



Neuromarketing-Related Marketing Stimuli and Consumer Buying Behaviour: A Comparative Study of Young and Middle-Aged Consumers in Vijayawada, India

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Abstract

Neuromarketing offers an interdisciplinary perspective for examining consumer responses to marketing stimuli through insights from marketing, psychology, and consumer neuroscience. This study investigates the relationship between consumer-perceived neuromarketing-related marketing stimuli and buying behaviour among young and middle-aged consumers in Vijayawada, Andhra Pradesh. A quantitative, descriptive, cross-sectional design was employed using data from 300 consumers, comprising 150 young adults aged 18–35 years and 150 middle-aged adults aged 36–55 years. Data were collected through a structured questionnaire containing 25 five-point Likert-scale items measuring Attention and Visual Appeal (AVA), Emotional Appeal (EA), Sensory and Packaging Appeal (SPA), Social Influence and Technology-Enabled Marketing (STI), and Consumer Buying Behaviour (CBB). Descriptive statistics, reliability and factor adequacy tests, Pearson correlation, multiple linear regression, and independent-samples t-tests were applied. All four explanatory dimensions were positively and significantly associated with CBB. The regression model was significant, $F(4, 295) = 86.742, p < .001$, explaining 54.1% of the variance in CBB ($R^2 = .541$). AVA showed the strongest association ($\beta = .352, p < .001$), followed by EA ($\beta = .276$), STI ($\beta = .229$), and SPA ($\beta = .183$). Significant age-group differences were observed for AVA, SPA, STI, and CBB, but not EA. The findings provide context-specific evidence that perceived visual, emotional, sensory, social, and technology-enabled marketing stimuli are associated with consumer buying behaviour. The cross-sectional, self-reported design, however, does not establish causality or direct neurological effects.

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Introduction

Consumer buying behaviour has become increasingly complex as consumers encounter diverse brands, advertising formats, digital platforms, sensory cues, social recommendations, and technology-enabled marketing practices. Traditional marketing research has predominantly examined consumer attitudes, preferences, intentions, and evaluations through questionnaires, interviews, focus groups, and related behavioural methods. Although these approaches remain valuable, consumers may not always be able to articulate all the cognitive and emotional processes associated with their responses to marketing stimuli. The emergence of neuromarketing and consumer neuroscience has consequently provided an additional perspective for examining consumer responses by drawing on concepts from neuroscience, psychology, economics, and marketing (Lee *et al.*, 2007; Plassmann *et al.*, 2015) ^[15, 18].

Neuromarketing broadly examines consumer responses to products, brands, advertising, prices, and other marketing stimuli with reference to processes such as attention, emotion, memory, perception, valuation, and decision-making. Consumer-neuroscience research has employed techniques including electroencephalography (EEG), functional magnetic resonance imaging (fMRI),

eye tracking, and other psychophysiological measures to investigate these processes (Ariely & Berns, 2010; Vecchiato *et al.*, 2011) ^[3, 24]. Such approaches can complement conventional behavioural and self-report methods by providing additional information about consumer responses (Cherubino *et al.*, 2019; Plassmann *et al.*, 2015) ^[6, 18]. Neuromarketing should therefore be regarded as complementary to, rather than a replacement for, established marketing research. Recent reviews have documented the development of neuromarketing methods and their applications in consumer research. Rawnaque *et al.* (2020) ^[19] reviewed technological developments in neuromarketing, including EEG, eye tracking, physiological measurement, and computational approaches to analysing consumer responses. Eijlers *et al.* (2020) ^[8] demonstrated how neural arousal measured during advertising exposure can contribute to the assessment of advertising effectiveness. More recently, Byrne *et al.* (2022) ^[5] systematically reviewed the use of EEG measures and machine-learning methods to predict consumer preferences. These developments demonstrate the potential of direct physiological and neuroscientific methods while reinforcing the importance of distinguishing such measurements from questionnaire-based assessments of consumer perceptions.

Marketing stimuli can engage consumers through visual, emotional, sensory, social, and technology-mediated cues. Colours, images, layouts, packaging, narratives, emotional appeals, influencer communication, online reviews, personalised recommendations, and digital advertising can shape consumers' attention and perceptions of products and brands. Research in consumer neuroscience has particularly highlighted attention, emotion, memory, and value-related processes as relevant to consumer responses (Plassmann *et al.*, 2012) ^[17]. However, the presence of attention or emotional engagement does not necessarily translate directly into purchasing behaviour. Consumer decisions are also shaped by price, perceived value, product involvement, social context, previous experience, and situational factors.

Research using direct physiological measures provides additional evidence concerning consumers' responses to marketing communication. Baldo *et al.* (2022) ^[4] examined the complementary roles of neurophysiological measures in tracking emotions, memory, and advertising effectiveness. Such research highlights the value of combining multiple indicators when evaluating advertising responses. Nevertheless, the present study relies on self-reported questionnaire measures and therefore assesses consumers' perceived responses to visual and emotional marketing stimuli rather than directly measuring neural arousal, memory processes, or physiological reactions.

This distinction is important because neuromarketing is sometimes presented as a means of directly identifying or predicting consumer preferences. The literature cautions against such interpretations and identifies limitations related to measurement, ecological validity, sample characteristics, interpretation of neural signals, and the translation of laboratory findings into actual market behaviour (Ariely & Berns, 2010; Plassmann *et al.*, 2015) ^[3, 17]. Accordingly, empirical research should distinguish between direct neuroscientific measurement and consumers' reported responses to marketing stimuli.

Ethical considerations are also relevant to neuromarketing. The collection and use of brain-based, physiological, behavioural, or digitally generated consumer information

raise questions concerning privacy, informed consent, autonomy, data protection, and responsible marketing practices. Murphy *et al.* (2008) ^[16] highlighted neuroethical concerns surrounding consumer autonomy and the responsible application of neuromarketing, while Stanton *et al.* (2017) ^[22] discussed broader ethical issues associated with consumer neuroscience. These considerations reinforce the need for careful interpretation and responsible use of consumer-related information.

The Indian context provides an important setting for extending this literature. Indian studies have examined neuromarketing-related constructs such as attention, emotion, social influence, technology, and consumer buying behaviour. Traymbak *et al.* (2024) ^[23], for example, examined the reliability and validity of neuromarketing-related constructs among Indian consumers, providing evidence for their empirical measurement in an Indian context. Other Indian research has examined consumer perceptions and ethical dimensions of neuromarketing (Kumar *et al.*, 2017; Alexander *et al.*, 2019) ^[13, 1]. Nevertheless, context-specific evidence concerning the relationship between multiple neuromarketing-related marketing stimuli and consumer buying behaviour remains limited.

Age is another relevant dimension. Consumers from different age groups may differ in their exposure to digital media, purchasing experience, technology use, social networks, and contemporary advertising formats. Young consumers may encounter social media, influencers, personalised advertising, and technology-mediated shopping more frequently, while middle-aged consumers may combine digital channels with established purchasing experiences and other sources of product information. Examining these groups within the same market therefore provides an opportunity to identify differences in reported responses to contemporary marketing stimuli.

Against this background, Vijayawada provides a relevant urban Indian setting for examining consumer responses to contemporary marketing practices. The present study focuses on young and middle-aged consumers and examines four consumer-perceived dimensions of neuromarketing-related marketing stimuli: Attention and Visual Appeal (AVA), Emotional Appeal (EA), Sensory and Packaging Appeal (SPA), and Social Influence and Technology-Enabled Marketing (STI). Their associations with Consumer Buying Behaviour (CBB) are examined using correlation and multiple regression analysis, while age-group differences are assessed using independent-samples t-tests and supplementary age-specific regression models.

Importantly, the study does not directly measure neurological activity. Rather, it examines consumers' reported perceptions and responses to marketing stimuli commonly discussed within the neuromarketing and consumer-neuroscience literature. This positioning ensures consistency between the study's conceptualisation, questionnaire-based methodology, statistical analysis, and interpretation of findings. The study therefore contributes context-specific evidence concerning how different marketing stimuli are associated with consumer buying behaviour among young and middle-aged consumers in Vijayawada.

Literature Review

Neuromarketing and Consumer Behaviour

Neuromarketing has developed at the intersection of marketing, psychology, neuroscience, and consumer

behaviour. It seeks to improve understanding of consumer responses by examining cognitive and affective processes associated with products, brands, advertisements, and other marketing stimuli. Consumer-neuroscience research suggests that attention, emotion, memory, valuation, and decision-making are relevant dimensions of consumer response (Plassmann *et al.*, 2012; Solnais *et al.*, 2013)^[17, 21].

Mandlik and Marathe (2015) discussed neuromarketing as an approach for understanding consumer responses to products, brands, and advertising and highlighted its potential to complement conventional consumer research. Plassmann *et al.* (2012)^[17] similarly identified attention, memory, valuation, and related psychological processes as important areas of consumer neuroscience. Hsu and Yoon (2015)^[10] reviewed developments in the neuroscience of consumer choice and highlighted continuing questions concerning attention, memory, preference formation, and the translation of neuroscientific findings into broader consumer populations. Shaw and Bagozzi (2018)^[20] further positioned neuroscience as a means of extending, rather than replacing, established approaches to consumer behaviour.

The methodological development of neuromarketing has also been examined through systematic reviews. Goecking *et al.* (2021)^[9] reviewed the development of neuromarketing research and its connections with consumer behaviour, management, and ethics. Byrne *et al.* (2022)^[5] examined the predictive use of EEG measures and machine-learning approaches, while Rawnauque *et al.* (2020)^[19] reviewed technological developments in neural recording and response-classification methods. Collectively, these reviews demonstrate the diversity of methods used in consumer-neuroscience research and support the need to define clearly whether a study measures physiological responses or consumers' reported perceptions.

Attention and Visual Appeal

Attention is central to consumer processing because marketing messages compete for consumers' limited cognitive and visual resources. Plassmann *et al.* (2012)^[17] identified attention as an important process in consumer neuroscience, particularly in relation to branding and marketing communication. Visual features such as colour, imagery, layout, product presentation, and advertising design can contribute to whether marketing information is noticed and processed.

Eye tracking and other psychophysiological techniques have enabled researchers to examine visual attention more directly (Solnais *et al.*, 2013)^[21]. However, attention alone does not determine consumer choice. Purchase-related responses may also depend on emotional reactions, perceived value, social influences, product characteristics, and contextual factors.

Experimental studies have also examined visual attention in specific marketing contexts. Kalkova *et al.* (2023)^[11] investigated consumers' visual perception of cryptographic product-package markings using recorded eye movements, illustrating how packaging information placement can be evaluated through direct attention measures. Yu *et al.* (2022)^[25] examined implied motion in product packaging and reported associations with visual attention, product evaluation, and purchase-related responses. These studies provide relevant evidence on the importance of visual presentation, although their direct observational and experimental methods differ from the self-reported measures used in the present study.

Emotional Appeal and Consumer Buying Behaviour

Emotional responses are an important component of marketing communication. Advertisements and brand messages frequently employ happiness, excitement, nostalgia, empathy, humour, storytelling, and other affective cues to create associations with consumers. Consumer-neuroscience research has identified emotion and value-related processes as important dimensions of consumer response (Plassmann *et al.*, 2012; Solnais *et al.*, 2013)^[17, 21]. The relevance of emotional responses is also evident in Indian consumer research. Traymbak *et al.* (2024)^[23] included emotion among the neuromarketing-related constructs examined among Indian consumers, providing a basis for further empirical examination of emotional responses in an Indian setting.

Sensory and Packaging Appeal

Consumers encounter products through multiple perceptual and sensory cues. Packaging communicates information through colour, shape, typography, imagery, material, and overall design, while sensory characteristics can influence expectations and perceptions before and during product experience. The consumer-neuroscience literature recognises perceptual and sensory processes as relevant to consumer responses to products and brands (Plassmann *et al.*, 2012; Shaw & Bagozzi, 2018)^[17, 20].

Packaging can also function as an attention-generating and information-processing cue in retail and digital environments where consumers encounter numerous alternatives. The present study therefore treats Sensory and Packaging Appeal (SPA) as a separate construct and examines whether stronger reported responses to packaging and sensory cues are associated with consumer buying behaviour.

Recent packaging research has investigated how particular visual design features relate to consumer responses. Yu *et al.* (2022)^[25] examined the use of implied motion on product packaging, reporting that this design feature was associated with increased visual attention and more favourable product-related evaluations in their experimental settings. Kalkova *et al.* (2023)^[11] examined the placement of cryptographic markings on milk packaging and used eye-movement data to assess visual attention. These findings support the relevance of packaging visibility and design in consumer research, while the present study examines consumers' reported perceptions of sensory and packaging appeal rather than directly recorded eye movements.

Social Influence and Technology-Enabled Marketing

Digital platforms have expanded the range and intensity of marketing stimuli encountered by consumers. Social media, online reviews, influencer communication, personalised recommendations, mobile applications, and targeted digital advertising have become important channels through which consumers discover and evaluate products.

Traymbak *et al.* (2024)^[23] examined social influence and technology alongside attention, emotion, and consumer buying behaviour in the Indian context. Their work provides a useful empirical foundation for considering social and technology-related dimensions in neuromarketing-related consumer research.

The growing role of digital influence in consumer decision-making is also reflected in recent reviews. Ao *et al.* (2023)^[12] conducted a meta-analysis examining relationships between social-media influencer characteristics, customer

engagement, and purchase intention. Laszkiewicz and Kalinska-Kula (2023)^[14] reviewed virtual influencers as an emerging area of marketing research, highlighting the increasing relevance of computer-generated personas in digital communication. In addition, Kanaveedu and Kalapurackal (2024)^[12] synthesised research on influencer marketing and consumer behaviour. These studies provide a basis for examining social-media recommendations, influencer communication, and technology-mediated marketing as components of the broader consumer decision environment.

Consumer Perceptions and Ethical Dimensions of Neuromarketing in India

Indian research has also examined consumer perceptions and ethical considerations surrounding neuromarketing. Kumar *et al.* (2017)^[13] investigated consumer perceptions of neuromarketing in India using the Kano model, contributing an Indian perspective to the emerging field. Alexander *et al.* (2019)^[1] examined ethical dimensions including privacy, consumer autonomy, potential manipulation, and responsible use.

These issues are important because the use of increasingly sophisticated consumer information should be considered alongside privacy, informed participation, autonomy, and responsible marketing. Stanton *et al.* (2017)^[22] similarly emphasised the importance of ethical boundaries in consumer-neuroscience research.

Ethical issues remain relevant as neuromarketing methods and applications develop. Christensen *et al.* (2022)^[7] discussed ethical considerations in consumer neuroscience, including the responsibilities associated with using psychological and neuroscientific findings in commercial settings. These concerns reinforce the importance of transparency, informed participation, privacy, and responsible interpretation of consumer data. Although the present study does not collect neural or physiological information, its conceptual framing distinguishes consumer-reported responses from direct neurological measurement.

Indian Evidence and Research Context

Traymbak *et al.* (2024)^[23] provide particularly relevant evidence by examining the reliability and validity of neuromarketing-related constructs among Indian consumers. Their framework included attention, social influence, technology, emotion, and consumer buying behaviour. This provides support for examining consumer-level measures of neuromarketing-related constructs in India.

The present study extends this line of research by integrating four marketing-stimulus dimensions—Attention and Visual Appeal (AVA), Emotional Appeal (EA), Sensory and Packaging Appeal (SPA), and Social Influence and Technology-Enabled Marketing (STI)—within a common analytical framework. It examines their statistical associations with Consumer Buying Behaviour (CBB), thereby moving beyond the measurement of individual constructs to an integrated assessment of their relationships with purchase-related responses. The study also provides location- and age-group-specific evidence by comparing young and middle-aged consumers within the urban Indian context of Vijayawada.

Synthesis of the Literature

The literature provides four relevant insights. First, consumer neuroscience can complement conventional consumer research by providing additional perspectives on attention, emotion, memory, valuation, and decision-making (Hsu & Yoon, 2015; Plassmann *et al.*, 2012; Solnais *et al.*, 2013)^[10, 17, 21]. Second, attention and emotional responses are important dimensions of consumers' processing of marketing stimuli. Third, sensory and packaging cues, together with social and technology-enabled communication, have become increasingly relevant in contemporary marketing environments. Fourth, Indian research provides an emerging empirical foundation for measuring neuromarketing-related constructs, but further context-specific evidence remains necessary.

An important methodological distinction follows from this literature. The term neuromarketing techniques may refer specifically to neuroscientific or physiological methods such as EEG, fMRI, eye tracking, and related measures. The present study does not employ such instruments. It instead examines consumers' reported responses to marketing stimuli associated with neuromarketing concepts. Accordingly, the constructs are more precisely described as neuromarketing-related marketing stimuli or consumer-perceived neuromarketing dimensions.

Recent systematic reviews and empirical studies have expanded the literature on neuromarketing technology, EEG-based preference prediction, advertising arousal, packaging-related attention, and influencer marketing (Baldo *et al.*, 2022; Byrne *et al.*, 2022; Eijlers *et al.*, 2020; Kalkova *et al.*, 2023; Rawnaque *et al.*, 2020; Yu *et al.*, 2022)^[4, 5, 8, 11, 19, 25]. Research on social-media and virtual influencers also indicates the growing importance of technology-mediated communication in consumer research (Ao *et al.*, 2023; Kanaveedu & Kalapurackal, 2024; Laszkiewicz & Kalinska-Kula, 2023)^[2, 12, 14]. These developments support further context-specific research while underscoring the distinction between direct neuroscientific measurements and consumer-reported perceptions.

Research Gap

The reviewed literature indicates several areas requiring further investigation in the field of neuromarketing and consumer behaviour. A substantial proportion of existing research is conceptual, review-based, or grounded in specialised neuroscientific and psychophysiological methods, creating a need for further behavioural research that examines consumers' reported responses to marketing stimuli in real-world market contexts. Although Indian studies have contributed to the measurement and understanding of neuromarketing-related constructs, comparatively limited evidence is available on the combined relationship of multiple marketing stimuli with consumer buying behaviour within specific urban markets. In particular, limited research has simultaneously examined Attention and Visual Appeal, Emotional Appeal, Sensory and Packaging Appeal, and Social Influence and Technology-Enabled Marketing within a common empirical framework. Age-group differences have also received relatively limited attention in location-specific Indian research, despite the possibility that young and middle-aged consumers may differ in their exposure to digital

platforms, purchasing experience, technology use, and contemporary marketing communication. Furthermore, there is scope for research that examines consumers' perceived responses to neuromarketing-related marketing stimuli without implying that self-reported survey measures directly capture neurological processes. Addressing these gaps, the present study examines the relationships between the four specified dimensions and Consumer Buying Behaviour and compares young and middle-aged consumers in the context of Vijayawada, India.

Objectives of the Study

Based on the literature review and the identified research gaps, the study aims to examine the relationship between Attention and Visual Appeal, Emotional Appeal, Sensory and Packaging Appeal, and Social Influence and Technology-Enabled Marketing and Consumer Buying Behaviour among young and middle-aged consumers in Vijayawada. Specifically, the study seeks to examine the relationship of Attention and Visual Appeal with Consumer Buying Behaviour; assess the relationship between Emotional Appeal and Consumer Buying Behaviour; examine the relationship between Sensory and Packaging Appeal and Consumer Buying Behaviour; and determine the relationship between Social Influence and Technology-Enabled Marketing and Consumer Buying Behaviour. In addition, the study aims to examine whether young and middle-aged consumers differ significantly in their responses to selected neuromarketing-related marketing stimuli and Consumer Buying Behaviour.

Hypotheses of the Study

Based on the theoretical arguments and empirical evidence reviewed, the following hypotheses were formulated:

H1: Attention and Visual Appeal is significantly positively associated with Consumer Buying Behaviour.

H2: Emotional Appeal is significantly positively associated with Consumer Buying Behaviour.

H3: Sensory and Packaging Appeal is significantly positively associated with Consumer Buying Behaviour.

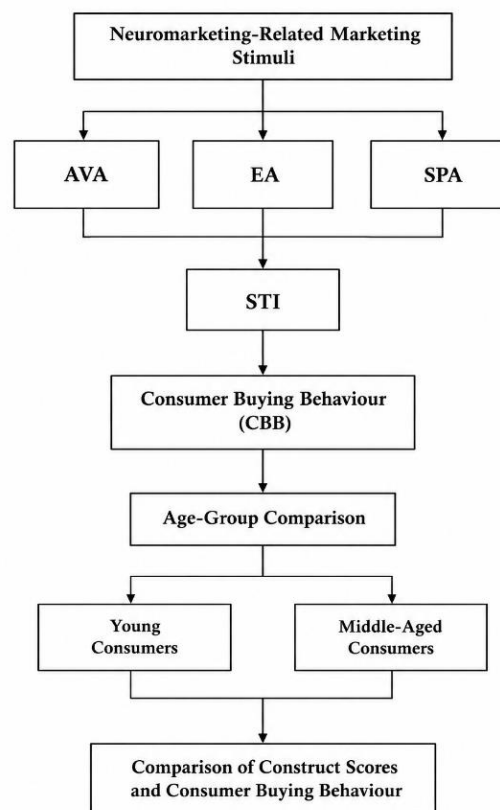
H4: Social Influence and Technology-Enabled Marketing is significantly positively associated with Consumer Buying Behaviour.

H5: Young and middle-aged consumers differ significantly in their responses to selected neuromarketing-related marketing stimuli and Consumer Buying Behaviour.

Conceptual Framework

The conceptual framework presented in Figure 1 is grounded in the consumer-neuroscience and consumer-behaviour literature and proposes that four dimensions of consumer-perceived neuromarketing-related marketing stimuli—Attention and Visual Appeal (AVA), Emotional Appeal (EA), Sensory and Packaging Appeal (SPA), and Social Influence and Technology-Enabled Marketing (STI)—are associated with Consumer Buying Behaviour (CBB).

The framework does not imply that these dimensions independently cause purchasing decisions. Instead, it specifies the relationships examined empirically through correlation and multiple regression analysis. Age group is treated as a grouping variable for comparing young and middle-aged consumers rather than as a predictor in the primary regression model.



Source: Developed by the researchers based on the reviewed literature.

Note: AVA = Attention and Visual Appeal; EA = Emotional Appeal; SPA = Sensory and Packaging Appeal; STI = Social Influence and Technology-Enabled Marketing; CBB = Consumer Buying Behaviour. The arrows represent the relationships examined in the study and do not imply causal effects.

Fig 1: Conceptual Framework

Model Specification

The primary analytical model can be written as:

$$CBB_i = \beta_0 + \beta_1 AVA_i + \beta_2 EA_i + \beta_3 SPA_i + \beta_4 STI_i + \varepsilon_i$$

Where:

CBB_i = Consumer Buying Behaviour for respondent i

β_0 = Intercept/constant

AVA_i = Affective Visual Attention for respondent i

EA_i = Emotional Activation for respondent i

SPA_i = Sensory/Physiological Activation for respondent i

STI_i = Stimulus-Induced Trust/Intention for respondent i

$\beta_1, \beta_2, \beta_3, \beta_4$ = Regression coefficients

ε_i = Error term for respondent

The model estimates the unique statistical contribution of each explanatory variable to CBB while controlling for the other three variables. Pearson correlation analysis is used to examine bivariate associations, while multiple linear regression is used to assess the combined relationship between the four dimensions and CBB.

For age-group analysis, respondents are classified into young consumers (18–35 years) and middle-aged consumers (36–55 years). Independent-samples t -tests are used to examine group differences in the measured constructs and CBB. Separate age-specific regression models are included as supplementary analysis to describe whether the pattern of associations differs across the two groups. These separate models are not interpreted as formal evidence of statistically significant differences between regression coefficients.

Research Methodology

Research Design

The study adopted a quantitative, descriptive, cross-sectional design to examine the relationships between selected neuromarketing-related marketing stimuli and consumer buying behaviour among young and middle-aged consumers in Vijayawada, Andhra Pradesh. The study focused on four explanatory constructs—Attention and Visual Appeal

(AVA), Emotional Appeal (EA), Sensory and Packaging Appeal (SPA), and Social Influence and Technology-Enabled Marketing (STI)—and Consumer Buying Behaviour (CBB) as the dependent variable.

The study examined consumers' perceived responses to marketing stimuli rather than direct neurological activity through EEG, fMRI, or eye-tracking technologies. Thus, the term neuromarketing is used in the context of marketing stimuli informed by consumer-neuroscience perspectives rather than as a claim of direct measurement of neural responses (Lee *et al.*, 2007; Plassmann *et al.*, 2015)^[15, 18].

Population, Study Area and Sampling

The study population comprised adult consumers residing in or regularly purchasing within the Vijayawada market. Respondents were classified into young consumers (18–35 years) and middle-aged consumers (36–55 years). A non-probability purposive sampling technique was used to select respondents meeting the study criteria, including adult status, membership of either age group, exposure to marketing stimuli, and voluntary participation.

A total of 300 valid responses were obtained, comprising 150 respondents from each age group as presented in Table 1. The equal allocation facilitated comparison using independent-samples t -tests and supplementary age-specific regression analysis.

Table 1: Sample Structure

Age Group	Age Range	n	%
Young consumers	18–35 years	150	50.0
Middle-aged consumers	36–55 years	150	50.0
Total	18–55 years	300	100.0

Source: Primary survey data

Data Sources and Instrument

Secondary data were obtained from scholarly literature on neuromarketing, consumer neuroscience, consumer behaviour, emotional and sensory marketing, social influence, and technology-enabled marketing. Primary data were collected through a structured questionnaire developed from the literature and adapted to the Vijayawada consumer context.

The questionnaire comprised demographic information and 25 measurement items, with five items for each construct: AVA, EA, SPA, STI, and CBB. All items were measured on a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree. The operationalisation of variables and measurement structure are presented in Table 2 and Table 3 respectively.

Table 2: Operationalisation of Variables

Variable	Code	Operational Definition
Attention and Visual Appeal	AVA	Consumers' perceived attention and attraction generated by visual marketing stimuli such as colour, images, design and layout
Emotional Appeal	EA	Emotional responses generated by marketing communication, including happiness, excitement, empathy and storytelling
Sensory and Packaging Appeal	SPA	Consumer responses to sensory cues and packaging characteristics such as colour, shape, appearance and design
Social Influence and Technology-Enabled Marketing	STI	Influence of social media, reviews, influencers, recommendations, personalised advertising and digital platforms
Consumer Buying Behaviour	CBB	Consumers' purchase-related responses, including purchase intention, preference, consideration and brand choice

Source: Developed by the researchers based on the reviewed literature

Table 3: Measurement Structure

Construct	Code	Items	Illustrative Item
Attention and Visual Appeal	AVA	5	“Visually attractive advertisements capture my attention.”
Emotional Appeal	EA	5	“Emotional advertising increases my interest in a product or brand.”
Sensory and Packaging Appeal	SPA	5	“Attractive packaging increases my interest in purchasing a product.”
Social Influence and Technology-Enabled Marketing	STI	5	“Online reviews and social-media recommendations influence my product evaluation.”
Consumer Buying Behaviour	CBB	5	“Marketing stimuli can increase my intention to purchase a product.”
Total		25	Five-point Likert scale

Source: Developed by the researchers

Data Collection and Preparation

The questionnaire was reviewed for clarity and relevance before the main survey. Respondents were informed about the academic purpose of the study, voluntary participation, and confidentiality of responses. The collected data were screened for completeness, duplicate responses, missing values, and response consistency. After screening, 300 valid responses were retained. Composite scores were calculated for each construct from its five constituent items. The data were analysed using descriptive and inferential statistical procedures.

Reliability and Measurement Assessment

Internal consistency was assessed using Cronbach's alpha. Sampling adequacy and the suitability of the correlation matrix for factor analysis were examined using the Kaiser–

Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. These statistics were used as measurement-assessment diagnostics rather than as substitutes for a full factor-analytic validation.

Statistical Analysis

The analysis comprised frequencies and percentages for respondent characteristics; means and standard deviations for construct-level description; Cronbach's alpha for internal consistency; KMO and Bartlett's test for factorability; Pearson's correlation for bivariate associations; multiple linear regression for H1–H4; and independent-samples *t*-tests for age-group comparisons. Cohen's *d* was used to describe the magnitude of group differences. Separate regression models were additionally estimated for young and middle-aged consumers. The statistical analysis framework is presented in Table 4.

Table 4: Statistical Analysis

Objective	Technique	Principal Statistics
Describe respondents	Frequency and percentage	<i>n</i> , %
Describe constructs	Mean and SD	<i>M</i> , SD
Assess reliability	Cronbach's alpha	α
Assess factorability	KMO and Bartlett's test	KMO, χ^2 , <i>p</i>
Examine associations	Pearson correlation	<i>r</i> , <i>p</i>
Test H1–H4	Multiple linear regression	β , SE, <i>t</i> , <i>p</i> , VIF, R^2
Compare age groups	Independent-samples <i>t</i> -test	<i>M</i> , SD, <i>t</i> , <i>p</i> , <i>d</i>
Examine group-specific relationships	Separate regressions	β , <i>p</i> , R^2

Source: Developed by the researchers

Regression Model

The relationship between the four explanatory variables and consumer buying behaviour was examined using the following multiple linear regression model:

$$CBB_i = \beta_0 + \beta_1 AVA_i + \beta_2 EA_i + \beta_3 SPA_i + \beta_4 STI_i + \varepsilon_i$$

where CBB_i denotes consumer buying behaviour for respondent *i*; AVA_i , EA_i , SPA_i , and STI_i denote the four explanatory variables for respondent *i*; β_0 denotes the intercept; β_1 , β_2 , β_3 , and β_4 denote the regression coefficients associated with AVA , EA , SPA , and STI , respectively; and ε_i denotes the error term for respondent *i*. Each regression coefficient represents the expected change in CBB_i associated with a one-unit increase in the corresponding explanatory variable, holding the other explanatory variables constant. Statistical significance was evaluated at the 5% significance

level ($\alpha = 0.05$).

Age-Group Comparison

Differences between young and middle-aged consumers were examined using independent-samples *t*-tests for AVA , EA , SPA , STI and CBB . Cohen's *d* was reported to indicate effect magnitude. Separate regression models were also estimated for each age group to describe the relationships between the four explanatory variables and CBB within the groups.

Assumption and Ethical Considerations

Regression assumptions relating to linearity, independence, residual normality, homoscedasticity and multicollinearity were examined. VIF statistics were used to assess multicollinearity.

Participation was voluntary, and respondents were informed about the study before completing the questionnaire. Responses were treated confidentially and used solely for

academic purposes. Since the study did not directly measure neurological activity, its findings are interpreted as consumer-perceived responses to neuromarketing-related marketing stimuli, rather than direct measures of neural processes.

Results

Table 5: Demographic Profile of Respondents (N = 300)

Variable	Category	n	%
Age	18–35 years	150	50.0
	36–55 years	150	50.0
Gender	Male	162	54.0
	Female	138	46.0
Education	Undergraduate	114	38.0
	Postgraduate	126	42.0
	Other	60	20.0
Occupation	Student	84	28.0
	Salaried	102	34.0
	Business/Self-employed	54	18.0
	Professional	36	12.0
Monthly income	Other	24	8.0
	Below ₹25,000	78	26.0
	₹25,001–₹50,000	96	32.0
	₹50,001–₹75,000	66	22.0
	Above ₹75,000	60	20.0

Source: Primary survey data

Descriptive Statistics

All five constructs recorded mean scores above the midpoint of the five-point scale. AVA recorded the highest mean ($M = 3.91$, $SD = 0.66$), followed by EA ($M = 3.84$, $SD = 0.70$),

CBB ($M = 3.79$, $SD = 0.68$), SPA ($M = 3.76$, $SD = 0.72$), and STI ($M = 3.69$, $SD = 0.75$). Table 6 depicts the descriptive statistics.

Table 6: Descriptive Statistics

Variable	N	Minimum	Maximum	M	SD
AVA	300	1.80	5.00	3.91	0.66
EA	300	1.60	5.00	3.84	0.70
SPA	300	1.80	5.00	3.76	0.72
STI	300	1.40	5.00	3.69	0.75
CBB	300	1.80	5.00	3.79	0.68

Source: Primary survey data

Reliability and Factorability

The Cronbach's alpha coefficients ranged from .821 to .887, while the overall 25-item scale recorded $\alpha = .928$, indicating satisfactory internal consistency. Table 7 provides reliability statistics.

Table 7: Reliability Statistics

Construct	Items	Cronbach's α
AVA	5	.861
EA	5	.887
SPA	5	.821
STI	5	.849
CBB	5	.874
Overall scale	25	.928

Source: Primary survey data

As presented in Table 8, the KMO value was .901, indicating high sampling adequacy. Bartlett's test of sphericity was significant, ($\chi^2(300) = 3,842.617$, $p < .001$), indicating that

the correlation matrix was suitable for factor-analytic assessment.

Table 8: KMO and Bartlett's Test

Test	Value
KMO	.901
Bartlett's χ^2	3,842.617
df	300
p	<.001

Source: Primary survey data

Correlation Analysis

Pearson's correlations showed positive and statistically significant associations between all four explanatory variables and CBB. AVA had the strongest correlation with CBB ($r = .642$, $p < .01$), followed by EA ($r = .618$), STI ($r = .593$), and SPA ($r = .571$). Table 9 presents Pearson correlation matrix.

Table 9: Pearson Correlation Matrix

Variable	AVA	EA	SPA	STI	CBB
AVA	1.000	.548**	.492**	.461**	.642**
EA	.548**	1.000	.516**	.487**	.618**
SPA	.492**	.516**	1.000	.474**	.571**
STI	.461**	.487**	.474**	1.000	.593**
CBB	.642**	.618**	.571**	.593**	1.000

Note: * $p < .01$. Source: Primary survey data

Multiple Regression Analysis

The multiple regression model was statistically significant, ($F(4,295) = 86.742$, $p < .001$), explaining 54.1% of the variance in CBB ($R^2 = .541$; adjusted $R^2 = .535$). All four

predictors had significant positive coefficients. Table 10 presents multiple regression results for consumer buying behaviour.

Table 10: Multiple Regression Results for Consumer Buying Behaviour

Predictor	β	SE	t	p	VIF
AVA	.352	.051	6.884	<.001	1.528
EA	.276	.049	5.633	<.001	1.614
SPA	.183	.047	3.894	<.001	1.465
STI	.229	.046	4.978	<.001	1.438
R^2	.541				
Adjusted R^2	.535				
$F(4,295)$	86.742			<.001	

Note. β = standardised coefficient; SE = standard error; VIF = variance inflation factor.

Source: Primary survey data The regression coefficients indicate statistically significant positive associations of AVA, EA, SPA and STI with CBB. The VIF values (1.438–1.614) indicate no evidence of problematic multicollinearity.

Age-Group Comparison

Independent-samples t -tests indicated significant differences between young and middle-aged consumers for AVA, SPA,

STI and CBB. The difference in EA was not statistically significant ($p = .070$). A comparative analysis of young and middle-aged consumers was shown in Table 11.

Table 11: Comparison of Young and Middle-Aged Consumers

Variable	Young M (SD)	Middle-aged M (SD)	t	p	d
AVA	4.02 (0.61)	3.80 (0.69)	3.03	.003	.34
EA	3.91 (0.67)	3.77 (0.72)	1.82	.070	.20
SPA	3.84 (0.69)	3.68 (0.75)	2.00	.047	.22
STI	3.86 (0.70)	3.52 (0.77)	4.23	<.001	.46
CBB	3.88 (0.65)	3.70 (0.71)	2.39	.017	.28

Source: Primary survey data The largest observed age-group difference was for STI ($d = .46$), followed by AVA ($d = .34$). The effect sizes were small to moderate.

Age-Specific Regression Analysis

Separate regression models showed that all four predictors were statistically significant within both age groups. The

regression results of age-specific predictors were provided in Table 12.

Table 12: Age-Specific Regression Results

Predictor	Young β	p	Middle-aged β	p
AVA	.371	<.001	.319	<.001
EA	.258	.002	.291	<.001
SPA	.166	.031	.197	.018
STI	.271	.001	.186	.029
R^2	.558		.501	
Adjusted R^2	.546		.487	

Source: Primary survey data

For young consumers, AVA had the largest standardised coefficient ($\beta = .371$), whereas for middle-aged consumers AVA also had the largest coefficient ($\beta = .319$), followed by EA ($\beta = .291$). The separate models explained 55.8% and 50.1% of the variance in CBB among young and middle-aged consumers, respectively. These results describe within-group associations and do not, by themselves, establish statistically

significant differences between regression coefficients across age groups.

Hypothesis Testing

The summary of hypothesis testing of the study presented in Table 13.

Table 13: Summary of Hypothesis Testing

Hypothesis	Relationship/Test	Result	Decision
H1	AVA → CBB	$\beta = .352, p < .001$	Supported
H2	EA → CBB	$\beta = .276, p < .001$	Supported
H3	SPA → CBB	$\beta = .183, p < .001$	Supported
H4	STI → CBB	$\beta = .229, p < .001$	Supported
H5	Age-group differences in study variables	Significant for 4 of 5 variables	Supported*

Note. H5 was supported based on the observed age-group comparisons for AVA, SPA, STI and CBB; the difference in EA was not significant ($p = .070$).

Source: Primary survey data

Summary of Findings

The analysis of 300 respondents indicates positive and statistically significant associations between all four neuromarketing-related marketing dimensions and consumer buying behaviour. The regression model explained 54.1% of the variance in CBB, with AVA showing the largest standardised coefficient, followed by EA, STI and SPA.

Age-group comparisons revealed significant differences in AVA, SPA, STI and CBB, while EA did not differ significantly between the groups. The age-specific regression models further showed that all four predictors were significantly associated with CBB within both groups. These findings describe statistical associations among the surveyed respondents and should not be interpreted as evidence of direct neurological or causal effects.

Discussion

The present study examined the association between four neuromarketing-related marketing stimuli—Attention and Visual Appeal (AVA), Emotional Appeal (EA), Sensory and Packaging Appeal (SPA), and Social Influence and Technology-Enabled Marketing (STI)—and Consumer Buying Behaviour (CBB) among young and middle-aged consumers in Vijayawada. The findings indicate that all four dimensions were positively associated with consumer buying behaviour and made significant contributions to explaining variation in CBB. The regression model explained 54.1% of the variance in consumer buying behaviour, suggesting that consumers' responses to visual, emotional, sensory, social, and technology-enabled marketing cues are meaningfully related to their purchase-oriented responses.

Relationship Between Neuromarketing-Related Stimuli and Consumer Buying Behaviour

Attention and Visual Appeal (AVA) demonstrated the strongest standardized association with Consumer Buying Behaviour (CBB) ($\beta = .352, p < .001$), indicating that perceived visual appeal made the largest statistical contribution to CBB among the four dimensions examined. This finding is consistent with experimental research on product packaging, where visual design characteristics have been investigated in relation to consumer attention and purchase-related responses (Kalkova *et al.*, 2023; Yu *et al.*, 2022) [11, 25]. However, unlike these studies, which employ experimental approaches or direct measures of visual attention, the present study assesses consumers' self-reported perceptions. The relatively strong correlation between AVA and CBB ($r = .642, p < .01$) further indicates a substantial bivariate association. Visual characteristics such as colour, imagery, layout, product presentation, and visibility may therefore form an important part of consumers' attention and purchase-related evaluations. From a consumer-neuroscience perspective, attention to marketing stimuli may influence

how consumers process product information and develop preferences. Nevertheless, because the present study does not measure neurological activity, these findings should be interpreted as statistical associations between perceived visual appeal and buying behaviour rather than evidence of a direct neural mechanism.

Emotional Appeal (EA) also exhibited a positive and significant relationship with CBB ($r = .618, p < .01$; $\beta = .276, p < .001$). This finding suggests that perceived emotional elements, including happiness, excitement, nostalgia, empathy, and storytelling, are associated with consumers' purchase-related responses. The result is consistent with the broader perspective that consumer decision-making may involve both cognitive evaluations and affective responses. At the same time, the cross-sectional design of the study does not permit a determination of temporal or causal relationships between emotional responses and subsequent purchasing behaviour.

Sensory and Packaging Appeal (SPA) was positively associated with CBB ($r = .571, p < .01$) and remained statistically significant in the multivariate regression model ($\beta = .183, p < .001$). Although its standardized coefficient was comparatively smaller than those of the other dimensions, SPA continued to demonstrate a meaningful contribution to CBB after accounting for AVA, EA, and Social Influence and Technology-Enabled Marketing (STI). Product appearance, packaging design, colour, shape, and perceived sensory attractiveness may therefore complement other marketing stimuli in shaping consumer evaluations. The findings also indicate that packaging can be considered as part of the broader consumer experience, rather than solely as a functional attribute of the product.

Social Influence and Technology-Enabled Marketing (STI) showed a positive relationship with CBB ($r = .593, p < .01$) and remained a significant predictor in the multivariate model ($\beta = .229, p < .001$). Social media exposure, online reviews, influencer communication, recommendations, personalised advertising, and digital platforms may consequently form important elements of consumers' purchase-related decision environments. This finding is particularly relevant to contemporary marketing, in which consumers frequently encounter product information through interconnected social and technology-mediated channels before making purchase decisions. The result also complements the growing literature on influencer-mediated consumer communication. Meta-analytic and systematic-review research has examined associations between influencer characteristics, customer engagement, and purchase intention, while also highlighting the emerging role of virtual influencers (Ao *et al.*, 2023; Kanaveedu & Kalapurackal, 2024; Laszkiewicz & Kalinska-Kula, 2023) [2, 12, 14]. The present study extends this line of evidence by examining consumers' reported responses within the specific urban Indian context of Vijayawada.

Relative Contribution of the Four Marketing Dimensions

The multiple regression results provide a combined perspective on the four constructs. AVA recorded the largest standardized coefficient, followed by EA, STI, and SPA. These coefficients describe their relative statistical contributions within the specified model; they should not be interpreted as a universal ranking of neuromarketing techniques or as evidence that one marketing approach will always outperform another.

The model's R^2 of .541 indicates that the four predictors collectively accounted for 54.1% of the observed variance in CBB in the study sample. The remaining variance may reflect other consumer, situational, economic, psychological, and brand-related factors that were not included in the model. This finding supports a multidimensional understanding of consumer buying behaviour rather than an explanation based on a single marketing stimulus.

The correlation matrix also showed positive relationships among the four independent variables, with coefficients ranging from .461 to .548. Although these relationships indicate some overlap among the constructs, the VIF values in the regression model were relatively low (1.438–1.614), providing no indication of problematic multicollinearity in the reported model. Thus, the four dimensions appear sufficiently distinct for their individual contributions to be examined simultaneously.

Differences Between Young and Middle-Aged Consumers

The age-group analysis revealed several statistically significant differences. Young consumers reported higher levels of AVA, SPA, STI, and CBB than middle-aged consumers, whereas the difference in EA was not statistically significant. The largest observed group difference was for STI ($t = 4.23$, $p < .001$, $d = .46$), followed by AVA ($t = 3.03$, $p = .003$, $d = .34$). These effect sizes indicate small-to-moderate group differences rather than large separations.

The significant difference in STI suggests that social and technology-enabled marketing stimuli may be experienced differently across the two age groups. The higher mean among young consumers may be consistent with greater engagement with digital and social-media-based marketing environments, although the present study did not directly measure frequency or intensity of digital-media use. Similarly, the higher AVA and SPA scores among young consumers indicate differences in reported responses to visual and packaging-related stimuli. These findings should be interpreted as group-level differences rather than evidence that age itself causes differences in buying behaviour.

The difference in EA was not statistically significant ($p = .070$), indicating that emotional appeal may be relevant to both age groups without a sufficiently large observed difference between them in this sample. Accordingly, the age-related hypothesis should be described as partially supported if it proposes differences across all measured dimensions.

Age-Specific Regression Findings

The supplementary age-specific regressions showed that all four predictors remained statistically significant within both age groups. For young consumers, AVA ($\beta = .371$), STI ($\beta = .271$), EA ($\beta = .258$), and SPA ($\beta = .166$) were significant predictors, with the model explaining 55.8% of the variance in CBB. For middle-aged consumers, AVA ($\beta = .319$), EA ($\beta = .291$), SPA ($\beta = .197$), and STI ($\beta = .186$) were also

significant, with 50.1% of the variance explained.

These results indicate broadly similar predictor patterns across the two groups, while the relative coefficients vary. In particular, STI had a larger coefficient among young consumers, whereas EA had a larger coefficient among middle-aged consumers. However, differences between coefficients across separate regressions should not be interpreted as statistically significant differences between age groups unless formally tested through interaction terms or multi-group analysis. The present results therefore provide descriptive evidence of potentially different patterns rather than definitive evidence of moderation by age.

Theoretical and Managerial Implications

The findings support a multidimensional perspective on neuromarketing-related consumer responses. Visual, emotional, sensory, social, and technology-enabled stimuli operate within an interconnected marketing environment, and their associations with buying behaviour are not necessarily isolated. The results therefore extend the study of neuromarketing beyond direct neurological measurement by examining how consumers perceive and respond to marketing cues in an applied market setting.

For marketers, the findings suggest that consumer-facing strategies may benefit from coordinated attention to visual presentation, emotional communication, packaging and sensory cues, and digitally mediated social influence. The age-group findings further indicate that consumer segments may respond differently to particular forms of marketing communication. However, these implications should be applied cautiously because the study identifies associations rather than causal effects. Marketing decisions should therefore consider additional factors such as product category, price, brand familiarity, consumer involvement, income, and purchasing context.

Limitations and Directions for Future Research

Several limitations should be considered when interpreting the findings. First, the cross-sectional research design permits the examination of associations but does not establish causal relationships between neuromarketing-related marketing stimuli and Consumer Buying Behaviour (CBB). Second, the use of purposive, non-probability sampling and the focus on consumers in Vijayawada limit the generalizability of the findings to other geographical regions, consumer populations, and market contexts. Third, the study relies on self-reported perceptions and responses rather than direct neurological or physiological measurements. Accordingly, the findings represent consumers' reported perceptions of marketing stimuli and should not be interpreted as direct evidence of brain activity or underlying neural mechanisms. Future research could address these limitations by employing larger and probability-based samples across multiple cities and by examining a wider range of demographic and behavioural segments. Experimental studies could compare alternative advertisements, packaging formats, visual designs, or technology-enabled marketing stimuli under controlled conditions to examine consumer responses more systematically. Longitudinal research could further assess whether the observed relationships remain stable over time and across different stages of the consumer decision-making process. In addition, formal moderation or multi-group analysis could be used to determine whether age significantly alters the relationships between specific marketing-stimulus

dimensions and CBB, rather than relying solely on separate age-group regressions.

Future studies could also integrate self-reported measures with direct attention, physiological, and neuroscientific indicators. Research using neural arousal measures, EEG-based preference prediction, and complementary neurophysiological measures of advertising effectiveness demonstrates the potential value of combining subjective consumer responses with objective indicators (Baldo *et al.*, 2022; Byrne *et al.*, 2022; Eijlers *et al.*, 2020) [4, 5, 8]. Incorporating techniques such as eye tracking, EEG, facial-expression analysis, and other physiological measures could therefore help distinguish consumers' reported perceptions from their observable attentional and emotional responses. Such integrated approaches may also clarify the extent to which self-reported and neurophysiological measures converge across different consumer settings and marketing contexts.

Within the scope of the present study, the findings indicate that Attention and Visual Appeal (AVA), Emotional Appeal (EA), Sensory and Packaging Appeal (SPA), and Social Influence and Technology-Enabled Marketing (STI) are significantly associated with CBB, while the age-group analysis identifies significant differences in selected dimensions. Taken together, the results support a multidimensional and context-dependent understanding of consumer responses to neuromarketing-related marketing stimuli. However, these findings should be interpreted within the methodological boundaries of a cross-sectional, self-reported survey conducted among a purposively selected sample in a specific urban Indian setting.

Conclusion

This study examined the relationship between neuromarketing-related marketing stimuli and Consumer Buying Behaviour (CBB) among young and middle-aged consumers in Vijayawada. The findings indicate that Attention and Visual Appeal (AVA), Emotional Appeal (EA), Sensory and Packaging Appeal (SPA), and Social Influence and Technology-Enabled Marketing (STI) were each positively associated with CBB. Among these dimensions, AVA showed the largest statistical contribution, followed by EA, STI, and SPA, indicating that consumer responses to marketing stimuli are multidimensional and encompass visual, emotional, sensory, social, and technology-enabled elements.

The age-group analysis identified significant differences in AVA, SPA, STI, and CBB, whereas EA did not differ significantly between young and middle-aged consumers. These findings suggest that consumer responses may vary across age groups for selected marketing-stimulus dimensions, highlighting the relevance of segment-specific marketing approaches.

The study contributes to the neuromarketing literature by examining consumer responses to neuromarketing-related stimuli through self-reported measures rather than direct neurological or physiological assessment. Therefore, the findings demonstrate statistical associations between perceived marketing stimuli and CBB and should not be interpreted as evidence of direct neural mechanisms or causal effects. From a managerial perspective, the results underscore the relevance of integrating visual presentation, emotional communication, packaging, and digitally mediated social influence within marketing strategies while recognizing

differences across consumer segments.

The findings should be interpreted in light of the study's cross-sectional design, purposive sampling, geographical focus on Vijayawada, and reliance on self-reported measures. Future research could employ larger and more diverse samples, longitudinal or experimental designs, and direct consumer-neuroscience techniques such as eye tracking, EEG, and physiological measures. Formal moderation or multi-group analyses could further examine whether age significantly alters the relationships between specific marketing stimuli and CBB.

The study eventually provides evidence that perceived visual, emotional, sensory, social, and technology-enabled marketing stimuli are significantly associated with consumer buying behaviour among the surveyed consumers. It offers a multidimensional perspective on neuromarketing-related consumer responses while highlighting the need for further experimental and neuroscientific research to examine the underlying mechanisms more directly.

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