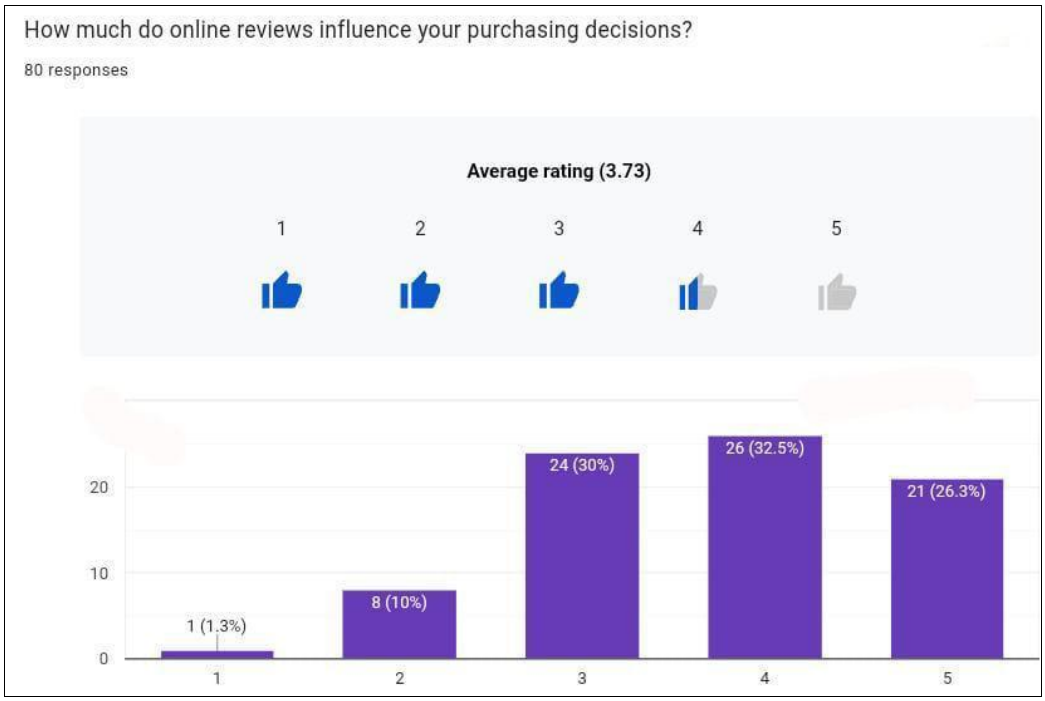

Chart 2: Showing online reviews of purchasing decisions by consumers

Interpretation

The given Rating represents the respondent's perspective does a online reviews influence purchasing decision, Out of 80 people they given average rating of 3.73.

Bar graph

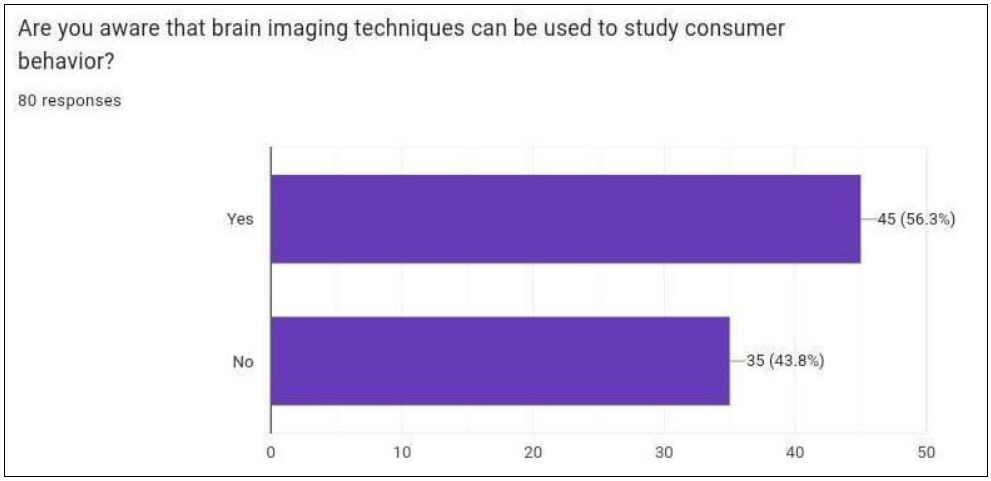

Chart 3: Showing brain imaging techniques by consumer

Interpretation

The above Bar Graph represents Out of 80 people, 45 people are true and the remaining 35 people are false for the study of consumer behavior by brain imaging technique.

Pie chart

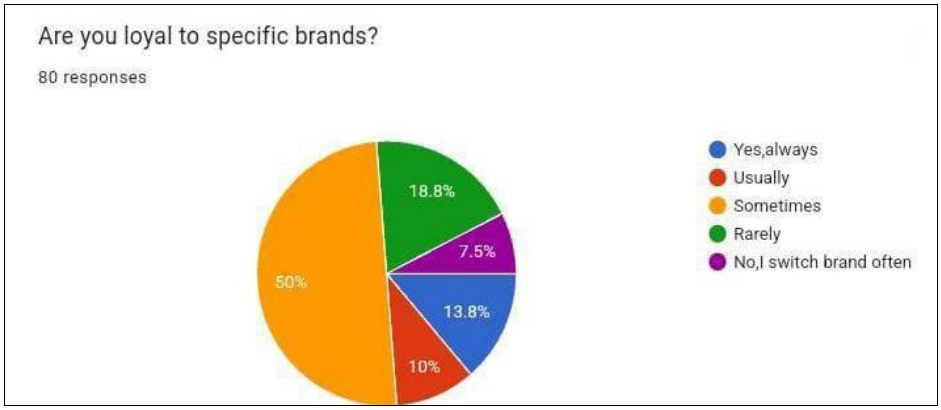

Chart 4: Showing loyalty towards brands

Table 2: Showing loyalty towards brands

Source	Respondent	Percentage
Yes, always	11	13.8%
Usually	8	10%
Sometimes	40	50%
Rarely	15	18.8%
No, I switch brand often	6	7.5%

Interpretation

This table shows out of 80 people 40 people are loyal to specific brand chosen option as always, 15 people are loyal to specific brand chosen option as usually,11 people are loyal to specific brand chosen option as sometimes,8 people are loyal to specific brand chosen option as rarely and 6 of them are chosen no, I switch brand often.

8. Findings

- **Emotional Influence in the Decision Making Process:** Emotion drives the decision making process. In most consumer decision making processes, it comes before rational evaluation. The limbic system, especially the amygdala, is strongly activated given that emotion drives consumer decisions. Brand loyalty involves activation in this region, including vmPFC and nucleus accumbens for reward. Familiar and liked brands are expected to elicit an emotional response based on past experience.
- **Reward and pleasure systems:** When there is pleasure anticipation or actual experience, the dopaminergic reward system, comprising structures like the striatum and nucleus accumbens, is very active. The brain often views shopping for the acquisition of desired products as a reward, as it does when it encounters such other activities.
- **Pain of Paying:** Pricing and Pain of Paying Brain imaging studies showed that high prices activate areas associated with pain, such as the insula. The activation has been described as the "pain of paying." When consumers perceive prices of goods to be too high, this activation will result in adverse emotions possibly resulting in a decision not to make the purchase. On the other end, when the consumers perceive a good deal, the reward centers are more active and will consequently purchase more.
- **Rational vs. Impulsive Decisions:** The rational components of decision-making remain locked in a tug-

of-war in the head between the prefrontal cortex, which anchors rationality and forward thinking, and the limbic system, which runs the impulsive, reactive responses. This is why some decisions are far more rational, such as comparing products on attributes, while other decisions are very impulsive, like buying based upon immediate desires or emotional triggers.

- **Branding and Memory:** Due to its role as a center for memory, the hippocampus is an area of high activity in brand recognition. More vigorous and faster responses are elicited by established brands because such brands already have existing positive associations and memories attached to them.

9. Suggestions

- Â Identify Neural Correlates of Decision-Making: Brain activity associated with the process of making decisions may be monitored using an fMRI or EEG, focusing on the prefrontal cortex for rational decisions and the limbic system for emotions.
- Measuring Emotional Responses: Measure activity in those brain regions linked with emotions, namely, insula as well as amygdala, that, in turn, can be interpreted to determine how a consumer perceives a product and advertisement. With this, get an idea about the level of emotional engagement and how it affects brand loyalty.
- Explore Reward Systems: Examine the brain's dopamine pathways or reward systems to understand better how consumers respond to discounts, rewards, or new product releases. Look for increased activity in the nucleus accumbens, a key node in response to reward anticipation.
- Assess Brand Awareness and Loyalty: Apply neuroimaging on the hippocampus (memory) to establish the extent to which the customers remember brands. Find out how long-term brand loyalty is formed and what stimuli-ads and packaging, for example-will accelerate the process.
- Understanding Impulse Buying The activity in the brain regions responsible for quick, impulsive decisions-orbitofrontal cortex and ventromedial prefrontal cortex-can be analyzed. Explain how emotionally triggered impulse purchase occurs.

10. Conclusion

The study of consumer decision-making using neuroimaging technologies, such as fMRI and EEG, can inform understanding of which cognitive and affective processes actually motivate purchase decisions. The possibility of viewing the neural correlates of consumer choices through such methods allows for the identification of how different parts of the brain are activated in response to marketing stimuli, product evaluation, and decision-making tasks. This knowledge of the neural mechanisms makes marketers better able to tailor their marketing campaign, working off effective strategies that have better psychological resonance for consumers. Research based on brain imaging indicates that consumer choice decisions are complex associations with neuropsychological interactions of emotional, cognitive, and social factors. The regions of the brain most involved include the prefrontal cortex, which involves rational decision making, the amygdala associated with emotional responses, and the ventromedial prefrontal cortex associated with valuation and reward processing. All these insights dispel the myth about the consumers being rational deciders, thus defining the importance of unconscious emotional factors while choosing. However, there are still limitations to applying brain imaging in consumer research. For one, these technologies entail substantial costs, and findings cannot easily be generalized to a vast population, which may not promote their adoption in most commercial applications. Of course, there are also concerns for privacy as well as manipulation of consumer behavior. Conclusion In conclusion, although brain imaging greatly provides revolutionary insights into consumer decision-making, it must be integrated with other research methods toward a better understanding. It might become possible to produce more accurate predictions of behavior if neuroscience and traditional consumer research are combined.

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