Impact of Digital Media on Consumer Behaviour - A Neuromarketing Perspective

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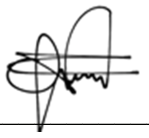

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ABSTRACT

Background. In this era of digitalization, the way consumers interact, process, and react to marketing information has changed drastically. Traditional self-report measures cannot determine the unconscious processes underlying these responses, which is why neuromarketing is necessary. This thesis will examine how the advancements of digital media are affecting consumer behavior day by day using a blend of Neuroscience and Marketing, which is known as Neuromarketing.

Research methodology. Three experimental studies were conducted to study the unconscious drivers of consumer behavior using neuromarketing. Each experiment was different in structure, but the aim of all was similar, i.e., to determine how different digital cues can impact the purchase intent at subconscious and conscious levels. All three experiments were performed in controlled conditions so that the differences in the results were solely due to the marketing stimuli and not from any external factors.

Conclusions. This thesis provides theoretical, methodological, managerial, and societal contributions. Each of the cues examined in this study has an impact on the consumer decision-making process. In simple words, this thesis encourages marketers and researchers to create digital ads in a way that aligns with how consumers feel about and neurologically process the brand messages.

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CHAPTER 1

INTRODUCTION

In this era of digitalisation and technological advancements, the way consumers interact with businesses has changed. This shift in consumer behaviour has to be constantly studied so as to learn the trends that affect it. One technique that helps to study the change in the consumer behaviour and trends is called neuromarketing. It is an emerging discipline which blends neuroscience and marketing and aims at exploring the changing consumer behavior (Dumitru and Preda, 2023).

It is important to understand the field of neuromarketing because the way consumers make decisions related to purchase happen below conscious awareness. This can be learnt using neuromarketing which helps to understand the complexities of the brain and learn how customers make their decisions by assessing the physiological and neural signals involved in the process (Harrell, 2019). In simple words, neuro marketing is not just about asking the customers what they would like to purchase but understanding how different emotions, messages and visuals affect their purchase decisions.

On the other hand, consumer behaviour is also quite dynamic based on the situation, and so it is important to observe this behavior continuously as changes in technology occur. With the help of neuromarketing, researchers can learn the different, unconscious processes that affect the purchase decisions of the customers. Neuromarketing and consumer behavior in this regard are complementary to each other (Razbadauskaitė Venskė, 2024).

The real time laboratories for such research nowadays are social media platforms and online advertisements where there are a number of emotional and visual stimuli. However, studying the impact of these digital stimuli is quite complex and cannot be done just with self reports. It can only be done when a number of different dimensions like behavioural, emotional and neural dimensions are studied in the best possible manner.

Consumer research has often been conducted by using self-reported methods that tend to focus on the surface level, resulting in missing the deeper elements that influence the actual behavior (Šášky, 2022). Surveys and interviews determine what someone thinks, but they do

not determine what their eyes and body movements focus on and what their mind considers worth it. When studying neuromarketing, self-conscious decisions are understood to see what guides the decision-making process in humans. So, it does not seek to replace current marketing strategies, but rather to augment them (Mansor and Mohd Isa, 2020). It attempts to close the gap between emotional connection and logical decision-making and allows marketers and scholars to understand the entire funnel of decision-making from perception to intent.

This study attempts to clarify that by focusing on how digital media advertisements are able to change consumer attention, emotional reaction, and value processing on a neural level. It seeks to understand how digital media architecture moves the consumer mind and behavior and by using a neuromarketing approach, how subconscious factors determine consumer buying behavior.

To gain insights into this phenomenon, the study focuses on three fundamental tools of neuromarketing: 1. GSR (galvanic skin response), which monitors emotional and physical arousal, through skin activity directly associated with the sympathetic nervous system (Sharma et al., 2019; Villanueva et al., 2016); 2. Eye-tracking that monitors the direction and duration of people's gaze (Wedel and Pieters, 2008; Bell et al., 2018); and 3. fMRI (functional Magnetic Resonance Imaging) which observes the brain activity during the response of reward system, with particular attention to ventromedial prefrontal cortex (vmPFC). This area is known to elicit the subjective value and the willingness to pay (Chib et al., 2009). These studies serve as a complete, cohesive chain of evidence. Engagement shows what is given attention to, emotion shows what is felt, and the mind shows how desire is transformed to value through desire.

In this study, we address each of the three experiments to the three dimensions of the digital customer experience. The fMRI study focuses on the brain reward system by examining neural activation patterns of vmPFC during viewing of luxury advertisements like the “iPhone 17 Pro Max,” focusing on how the vmPFC neural circuits encode value signals during stated purchase intent. This area of the brain shows an individual’s willingness to pay for a product, thus showcasing their internal value (Chib et al., 2009). Secondly, this research performs eye tracking, which is considered as a secondary neural response, resulting from the activation of the visual cortex (Çakar et al., 2018; Venkatraman et al., 2015; Pilelienė and Grigaliūnaitė, 2017; Ceravolo et al., 2019; Ungureanu et al., 2017). This eye tracking study

focuses on the enhancement of advertisements by customer reviews and assesses the impact of the testimonials on purchase intent and on visual attention (dwell time, first view, and viewed by percentage). The GSR study assesses the emotional reaction (Sharma et al., 2019) to the purchase of a discount or a limited-time offer and whether there is any physiological correlated reaction to the purchase intent.

The conclusion from all three studies is that digital media actively consumes and also captures the attention of a person on different physiological levels of the brain, body, and eyes. Using such a multi-disciplinary approach, where both the insights of neuroscience and marketing are combined, is important to understand the intricacies of consumer behaviour in this technological age (Fahim et al., 2024).

The implications of the findings from this study are not restricted to theory, as it provides valuable guidance on the structure of digital ads to capture attention, evoke emotion, and create perceived value that drives purchase. This approach, therefore, enriches the understanding of consumer behaviour on digital focus stimuli by moving away from self-reported metrics, which tend to suffer from attitude-behaviour inconsistency (Viglia et al, 2021).

With this comprehensive approach of integrating different neuro scientific tools with digital marketing theories, a number of businesses will be better able to understand the choices and motivation behind the decision making process of the customers, thus, helping them to make more favourable decisions for their target audience (Bhardwaj et al., 2024).

1.1 Statement of the Problem

Nowadays, attention spans and purchase decisions of the individuals can be formed and broken in just a matter of a few seconds. In this digital world, people are bombarded with a range of stimuli like ads, pop-ups, recommendations, and other forms of scrolling feeds. Due to this rise in the internet and other digital technologies, the entire funnel of the customer decision-making process, from initial awareness to the post-purchase, has reduced the effectiveness of any traditional linear marketing models (Chaffey and Ellis-Chadwick, 2025).

Generally, different design elements like a review rating, limited time label or even the premium feel of a product may appear to be very minimal and subtle. However, in reality, it is these micro cues that can change the way the human brain perceives a product and makes

decisions related to purchase. Consumers are far less likely to evaluate each aspect of every offer presented to them in a methodical manner. They are much more inclined to focus on ‘fast thinking’, automatic and implicit responses (Venkatraman et al. 2015).

Interviews and traditional surveys, although useful, probe only the surface level thoughts and ideas of a person. Their methodology does not account for the fast, automatic responses that determine the outcomes of various micro and macro decisions (Hakim and Levy, 2019). Therefore, it is important to understand consumer behaviour by not just their self reported data but also their unconscious level of thinking because habits and preferences of the consumers are shifting daily to adapt to the new market trends (Nevskaya and Albuquerque, 2019; Bhardwaj et al., 2024). Moreover, besides the changing consumer behaviour, the decisions consumers take are not linear. They are always a result of a mix of reasoning, personal beliefs and intuition, all of which are difficult to assess and measure (Rand et al., 2014; Bhardwaj et al., 2024).

Many times, people make their decisions and later on explain why they did so, which can, in reality, hide their actual emotional and brain responses. This creates a lasting measurement gap, and this is where neuromarketing techniques shine. These techniques can highlight the emotional, reward, and memory systems that function within consumer choices, and in doing so, offer a more complete understanding of a consumer’s response (Haidinger and Koller, 2023).

This gap can also be addressed using biometric tools as they capture physiological and neurological responses customers use when making decisions, to understand the subconscious processing of the customers in a better way (Wagner and Hort, 2025). These metrics, rather than self-reporting, are often less biased and therefore more beneficial and richer in context for those in marketing use (Bell et al., 2018).

Using this knowledge, Neuromarketing, which is still becoming established, researches how people’s brains and feelings respond to marketing, moving beyond the realm of traditional market research, which fails to capture these subconscious factors. To gauge brain activity and bodily responses, it uses different neuroscientific techniques like fMRI, EEG, and eye-tracking, thereby providing more objective data on consumer decision-making (Guo et al., 2025).

Galvanic skin response (GSR) captures shifts in psychological and physiological arousal (Shivappa and Ramanjaneyalu, 2021). Eye-tracking logs which areas people focus on and for how long, showing what images interest and keep attention (Aksoy and Basaran, 2013). fMRI assesses changes in blood-oxygen-levels dependent (BOLD) activity to identify which brain areas (Soares et al., 2016) involve value, reward, and motivation. Each of these tools offers a different perspective on consumer experience: one physiological, one behavioral, and one neural, and almost all research uses one perspective. When these different elements are taken in isolation, they are incomplete and do not show the decision-making process as a whole.

Previous studies have worked on advertising tactic appeal and brand awareness, but they have given less attention to the design elements of digital ads. Because of that, it has been a challenge for literature to help these practitioners who have to decide on an ad format and placement, or promotional frames. Also, the few studies that have used multiple neuromarketing techniques in a series of coordinated studies to understand consumer response to an ad of a product have been very limited. This research, therefore, seeks to resolve this issue by addressing the influence of certain digital media attributes on consumer behavior using a multi-modal neuromarketing technique that integrates fMRI, EEG, and eye-tracking to understand the entire cognitive and affective response (Bagdziunaite, 2018).

The first study, which involves fMRI, tries to determine if luxury product ads stimulate the reward and value centers in the brain, more specifically, the ventromedial prefrontal cortex (vmPFC). The second study, which utilizes eye-tracking, looks to see if the inclusion of consumer reviews on a product alters the consumers' viewing behavior and their intention to purchase. The third study uses GSR to see if offers that have a time urgency, in conjunction with discount signals, enhance the stimuli of buying or physiological arousal. Collectively, these studies are triangulated to connect the three links: attention, emotion, and scarcity, which provide opportunity for both clarity and insight into the theory.

In simple words, the major issue that this research attempts to address is that there is a gap or a disconnect between what people say and how their bodies and brains react while interacting with the ads. Hence, by combining a number of neuro marketing tools in one framework, this study will understand the psychology that affects the responses of the customers, moving beyond the realm of self-reported data to directly understand the way the “black box” or the mental chamber of humans operates in humans (Shabir et al., 2020). This helps to develop more psychologically accurate theoretical models by explaining variance in differently

studied phenomena through insights that are richer in context and deeper than traditional models (Bagdziunaite, 2018).

1.2 Significance of the Study

The main aim of this study is to understand how people respond to digital ads. It is important to understand the response because it helps us to learn what goes behind the surface level of these ads. When people see ads, they make their decisions in a matter of seconds while scrolling, viewing images or reading texts like the ratings/reviews or the limited-time cues on the images. Traditional surveys fail to record intervals that short (Hakim and Levy, 2019). This research examines the subconscious processes to understand how individuals look, feel, and think when they view the ads (Chan, 2020; Alvino et al., 2024).

The most important reason to conduct this study is that it considers particular design elements, rather than ads in the aggregate. It analyzes small but significant elements such as urgency messages, product reviews, and the design of ad creative. These are the same triggers that most individuals encounter while engaging in online shopping. Experiments that identify and isolate these elements are able to demonstrate which triggers cause attention, emotion, or desire, and how each contributes to the likelihood of purchase. This enhances the predictivity of marketing effects to be utilized in real-life digital designs.

The second reason is about methodology. All other works might be based on a single methodology, such is the case with a survey, or applying a single specialist approach in neural marketing. This study is unique in the sense that it combines three different experiments, each with its own participant groups and varied research instruments. The fMRI study investigates the neural activity of the brain (Medina et al., 2020) with activity underlying value and reward, the eye-tracking study measures the duration and focus of gaze (Aksoy and Basaran, 2013), and the GSR study attempts to tap into the emotional processes that are usually left uncovered (Caruelle et al., 2019). Even though these studies use different participants and research setups, they are united in their purpose, which is to find the relation between attention, emotions, and brain activities to the buying decisions. These studies together contribute to a comprehensive understanding of consumer behavior.

The third reason why this study is important is its practical value in the real world. The experiments conducted in this study provide practical advice and guidance to the marketers.

This means that it helps researchers and marketers to make their digital ad designs by studying which attributes and features capture attention, trigger emotions, and lead to purchase decisions, rather than relying on abstract and unverified assumptions (Caratù, 2023).

Let's understand this with the help of an example. If limited time offer callouts on ads increase viewers' excitement but don't lead to any purchases, then one should be very careful in using them in future. Another example is that if adding reviews and ratings on ads actually nudge people towards purchase, then they should be used more often. Lastly, if the reward area in the brain leads to a higher purchase intent, then it is likely that the emotional value is a reason behind the purchases.

In conclusion, this study contributes to both science and practice. It illustrates the impact of minute design details on human behavior. This further helps to learn how neuromarketing can be used in an effective manner to comprehend the underlying factors incentivising consumer behavior. It is this multifaceted perspective that enhances theoretical contributions to the relationship between stated preferences and neurophysiological reactions, and at the same time, provides practical contributions to digital marketing approaches (Yadete and Kant, 2023) to the aid of marketers and scholars (Viglia et al., 2021).

1.3 Research Questions

This research is structured around four main questions that drive the three experiments.

RQ1: Do luxury product ads, like an ad for iPhone 17 Pro Max ad, trigger the reward and value areas in the ventromedial prefrontal cortex (vmPFC) of the brain and does that predict stronger purchase intent? (fMRI – Study 1)

RQ2: Do ads with visible customer reviews increase attention and purchase intent more than product ads without reviews? (Eye-tracking – Study 2)

RQ3: Do urgency-framed price cues, such as "Limited-time offer," lead to more emotional response and purchase intent than ads with regular prices? (GSR – Study 3)

RQ4: Within each of the three studies, how the brain patterns in activity, attention, and emotional response match with people's self-reported purchase intention?

These four questions aim to understand the three separate dimensions of purchasing decisions - the brain, the eyes, and the emotions.

1.4 Hypotheses / Objectives

This research seeks to test the following hypotheses in the same order as the three experiments.

H1: Viewing a luxury product advertisement will activate the reward and value areas of the brain, especially the vmPFC. Higher self-reported purchase intent will be associated with greater neural activity. (Tests RQ1 — fMRI, Study 1)

H2: Customer ads that have customer reviews will have users focus on them more, retain their attention more, and have a greater intent to purchase than ads that do not have reviews. (Tests RQ2 — Eye-tracking, Study 2)

H3: Offers that use a sense of urgency to describe pricing will lead to more emotional arousal as demonstrated by stronger GSR readings, and carry a greater intent to purchase as compared to regular offers and simple discounts. (Tests RQ3 — GSR, Study 3)

H4: Looking at the results across the 3 studies, stronger reward activation (fMRI), prolonged focused attention (eye tracking), and greater emotional arousal (GSR), each is likely to have stronger purchase intent, but the strength of the correlations will vary.

These hypotheses attempt to explain the factors that neural reward, visual attention, and emotional arousal that influence a person's purchase decisions in cyberspace. Each of these three levels is a separate experiment that sheds more light on digital advertising and its conscious and subconscious impacts on a consumer.

1.5 Limitations, Delimitations, and Assumptions

Limitations refer to the attributes that are outside the control of the researcher. On the other hand, delimitations refer to the choices an individual purposely chooses which describe what the researcher's frame of study would and would not include

Limitations

All three of the studies focused on were carried out under simulated conditions. This helped to enhance accuracy but created environments that differ from how people actually shop and view ads online in the real world. Each study had its own unique participant criteria and digital cue.

The small sample size, especially with the fMRI study, greatly reduces how the findings can be generalized (Alsharif and Isa, 2024). Each study assessed purchase intent based on self-reported measures instead of actual purchases, but these self-reported measures generally differ from actual buying habits (Villanueva et al., 2016). Such limitations are typical in

neuromarketing research and can be addressed through consideration in study design and transparency in the reporting of findings.

Delimitations

This investigation centered on three specific digital cues, namely, luxury imagery, reviews, and luxury, due to their prevalence in online marketing strategies. The stimuli used in all 3 studies included static ads and video ads alongside other cues, were excluded because their presence would have complicated the focus of the research.

With respect to the time the participants were exposed to the stimuli, the instructions, and the preprocessing measures, we tried to minimize any noise in the data in order to enhance the clarity and comparability of the results. This made the results more applicable in understanding the impact of micro-visual and emotional cues on digital consumer behavior.

Assumptions

It is assumed that all participants followed the instructions and understood the rating scales, and all had normal vision. The study also assumes that GSR, eye-tracking, and fMRI assess emotional arousal, sustained attention, and neural activity in the reward area of the brain (ventromedial prefrontal cortex), respectively.

Also, it is believed that the noise and outlier detection and removal procedures were done in a manner that biased the data as little as possible. Lastly, participants paying attention and honestly responding to all the tasks was the expectation. Moreover, the purchase intent given by the participants was also assumed to be in alignment with their actual purchase decision. In addition, the aim of the study was to construct a genuine purchasing environment to unveil the real thoughts of consumers during the decision-making phase of a purchase regardless of the type of stimuli present (Khondakar et al., 2024).

1.6 Definition of Terms

Areas of Interest (AOIs): A set of predetermined regions within an image or a screen that is used for targeted analysis. The Eye tracking study uses this region to capture different metrics.

Digital cue: An individual component of a digital advertisement or image, like a discount tag, user review, or urgency cue, intended to grab attention or stimulate interest.

Eye-tracking: Another neuromarketing tool that helps to assess how long people look at a specific area of an image.

Functional Magnetic Resonance Imaging (fMRI): A non-invasive imaging technique used to assess neural activity by monitoring blood oxygen level changes and, consequently, brain activity.

Galvanic Skin Response (GSR): The measurement of skin arousal, i.e., emotional skin conductivity, which arises with emotional arousal. The greater the GSR, the stronger the emotional response.

Mean: It is the sum of the total scores attained by all participants divided by the number of participants.

Median: It is the middle score in the list of scores when the list is arranged in ascending or descending order. Median is said to be the mid score, in which half of the scores are above and half below.

Product reviews: Ratings and reviews of users are displayed next to the detailed information of a product, which impacts the way potential buyers assess the item.

Purchase intent: A self-reported metric illustrating the likelihood a person would want to buy or engage with a product after viewing it.

Standard deviation (SD): It represents the dispersion of the closeness of scores to the mean. The greater the SD, the greater the variation in the scores of the participants.

Urgency / limited-time pricing: Frequently used in marketing, this tactic induces price urgency by suggesting time-sensitive offers, like saying “Offer ends soon”, which is likely to encourage faster decisions.

Ventromedial Prefrontal Cortex (vmPFC): The part of the brain connected to the emotional value, reward, and decision-making processes most deeply. It is the focus area in our fMRI study.

Within-subject and between-subject designs: In a within-subject design, the same participant goes through different conditions, whereas in a between-subject design, different groups are exposed to varying conditions.

1.7 Background

The behavior of consumers online is now more complicated than ever due to the interaction with different screens, advertisements, and messages, all within the same day (Yadete and Kant, 2023). Consumers are bombarded with a constant stream of information from diverse sources like social media feeds, brand websites, influencer reels, personalized messages and emails, and many more. The bifurcation of attention under such circumstances is invertible and only a few seconds are permitted to a brand to capture the viewers' attention. Such over exposure is what has also led to a rise in expectation from consumers.

As a result, customers now make comparisons across platforms and want seamless, speedy, and emotionally enriched engagements (Agrawal and Gupta, 2023).

Small design features can influence people's thoughts and feelings within those brief moments. A countdown timer can instill urgency, a detailed review can boost confidence, and high-end visuals can evoke desire. They operate in a matter of milliseconds, oftentimes before the individual recognizes the impact of those cues. Traditional marketing methods can capture the resultant behavior to those cues, such as clicks or conversions, but not the synergy that occurs within the mind and body. Thus, the domain of neuromarketing fills that gap. It attempts to isolate and study the subconscious thoughts of people and the resultant activity of the brain, eyes, and feelings that correspond to digital content (Yadete and Kant, 2023; Medina et al., 2020).

In parallel, e-commerce data provides a detailed, real-time perspective of consumer behaviour. High-level data analysis enables firms to detect emerging trends, anticipate demands, and customize their marketing efforts (Hollensen, 2019). Tailoring content and offers to individual's preferences can relieve choice fatigue, simplify decision-making, and alleviate mental strain, resulting in time savings (Chandra et al., 2022). These frameworks, and more, enhance user journeys across multiple webpages and apps.

Retention and advocacy depend on the seamless and enjoyable experiences users have in the various interactions, and analyzing customer use of each respective channel aids in more

intuitive, user centered design (Chaffey and Ellis-Chadwick, 2025). Easing the user's interaction with a site effectively adds to their satisfaction, and more importantly, improves the conversion rates when browsing the site is a breeze (Mastroberte, 2022).

As discussed, this research employs three tools to capture the precursors to stated choices that are often faster and nonconscious. fMRI focuses on the ventromedial prefrontal cortex and tracks the neural BOLD signal (Soares et al., 2016) associated with value and reward during product evaluation. Eye-tracking is a technique that records the points of gaze and fixation and the duration of each fixation and is important where layouts have competitive elements like pictures, prices, and reviews. Finally, GSR measures the electrodermal activity of the skin by analysing the increased output of sweat by the sweat glands which results in lower skin resistance (Holper et al., 2014; Mee et al., 2021).

These three different studies capture the results of 3 digital cues:

- **Study 1 (fMRI):** The first study investigates whether the imagery of a luxury product is able to activate the value and reward centers of the brain, as well as enhance purchase intent.
- **Study 2 (Eye-tracking):** The 2nd study assesses if including customer reviews on product ads change the gaze focus and increase purchase intention.
- **Study 3 (GSR):** The 3rd study checks whether the presence of urgency messages such as "Limited-time offer" increases the level of arousal and correlates with purchase intention.

All studies employ the same procedures and methods to allow as much clarity as possible to the interpretation. In summary, inference gained from this kind of behavior helps organizations to better connect and compete through large-scale personalization. There is evidence that data and smart technologies are crucial in pinpointing and adjusting for changing needs in marketing (Rathore, 2019).

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Introduction

Digital technology has changed not only the ‘where’, but also the ‘how’ and ‘what’ people think and feel while shopping. As discussed, this technological era along with a number of offers and visuals, has decreased the attention spans of the people while increasing their engagement with the online media. Neuromarketing is the most useful field that helps to understand the responses of the people to the numerous digital cues they face everyday.

This research studies the micro-cues that affect the daily consumer behaviour and not the overall campaign results. Previous research has examined the concepts of emotion and involvement and their impact on attitudes toward the offered product or service (Anderlová & Pšurný, 2020). Content that is designed with social or human elements such as stories, facial features, and other relatable attributes increases emotional connection and engagement (Zeng and Lobo Marques, 2023). The process in which attention is increased as a result of a stimulus and evokes emotion is called emotion driven attention (Ramsøy, 2019).

In conclusion, these insights suggest the idea that the internet is emotionally interactive, rather than just being a repository for information. Each movement of the pointer, each click, and even each passing moment of a screen reveal is an opportunity to capture attention. The growing field of neuromarketing helps in visualizing these influences instantaneously (Alvino et al., 2020) and helps in correlating the user's visual and emotional experience to the actionable decision of a purchase.

2.2 Inclusion Criteria

This study is informed by peer-reviewed research and scholarly work on digital consumer behavior and neuromarketing. It includes research employing fMRI, GSR, and eye-tracking (Mishra and Shukla, 2020; Alsharif et al., 2021; Alvino et al., 2024), as well as other works analyzing digital cues such as urgency (Barton et al., 2022; Nguyen et al., 2023) premium/luxury imagery (Murawski et al., 2012) and social proof in the decision-making context (Fernandes et al., 2022; Mallik, 2025).

Primary consideration is given to research that offers actionable and quantifiable evidence on the ways individuals perceive, assess, and act on information presented in a digital format. This strategy seeks to integrate research conducted using various approaches to arrive at a comprehensive understanding of the neural, physiological, and behavioral mechanisms of consumer interaction with digital content (Alvino et al., 2020).

Studies were given priority if they outlined their experimental design, stimuli, and analysis in detail; provided task-related metrics such as blood-oxygen-level changes in an fMRI, skin-conductance changes in GSR, or fixation metrics in eye-tracking; and employed robust sampling and data-cleaning processes that aid in study replication. Preference was also given to research that focused on fast and subconscious processes, as opposed to only conscious evaluations. Foundational studies were included if they comprised the definition of key concepts such as attention, arousal, and value that this thesis seeks to build on.

In addition, works looking at different digital marketing stimuli and consumers' reactions to them provided a more elaborate picture on how multiple cues engage the decision process (Gill and Singh, 2022).

The combined keywords from the different searches were digital media, consumer decision making, intent to purchase, galvanic skin response, fMRI, eye tracking, urgency or time-limited offers, visual complexity, product reviews, social proof, attention, arousal, and engagement. The searches were carried out across multiple databases and checked against the reference lists from related research.

2.3 Clear Organising Themes

2.3.1 Understanding Key Mechanisms

Decisions made by digital consumers are rapid and triggered by cues. Because online interactions are fast and the amount of information is overwhelming, consumers rely on heuristics and subconscious processing. There are three fundamental mechanisms that shape this decision

1. Attention: The observation of the first thing someone sees and the duration of time spent focusing on the item.

2. Arousal: The extent to which the stimulus has the potential to activate emotional and physiological response systems.
3. Processing depth or engagement: The extent of brain allocation of mental effort or neural resources to the evaluation of the stimulus.

These processes can be in alignment or diverging. For example, an advertisement captures focus and attention but elicits little emotional response, or in some cases, it can evoke excitement but fails to maintain focus. Thus, the field of neuromarketing aims to look at many different signals at the same time in order to understand the interplay between attention, emotion, and value. This kind of approach, which uses many different tools that fall under the umbrella of neuromarketing, offers a far richer understanding of consumer behavior than is provided by traditional self-report methods, which are often used and fail to shed light on subconscious influences (Alsharif et al., 2023).

2.3.2 Linking Tools to their Functions

There is a vast body of research in both marketing and psychology that links these triggers to specific measurement tools.

- fMRI (Functional Magnetic Resonance Imaging) measures the change in the oxygen level of the blood in the brain (Daliri, 2012; Alsharif and Isa, 2024). This technology has the capability of spotting the neural activity in the ventromedial prefrontal cortex (vmPFC) where subjective value and reward is imprinted. Participants having a preference for certain products or a high purchase intent, see an increased vmPFC activation, showing emotion to valuation and intent processing.
- Attention is tracked by eye movement (Suurmets, 2019; Henderson and Ferreira, 2004; Shen et al., 2020). Research employing eye tracking has demonstrated robust correlations between recall, brand recognition, and purchase probability. The marketers' concern for engaging interest is captured by fixation count and dwell time, which enhance decision-making in layout design and placement.
- Changes in skin conductivity resulting from skin perspiration and autonomic nervous system activity is called GSR (Galvanic Skin Response) (Sharma et al., 2019; Villanueva et al., 2016). Feelings of excitement, curiosity, and urgency stimulate an increase in sweat gland activity, resulting in an electrical pulse (Holper et al., 2014; Mee et al., 2021). Prior research connects higher GSR peaks with stronger emotional

intensity and, in many cases, with greater purchase intent when the emotion is positive.

Recent surveys emphasize the necessity of these tools in real digital settings so that internal and external findings resonate with the actual consumer experience.

They also emphasize that neuromarketing should be an addition to existing behavioral approaches, not a substitute. The combination of these methods offers deeper insights into the cognitive and emotional responses (Bhardwaj et al., 2024) triggered by various digital design elements, such as urgency messages, visual style, and social proof, and how these, in turn, influence consumer behaviour.

2.3.3 Literature Aligned to the Three Studies

A. Neural valuation in luxury advertising (fMRI)

Luxury advertisements seek to elicit emotional desire by emphasizing exclusivity (Lie and Lee, 2025; Agarwal and Kumar, 2025). In consumer neuroscience, fMRI studies show the activity in the ventromedial prefrontal cortex (vmPFC) as the brain assigning value to products and experiences (Schmidt et al., 2017). This part of the brain synthesizes emotional and motivational signals to determine worth and desirability (Audrin et al., 2017).

Hence, vmPFC decides how much a person is willing to pay for a product, thus showcasing their internal value (Chib et al., 2009). In line with this, this study tests the hypothesis that for premium or aspirational products, people should demonstrate higher vmPFC activation, meaning a stronger perceived value and purchase motivation. So, in this study, we use fMRI to extend this by focusing on activation of reward-related brain areas after being exposed to luxury advertisements of the iPhone 17 Pro Max and self-reported purchase intent.

In particular, the changes in the blood oxygen level in the vmPFC and other valuation areas of the brain help the researcher understand the subconscious appeal of luxury brands that self-reported measures do not capture (López, 2016; Alsharif and Isa, 2024).

B. Product reviews and social proof in ads (Eye-tracking)

Customer reviews work like social proof for the consumers (Rajender et al., 2024; Mallik, 2025), and thus act as reliable information to help the consumers evaluate the product's usefulness and credibility (Chen et al., 2016).

An online review study found that female consumers specifically paid more attention to negative comments than positive ones. Additionally, there was a significant correlation between the purchase intention and the visual browsing behavior of the consumers (Chen et al. 2022). These results suggest that review sections in ads are visual anchors that heavily influence attention and evaluation.

C. Urgency or limited-time pricing (GSR)

The scarcity principle holds that people assign more value to things that are scarce (Barton et al., 2022; Nguyen et al., 2023). Thus, pricing that conveys scarcity works to emphasize the opportunity, increasing arousal and emotional desire to purchase. Psychologically, scarcity triggers a low-grade stress response (Button et al., 2023), that can be observed physiologically, like with skin conductance. Scarcity cues tap into the innate fear of missing out and, in doing so, shorten the window for decision and trigger loss aversion neural circuitry (Nijssen et al., 2020).

Interestingly, another study concerns the indirect effects on purchase intention. Scarcity of time positively influences the intention to purchase because it enhances perceived competition, which, in turn, intensifies perceived scarcity. These effects were identified only in Italian consumers in this study, and not in the Dutch consumers (Broeder & Wentink, 2022).

As such, the data suggest that urgency-pheromones trigger emotions, and do not act simply as persuaders.Therefore measuring the arousal condition through GSR helps in ascertaining whether a "limited-time" stimulus actually registers in the body enough to spark a sympathetic reaction which correlates to heightened chances of purchasing a product.

D. Synthesis and gaps

Neuromarketing integrates neuroscience and marketing by examining brain activities and physiological responses to consumer behavior (Lee et al., 2007; Shaw and Bagozzi, 2018; Solomon, 2018; Bhardwaj et al., 2024). Its significance has also grown with digital media and

how tiny interface elements can dramatically captivate attention, stir emotion, and influence judgment.

For example, younger people pay more attention to simplified flat logos of brands on digital platforms than older people (Mañas-Viniegra et al., 2020). This explains digital design and customized marketing. Secondly, it shows that the brain can respond to the same element of design differently, depending on the digital platforms used. This therefore indicates that more studies should be conducted on how to improve marketing techniques that use digital formats to maximize engagement and improve customer perceptions.

Attention spans are different on fast-moving, social platforms, where the situations change from minute to minute. This brings us to the major issues neuromarketing faces on the net, especially social networks, where consumer behavior sways like a pendulum from one extreme to the other. Micu et al., (2021) look into this gap, indicating a stark lack of evidence on the real use of neuromarketing for social media campaigns and urging the development of more aligned approaches to these multifaceted online ecosystems.

To start off, let's learn about the chances of a piece of content going viral, the roles of influencers, and how social networks manipulate emotions tied to brand interaction. Trust and community involvement add more complexity, which makes it imperative for neuromarketing strategists to consider a number of factors to make the campaigns successful within the social dimensions of the digital economy.

Artificial intelligence (AI) and its parallel advancements also influence the area. AI enables further content personalization and creative optimization, which allows more continuous real-time shifts of the campaigns based on feedback. This interrelationship of AI-driven flexibility and neuromarketing knowledge enhances the effectiveness of social media and digital advertising strategies and also increases the ROI for social media and digital advertising specialists (Nair and Gupta, 2021).

There is also a profound gap in neuromarketing concerning the ethics, particularly the ethics of the possible digital media attention, and for this reason, the current study makes the ethical considerations the focal point. It is also important to note that the expanding scope of neuromarketing is a potential boon for the marketers and the consumers. It is however important to note that ethical issues should be properly resolved in order to make sure that

neuromarketing practices are applied in a responsible manner (Shivappa and Ramanjaneyalu, 2021).

With growing research, there are still lots of unanswered questions. Earlier research illustrates how neural marketing operates, yet very few explain how the awareness from such marketing techniques can be utilized in functional marketing design. There's also very little data available on how these reactions occur during the limited times of focus that are typical in today's digital era. The upcoming section highlights some of the research gaps and discusses how this thesis works towards addressing them.

Gap 1: Converting neural signals into actionable strategic

Past work agrees on the point that the field of consumer neuroscience needs to move beyond fundamental research and integrate marketing theory and practice. This is to ensure that the applied contexts of marketing are appropriately underpinned and estimated in the marketing practice (Plassmann et al., 2015).

Addressed here: Each of the conducted experiments links measures from neuromarketing to self-reported purchase intent at the cue level, generating interpretations that can be used to inform advertising design and digital advertising strategy.

Gap 2: Duration of attention at micro-exposure levels

Research shows that web viewing is most often in short bursts, yet many studies still rely on long exposures or task designs that do not match actual scroll speeds. Holding total exposure time constant, recent research states that typical advertisements benefit most from more frequent but shorter exposures (Elsen et al., 2025). This suggests a need for rapid-exposure approaches in research that are more realistic.

Addressed here: Every research study in this case is associated with short, framed exposure durations for which immediate answers are linked with rapid intent ratings.

Gap 3: Ecological validity of lab tasks.

Constricted settings do not equate to real world consumer behavior. While laboratory studies are precise with a higher degree of control, their ecological validity is still very low, and generalizability to real life remains a mystery (Gupta et al., 2025).

Addressed here: This research attempts to replicate real life e-commerce in social media and other contexts by using authentic digital materials, trying to mirror everyday advertisements on e-commerce platforms.

Gap 4: Social media dynamics and volatility.

Attention on social media is highly volatile, determined by various trends and influencers' perspectives. This volatility can pose challenges when attempting to define individual consistent behavioral patterns (Appel et al., 2020).

Addressed here: This research aims to examine portable cues, urgency, reviews, and luxury imagery that cut across digital spaces rather than analyzing specific digital platforms.

Gap 5: Integration with platforms and practice.

The gaps between the marketing strategies and the findings of neuromarketing are not the same. There is a lack of consumer data and marketing actions and calls for further investigation on how marketing methodologies and digital tactics can be reused and applied (Micu et al., 2021).

Addressed here: Each of the findings on cue level is transformed into practical design strategies, for example, the phrasing of urgency messages, the positioning of reviews in the adverts, and the presentation of the premium products to enhance perceived value.

Gap 6: From attention to intention in review modules.

Past research has not sufficiently defined how consumers integrate reviews with other advertisements elements. Pattern of attention varies with product type, suggesting that consumers process review information in context, making decision intention more complex (Maslowska, et al., 2020).

Addressed here: Self-reported intent in standardized ad layouts and eye-tracking data on review sections have been analyzed to review how and when decisions are made.

Gap 7: An overreliance on neural responses in the absence of behavioral context.

Consumer neuroscience merges with marketing research to enhance forecasting of market level behavior and understanding of organizational and marketing behavior (Karmarkar and Plassmann, 2019). The strong emphasis placed on neuroscience within the context of consumer behavior and digital media has been critiqued on reductionist grounds. Observers

contend that the sheer neural pathways activated in response to specific stimuli do not capture the essence of the decision-making process, as such an attempt is reductionist and ignores other variables that inform the behavior in question.

Addressed here: The current research dissects purchase intent to neural, attentional, and physiological data to connect self-reported and subconscious evaluation and behavioral responses.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The research consisted of three cue-specific experiments. Each experiment was distinct in its structure, but all aimed to determine how visual and emotional cues impact purchase intent at subconscious and conscious levels.

The controlled experimental conditions ensured that the differences in the results were from the cues, and not from other external factors, such as lighting and screen settings. All the data were captured using verified instruments, applying standard preprocessing to clean the data, and the analysis was performed according to the pre-specified rules. This was to make the design as transparent as possible. This design used controlled exposure times and exact timing of stimulus presentation to make the results as reliable as possible, which in turn would allow stronger conclusions to be drawn about the role of each setup on the consumer's response and overall behavior (Suurmets, 2019).

This chapter offers a comprehensive overview of the research design, participant recruitment, instruments, data acquisition, stepwise procedures of the experiment, adopted techniques of analysis, and the related ethical aspects of the study.

3.2 Research Design

3.2.1 Overall Approach

The research approach used in this thesis was an experimental cue-level design. This means that for each study, a single digital cue was isolated, and an appropriate tool was selected to measure consumer responses. Each study focused on a different cue, neural valuation, attention, and arousal. However, to facilitate comparison, all three had a common outcome measure of purchase intent.

For study 1 (fMRI), each participant had a single stimulus scan. During the stimulus, an HD advertisement image of the iPhone 17 Pro Max was shown to the participants. For the entire scan, the participants had to remain still and watch the ad. Afterwards, the participants were allowed to rate their purchase intent on a 1-7 scale after leaving the MRI room.

In Study 2, in which eye tracking was employed, participants were shown two versions of a static advertisement of the Fastrack Limitless FS2 Pro Smartwatch. One version included a visible review and rating section, and the other did not. The purpose was to investigate the way in which reviews steer attention and shape intention. The technique replicated real-life scanning behavior that users exhibit in web-based advertisements, when viewers are in a hurry and rapidly evaluate the various components of an advertisement.

In Study 3 (GSR), the participants viewed one version of a Samsung Galaxy M06 5G price ad in the urgency frame, including discount and time-limited offer indicators. The objective was to capture and record moment-to-moment emotional shifts and changes in skin conductance due to skin conductance response (GSR) and assess the degree of arousal to the purchase intent.

3.3 Population and Sample

3.3.1 Target Population and Eligibility

The target population was adult consumers with the ability to see and assess a digital advertisement. All participants were aged 18 and over and were also able to provide informed consent. The exclusion criteria were tool-based: People with neurological disorders for fMRI, skin problems in the area of the electrodes for GSR, and those with uncorrected vision or calibration errors for eye tracking. Prior to participation, people were informed about the purpose of the study and the methods, and they provided informed consent to participate (Bagdziunaite, 2018; Escandón‐Barbosa et al., 2023).

Anyone with factors that could compromise safety or data quality was excluded.

3.3.2 Sampling and Final Subject Count

This study balanced feasibility and quality of data during the sampling. In the fMRI study, there were 8 participants and all 8 datasets were included in the analysis. In the eye-tracking study, 45 participants were recruited, however, 7 were excluded because their dwell times were greater than the three second ceiling, leaving 38 valid cases. In the GSR study, 23 participants were recruited and 2 were excluded from analysis, one because of a very high skin conductance level, which is indicative of an abnormal physiological state or

electrode/technical problems, and the other one because there was no measurable response close to the calibration values. This results in 21 participants in the analytic sample.

3.3.3 Demographic Data Collection Using a Questionnaire

Participants in all three studies filled out a standardized Google Form prior to any data collection which included age (in years), gender (self-identified), city (current place of residence), income bracket (1-4; self assigned classification of household income where 1 = lowest and 4 = highest), frequency of shopping (1-7; rating of how often participants shop online/offline where 1 = least frequent and 7 = most frequent), and price sensitivity (1-7; how much price change is likely to impact their purchase decision where 1 = least likely and 7 = most likely).

Responses for GSR, EEG and eye-tracking experiments were all from the same standardized form and were linked to the sessions using an anonymized participant ID.

The form's questions are presented in Appendix A.

3.4 Data collection and Instrumentation

3.4.1 Study 1: fMRI

Functional images were processed using Mango MRI Viewer and its Behavioral Analysis Plugin. The ventromedial prefrontal cortex (vmPFC), a region consistently linked to willingness to pay (Chib et al., 2009), was selected as the region of interest (ROI) using its "Reward/Gain" area. Each participant's brain data was normalized to Talairach space, and the software computed Z-scores representing activation levels in the vmPFC (Saffar et al., 2021). These Z-scores became the study's primary neural index of value processing, which were later assessed against the purchase-intent ratings from each participant.

The final dataset included the normalised fMRI images in NIfTI format, Z-scores for vmPFC activation within the Reward/Gain region of interest, and self-reported purchase intent ratings from each participant on a scale of 1 to 7.

3.4.2 Study 2: Eye-Tracking

GazeRecorder was the software that provided the tracking data, which estimates the position of a user's gaze. The sessions were held in a silent room that was uniformly lit. Each subject was positioned approximately 60 cm in front of the monitor. Before beginning, calibration was performed by the software for 2 minutes to align gaze and re-calibration was even performed if a drift was found (Sulikowski et al., 2022; Bue, 2020).

The primary focus of the research was the target region that contained review text in the "review" ad and the corresponding visual space in the "no-review" version. Hence, the data for both the regions was captured. After each advertisement, participants rated their purchase intent on the provided scale from 1 to 7. The dataset consisted of purchase intent estimates and the associated Dwell Time, First View, Viewed By for both review and no-review target area of each participant.

3.4.3 Study 3: GSR

We recorded GSR data with Grove GSR sensor and an Arduino Uno microcontroller. Before starting each session, a potentiometer was adjusted to a stable baseline output (around 512). The electrodes were placed on the index and middle fingers of the non-dominant hand. We swabbed the contact area with alcohol and cotton pads prior to placement to clean the area and also mitigate the effects of slippage (Jang et al., 2019).

The recordings were sampled at 10 Hz (10 readings in 1 second). The first four seconds after the onset of ad was used as the response window (Juuse et al., 2024; Boucsein, 2012; Sjouwerman & Lonsdorf, 2019). Hence, the data was calculated for this window which resulted in 40 readings per participant.

For each participant, the average of these 40 sensor values was used to calculate the resistance, which was, in turn, converted into conductance. The average of the 40 sensor values were used to calculate the Raw resistance data, which was, in turn, converted to Conductance. Afterwards, participants evaluated their purchase intent in the same 1-7 scale used earlier.

All parts of the studies were carried out under the same conditions of temperature and noise. The temperature and humidity were controlled to stabilize these factors to protect the sensitive physical parameters and avoid variations in the data due to anything except the digital cue (Bartolo et al., 2019; Sonkusare et al., 2021).

3.5 Procedures

3.5.1 Study 1: fMRI

Upon their arrival at the MRI center, each one of the participants was subjected to the standard safety protocol to determine whether the person could be scanned. The participants were advised to relax during the procedure.

Head motion during fMRI acquisition is a significant source of artifacts that can degrade data quality and lead to spurious results. Even a single movement, however small (down to millimeters), can cause intricate and complex changes that can morph the fMRI signal and, in turn, impact the assessment of functional connectivity. In turn, this leads to false positives or spatial distortions in the brain connectivity maps (Power et al., 2013; Maknojia et al., 2019). These artifacts can be particularly problematic in studies involving the pediatric, elderly, and clinical people who have difficulty remaining still (Power et al., 2013).

After completing the preparatory stage, the subjects were asked to take their position on the bed of the scanner in a comfortable manner. Then they were shown a static advertisement for about 30 seconds.

Once the participants completed the scan, they were escorted to a serene area where they self-reported their willingness to buy the product on a 1-7 Likert scale (1 “not at all likely to purchase”, 7 = “extremely likely to purchase”). Each session (inclusive of preparation, scanning, and debriefing) lasted approximately 15-20 minutes. To ensure data consistency, all participants were scanned by the same trained MRI personnel who followed the same protocols for all of the sessions.

3.5.2 Study 2: Eye-Tracking

Every participant went through a one-on-one session in a quiet room with no ambient noise and stable lighting. Each participant was situated approximately 60cm away from a 24-inch screen (1920 x 1080 resolution, 60 Hz refresh rate).

Participants viewed two digital advertisements for the same product, the Fastrack Limitless FS2 Pro Smartwatch, one of which contained a customer-review section that included star ratings, and the other one that was identical with no reviews. The order of the two ads was random for each individual to prevent order effects.

Participants viewed two digital advertisements for the same product, the Fastrack Limitless FS2 Pro Smartwatch, one that included a customer-review section with visible star ratings, and another identical version without reviews. The order of the two ads was randomized for each person to avoid sequence effects (Trabulsi et al., 2021).

Each advertisement remained on the screen for around 10–15 seconds, after which the participant rated how likely they were to purchase the product on a 1–7 scale.

3.5.3 Study 3: GSR

The experiment was performed in a one-on-one session for each participant. Prior to the recording, the GSR sensor was connected to the Arduino Uno and was calibrated. The calibration was performed by the researcher by adjusting the potentiometer until output on the screen was stabilised.

After the setup, the subjects were instructed to rest for a few moments to allow the body to assume a baseline. During this phase, they sat with closed eyes, wearing the noise cancelling headphones. Approximately 20 seconds prior to the focus, they were instructed to open their eyes and concentrate on the screen (Sugimine et al., 2020).

This time, the subjects were shown an advertisement for the Samsung Galaxy M06 which highlighted a sense of urgency with the promotional line of a discount (FLAT 20% OFF) in addition to a limited time offer.

Upon completion of viewing the advertisement, the participants were asked to evaluate the ad's impact on their intended purchase rating. Every participant underwent the same steps to maintain reliability of the data collected.

3.6 Data Analysis Limitations

Each experiment performed followed a certain logical framework. Moreover, all 3 studies used the same standard procedure for each participant so that the variations in the data set

related directly only to the digital cue and not any external stimuli. Nevertheless, some limitations were faced in the experiments while analysing the data.

3.6.1 Study 1: fMRI: Neural Response to a Luxury Advertisement

Data Analysis

The data for the fMRI study was analyzed using the Mango software (Lancaster et al., 2010; Zhao et al., 2024; Fascher et al., 2023) and its Behavioral Analysis Plugin. Each participant's data was aligned to Talairach space for consistent coordinate mapping. It was later statistically analyzed using the IBM® SPSS® platform.

To analyze the neural activities, Mango computed individual Z-scores depicting the changes in the blood-oxygen-level-dependent (BOLD) signal within the vmPFC region as participants viewed an iPhone 17 Pro Max advertisement. Neural metrics were then integrated with the post-scan (1-7 scale) purchase-intent scans to analyze level of intent activation and purchase intent.

Limitations

The fMRI analysis offered unique valuable insights regarding neural valuation system processes, but it had a number of principal limitations. The number of participants (n=8) in this study is aligned with the guidelines for fMRI studies; however, it still diminishes statistical power, and hinders generalizations. This is a well-known limitation in the field of neuroscience due to the high costs and significant processing demands associated with fMRI data (Hubert et al., 2024).

Other than this, even with head stabilization, motion artifacts, along with the noise produced by the scanner, are known to limit sensitivity to activation differences (Vujičić et al., 2021). In addition, the decision to focus exclusively on the vmPFC region of interest (ROI) may have excluded important brain areas associated with emotion or attention. Despite these limitations, the procedure was sufficient to identify the consistent reward-related activation associated with advertising digital luxuries.

3.6.2 Study 2: Eye Tracking: Product Reviews and Visual Attention

Data Analysis

GazeRecorder software was used to record the eye tracking data. This software automatically assessed the dwell time during the sessions. Analysis began with assessing whether the calibration was performed accurately or not.

The software then recorded three variables for both the conditions of review and no review out of which one was the primary variable. The data was captured and stored in CSV format which was then statistically analyzed using the IBM® SPSS® platform. Within subject analyses prevented any inter-individual variations (Lee et al., 2025) and evaluated whether ads with visible reviews were paid more attention to.

Limitations

Webcam-based gaze tracking is easier to use but less accurate than infrared gaze systems. This is mainly because of their low data quality (Cheng et al., 2023). The measurement error is small but can still interfere with fixation localization. Other than this, the study has ignored the effects reviews might have on the overall scanning behavior across the ad by limiting the analysis of attention to a single region of interest.

Finally, the final data set of 38 participants is modest and sufficient for within-participant comparisons. Despite all these limitations, this study provides a clear picture to learn about the impact of reviews on consumer attention.

3.6.3 Study 3: GSR: Urgency Cues and Emotional Arousal

Data Analysis

GSR data were gathered at a sampling rate of 10 Hz, translating to ten readings every second while participants were exposed to the urgency-framed advertisement. Emotional arousal is usually at its peak just after the stimulus onset, and therefore, the first four seconds interval after the stimulus onset was selected as the analysis interval (Juuse et al., 2024; Boucsein et al., 2012; Sjouwerman & Lonsdorf 2019).

The data were first preprocessed and then statistically analyzed using the IBM® SPSS® platform. Preprocessing steps involved dropping two participants. This left us with a final sample of n = 21.

Limitations

Although GSR measurements are fairly accurate while measuring arousal, it does not provide whether the emotions are positive or negative. This means that it cannot tell the cause of emotional arousal (Khosravi et al., 2024). An increase in measurement denotes mere emotional intensity and does not provide an emotional state. Moreover, the measurement of skin conductance is influenced by the amount of sweating a person has, the temperature, as well as the contact made with electrodes (Nechyporenko et al., 2024). Even though the calibration and cleaning steps minimized this variability, some components of noise or static are certain.

Furthermore, the study used a single urgency-based stimulus, which means that the results pertain only to that specific trigger as opposed to any other time or scarcity constraints. The already small final sample (n = 21) also limits the ability for broad generalization. However, the data still captures real time emotional responses and it complements the other two tools used in the research.

Future studies can expand on these findings by using a number of different physiological measures like heart rate variability to understand the direction of the emotional valencies. These studies can also use more diverse and larger samples to increase the generalizability of the findings to a wider range of consumer demographics (Bagdziunaite, 2018).

3.6.4 Shared Limitations

In all 3 studies, data collection was performed in controlled environments for the sake of accuracy. This enhances internal validity, but it also comes at a cost to external validity, especially compared to naturalistic environments involving web browsing or e-commerce. Subsequent studies should include observational research in collaboration with businesses and companies to understand consumer behavior in the most natural environment (Viglia et al., 2021).

The selected samples are focused on data quality as opposed to representing the population, so the results should be interpreted as directional and not absolute. Self-reported purchase intent, as indeed present in other neuromarketing studies, is a proxy of behaviour and not purchase action itself (Boardman and McCormick, 2022; Viglia et al., 2021).

Consequently, the analyses provided in these three studies integrate neural valuation, visual and psychophysiological attention, and conscious purchase intent. Each method provided distinct insights on the impact of digital cues on consumers. Although there are methodological and contextual limitations, the integrative combination of these approaches offers a more holistic understanding of digital consumer behavior than any single method could provide.

This integrative approach seeks to uncover the neurocognitive processes involved in the consumer response to stimuli derived from digital marketing, thus offering the foundation for further development in the field of neuromarketing (Yun, 2023).

3.7 Ethics Related to Human Subject Participation

Neuroscience and neuromarketing produce large and complex datasets. This results in ethical dilemmas surrounding informed consent, consent, privacy, data protection, and the possible reuse of data. These issues must be addressed to minimize potential harm and disrespect towards participants.

In the broader context of neuroethics, informed consent is a perennial issue, particularly in the context of medical neuroscience, where it is the most dominant concern (Mouammine and Azdimousa, 2023). This is particularly relevant in the context of neuromarketing, which treats the physiological and neural data as the gold standard and uses it to analyze subconscious data.

In line with this, ethical approval was received prior to the commencement of data collection in all three studies. Participants received verbal and written descriptions of study aims, expected participation time, and nature of the tasks. Being transparent regarding all ethical issues, particularly in potential neuromarketing studies, is essential to minimize risks surrounding data privacy and possible cognitive manipulation (Cluley and Green, 2024; Bhardwaj et al., 2024; Khondakar et al., 2024; Mouammine and Azdimousa, 2023).

Moreover, critics contend that neural privacy may be abused and the respondents may be manipulated, given the various tools that neuroscience provides (Lim, 2018; Murphy et al., 2008). In conclusion, researchers should focus on establishing sound and effective data protection measures and upholding the confidentiality of participants' data.

Furthermore, in all three studies, participants were free to take a break or withdraw from the study at any time without any penalties or consequences.

With regard to the complete confidentiality and anonymization protocol, when the data was to be saved, the participant names were to be replaced with numerical identifiers. Additionally, all data were saved to secure drives, and were only accessed by the authorized members of the research team. They also confirmed that all data were used just for the scholarly purposes mentioned in the consent.

3.8 Summary

This chapter outlined the research methods used to assess the impact of certain digital cues on consumer behavior through the measures of the brain, the eyes, and the body. It also described the participant recruitment, data collection, and preliminary analysis procedures to comprehensively address the scope of the interplay between digital media and consumer behavior (Alvino et al., 2020).

CHAPTER 4

RESULTS

4.1 Study 1- fMRI (Functional Magnetic Resonance Imaging)

4.1.1 Objective and Research Question

This Functional Magnetic Resonance Imaging study aims to evaluate the purchase intent of consumers while watching the iPhone 17 Pro Max advertisement and the neural mechanisms that trigger the buying intent. Through fMRI, insights can be achieved to understand the kinds of activities that occur in certain areas of the brain (Region of Interest) when a person assesses a product regarding its desirability or emotional appeal.

This study will use an ROI (Region of Interest) mechanism and concentrate on the ventromedial prefrontal cortex (vmPFC) because this part of the brain estimates the emotional value of an item to an individual, and is associated with their willingness to pay. This region has been selected because of prior research demonstrating that this area of the brain shows how much a person is willing to pay for a product, thus showcasing their internal value (Chib et al., 2009). It is also important to combine a number of task-dependent variables into a cohesive value so as to influence the purchase decisions (Simonetti et al., 2021). Understanding this emotional trigger in the brain during the visual of the iPhone 17 advertisement will reveal the extent to which participants are willing to purchase and how underlying mechanisms drive them.

This will be done by measuring the Blood Oxygen Level Dependent (BOLD) response while they view the ad. BOLD response is an accurate and non-invasive measurement of local blood oxygen. It has been a valuable technique used to assess the buy-in response for various stimuli (Gauthier and Fan, 2019).

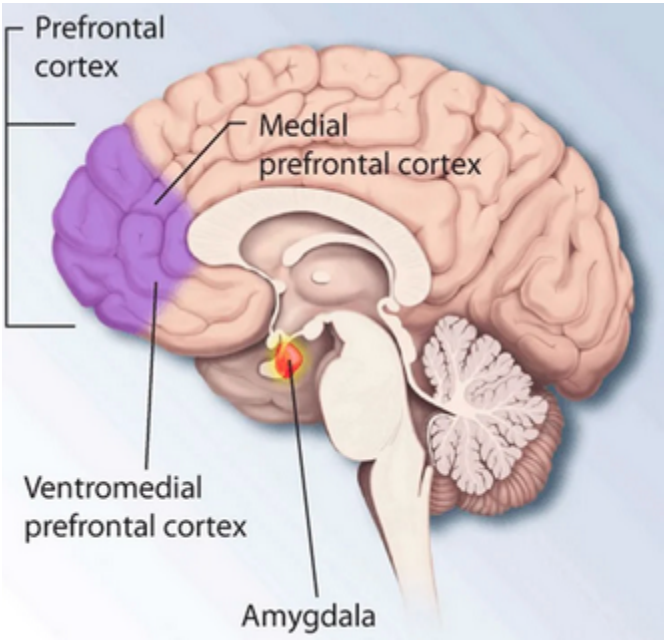

Figure 1. vmPFC Region of the Brain

Moreover, the study is exploring the "reward/gain" emotional trigger in the vmPFC because both the product that we are selling (the iPhone 17 Pro Max) and our target market (luxury buyers in India) are high-end. In simple terms, if the ad feels rewarding to this audience, then vmPFC is likely to show it. Since the target audience is a premium one, seeing an advertisement of a premium product, such as the iPhone 17 Pro Max, is bound to make them feel a sense of "reward/gain". Prior research shows that an activation in the vmPFC is related to the affective and conceptual information, especially when there is a link between a luxury brand and a product. This indicates a clear neural demonstration of perceived value and satisfaction (Audrin et al., 2017).

This research aims to determine the z-scores related to the rewards/gains section of the vmPFC area. The Z-score indicates the measure of a specific parameter divided by its standard error, which is a way to measure the activation of a given area of the brain (Saffar et al., 2021). The Z-scores in this study quantitatively assess the neural activation that occurs during the presentation of the stimulus, which is then correlated to the purchase intent self-reports given by the participants right after the scan.

The objective is to determine whether the vmPFC z-scores for the ad of the iPhone 17 increased during the ad and then predicted the purchase-intent ratings on a scale of 1 to 7 or not.

In this regard, the study will seek to answer:

Do the reward/gain z-scores in the vmPFC region during the ad viewing sessions positively correlate with self-reported purchase intent?

This approach reveals the neural correlates of consumer responses beyond conscious self-report, offering a more objective view of how the audience engages with marketing stimulus. It uses self-report and explains the neural correlates of consumer responses to the ad, and thus provides a clearer understanding of the engagement with the marketing stimulus.

4.1.2 Participants

A total of eight participants (n = 8) were engaged in the fMRI experiment. Their ages ranged from 25 to 35 years (M = 29.9, SD = 3.04). With the use of a prescreening questionnaire, all buyers were classified as Indian luxury buyers. Every participant underwent thorough screening to identify any risks associated with MRI before the scans.

The clinical impact of MRI Safety practices needs more attention. So in this study, each participant completed an MRI safety evaluation standard for every participant, which consisted of an interview, a checklist, and a description of contraindications.

Each participant took a demographic and behavioral pre-screening, which was done using Google Forms. Information during the questionnaire included participants' income (measured in four income brackets), total online shopping frequency, and price sensitivity. All responses, except the participants' income, were on a seven-point scale.

Before the scanning process, participants were instructed on the steps they were to follow in the experiment and how fMRI data were to be collected. All participants recorded their informed consent, having been fully informed of the study, the conduct of the study, the possible benefits and drawbacks, and that their participation was voluntary (Vujičić et al., 2021). All the recorded responses and imaging data were kept confidential and were

anonymized in line with the ethical principles of research on human subjects set out by the institution.

4.1.3 Inclusion Criteria

The participants who were chosen for the fMRI experiment had to satisfy certain conditions in order to protect the quality of the data collected and their safety. People who were between 25 and 35 years of age were taken, which is the target age for the demographic of consumers that the study focuses on. Only participants who were determined to be physically healthy for an MRI scan were chosen. To adhere to the eligibility for the neuroimaging procedure and to ensure the safety of the participants, they were screened for any fMRI contraindications (Scult et al., 2017).

To effectively engage with the brand stimulus showcased during the experiment, the selected candidates needed to have a background understanding of consumer electronics and online shopping. Participants also needed to follow the rest of the guidelines and demonstrate the ability to stay quiet and still for long time periods, as even the slightest movement of the head may disrupt the fMRI signal. Before partaking in the study, each volunteer signed an informed consent form (Vujičić et al., 2021).

4.1.4 Exclusion Criteria

Participants were excluded if they described any medical, neurological or psychological conditions that might disrupt normal brain function and might pose some safety problems during the MRI scan. They were excluded if they had any metallic implants, a pacemaker, any prosthetic devices, or a history of brain injury, epilepsy, or severe migraines. Other than this, participants with permanent makeup that contained metallic pigments or unremovable body piercings with metals were also excluded because these metallic elements could clash with the magnetic field and result in image artifacts (Banerjee et al., 2020).

Those individuals were also excluded from the study who experienced claustrophobia or discomfort in relation to a confined space due to the nature of the MRI. Furthermore, the participation of patients receiving any high dose of a sedative or those who had recent seizure activity was also excluded, as these would contaminate the data and result of the study (Weijer et al. 2016).

The list of exclusions also included pregnant ladies and those who had medical procedures involving metal instruments. Additionally, the participants were also screened for any psychiatric conditions like mood disorders or depression, or even a history of drug consumption, which could affect the neural activity analysis (Bagdziunaite, 2018; Gier et al., 2023).

4.1.5 Lab and Experimental Setup

The fMRI experiment was set up within one of the neuroimaging studies in the laboratory on a Siemens 1.5 Tesla (1.5T) MRI in a specially constructed fMRI room for the neuroimaging part of the study. The room used for scanning was specially constructed to provide sound-proofing and magnetic shielding to eliminate external noise and magnetic interference. Temperature and illumination of the room were stabilized and set to comfortable levels to maintain participant comfort and within and across session control.

During the Pre-Session brief, participants received a comprehensive orientation of the fMRI scanning process. After the presentation, the subjects lay on the MRI table in a comfortable position and their heads were stabilized with foam pads to minimize relative head motion. Communication with subjects is achieved with a 2 way intercom to talk with them and the research team as well. Talking with subjects before the MRI and also during the MRI is essential for high-quality imaging acquisition, as well as for reducing anxiety and risks (Weidman et al., 2015).

On the rear projection screen located behind the scanner bore, the participants were able to view the visual stimulus (iPhone 17 advertisement) through the angled mirror that is positioned above the head.

Participants completed the testing, and right after leaving the MRI room, they were asked to rate how likely they would purchase the iPhone 17 on a scale of 1 to 7.

4.1.6 Materials

The key material in this study consisted of one visual stimulus, a single image from an official advertisement for an iPhone 17 Pro Max. The image selected demonstrated the brand’s emphasis on luxury and aspirational identity. Each participant engaged with the advertisement image for the allocated duration of 25-30 seconds during the fMRI scan.

Figure 2. iPhone 17 Pro Max Ad - fMRI Study Stimulus

4.1.7 Participant Instructions

Prior to the beginning of the experiment, participants were briefed, both verbally and in writing, on the procedure to be followed in the fMRI. They were told the purpose of the study and the focus of the study was to attempt to understand the brain's reaction to marketing stimulus in the form of images, and their role in the study was to avoid any movements in the MRI scanner in order to maximize the quality of the imaging data.

Participants were asked to remain still and, in particular, relax to the point of avoiding any movements and keeping their face and mouth closed during the entire duration of the scanning sessions. They were instructed to refrain from any form of complex cognitive activities, such as reciting, visualizing, or enumerating, and more to simply relax and be focused. They were also told beforehand not to be involved in any recreational drugs or consume alcohol at least 24 hours before the study was performed to avoid any neurophysiological clashes that could affect the fMRI results (Endendijk et al., 2019).

They were told that an image ad would be displayed on the screen. They were told to look at the image without thinking too hard, as they would do when seeing an advertisement in everyday life. No answers were needed during the scan itself. After the scan, each individual was asked to rate how likely they were to purchase the advertisement on a 1–7 scale, where 1 was “not at all likely to purchase” and 7 was “extremely likely to purchase.”

Participants were made to understand that there were no right or wrong answers, and the focus was on their comfort. All participants were told that they could leave the study at any time without facing any issues.

4.1.8 Procedure

The experiment was carried out in a single session of about 15 to 20 minutes for each participant. Upon arrival, participants were screened for MRI safety and were briefed on the purpose of the study, the expected duration of the study, and the scanning procedure to be followed. Upon consenting, participants were taken to the MRI room, where they were made comfortable on the scanning device. Foam pads were put around the participants’ heads to minimize any kind of motion during image acquisition (Vujičić et al., 2021).

Each participant completed a single stimulus scan during the scanning phase. For the participant’s fMRI scan, a high-definition advertisement image of the iPhone 17 Pro Max was rear-projected and viewed through a mirror attached to the head coil. The participants were instructed to be motionless and to view the image till the end of the scan.

After the scanning phase, participants left the MRI room and were taken to a post-scan area. There, they rated the advertisement for purchase intent on a 1–7 Likert scale (1 = “not at all likely to purchase” and 7 = “extremely likely to purchase”).

To avoid confusion about timing, the overall 15-20 minute session involves a stimulus screening, where the subject is positioned and given instructions, a short scan, and a post-scan rating/debrief, followed by the actual stimulus presentation, which is 30 seconds.

All scanning sessions were carried out by trained MRI personnel to maintain high quality and to properly follow the safety protocols. The same steps were taken for all 8 participants in the study to ensure non-biased distribution of data.

4.1.9 fMRI Measures

fMRI captures the neural measurement as the change in the dependent BOLD signal intensity within the duration of the stimulus condition (a singular advertisement exposure of 25-30 second intervals). The BOLD signal is a measure of an indirect indicator of neural activity, as it is a reflection of the complex interplay of changes to the regional cerebral blood flow, blood volume, and blood oxygenation within the brain (Soares et al, 2016).

Analysis centered around an area within the vmPFC region of the brain, with emphasis on the Reward/Gain category relevant to premium product evaluation. Functional data were processed in Mango Viewer (Lancaster et al., 2010; Zhao et al., 2024; Fascher et al., 2023) with the Behavioral Analysis Plugin, which performs coordinate-based regional analysis within the user-controlled ROIs. Prior to analysis, all images were Talairach normalized using Mango's Spatial Normalization (SN) plugin. For data that were originally oriented in the MNI space, the MNI to Tal transform was used. The pivot point of images was checked using the Mango ('o') key to perform accurate coordinate mapping.

On the plugin, the stimulus-period data were used to calculate the Z-scores describing the BOLD activations in the vmPFC (Reward/Gain) ROI. Each Z-score acted as a neural quantitative measure for every participant for later statistical computation (Pearson and Spearman correlation) with ratings of purchase intent. In a post hoc statistical context, thresholded outputs served as Z-scores for describing Significance, while the primary analysis treated Z-scores as continuous neural indices of reward-related activation while viewing the advertisement (Li and Zhang, 2024; Lv et al., 2014).

4.1.10 Behavioral Measure

Behavioral biases were directed toward purchase intent, which was assessed post-scan. Each participant was asked to rate themselves on a scale of 1 (not at all likely to purchase) to 7 (extremely likely to purchase) as to the degree they would wish to purchase the iPhone 17 Pro Max. This helped to gather the behavioral measure data, which is 100% accurate and is a result of the presented stimulus without any influence from the scanning environment (Medina et al., 2020).

The acquisition of the behavioral ratings took place after the fMRI scans, and the purpose was for the participants to give spontaneous reactions to how they perceived the advertisement. Subsequently, the ratings were integrated with the neural data, and it was made to determine how BOLD changes in the ROI selected corresponded to differences in purchase intent on a participant level.

4.1.11 Quality Control

The importance of quality control in processing and analyzing fMRI data cannot be overemphasized in relation to its purposes - to eliminate data that, if retained, would result in errors in the subsequent analysis and result reporting (Williams et al, 2023).

Quality control measures were taken in the fMRI data to guarantee its quality and precision. Before analysis commenced, all images were assessed for head movement (motion) artifacts, scanner noise, and alignment artifacts (Vujičić et al., 2021). Datasets showing excessive motion and/or spatial distortions were flagged for review.

Initially, all anatomical and functional images were subjected to Talairach brain space normalization through the use of Mango's Spatial Normalization (SN) plugin. For images that were originally aligned to the MNI template, we applied an MNI to Talairach transformation template in order to maintain the consistency of cross-participant coordinate mapping. The spatial origin (center) of each image was checked manually in regard to alignment to ensure accurate alignment of the ROI in relation to the associated brain structures before processing.

Before commencing with the analysis of ROI data, all the data were inspected for completeness and signal uniformity. This pre-processing approach included a number of steps

to ensure accuracy and reliability of the data collected, like spatial normalization of the images, spatial smoothing, and head motion correction (Motoki et al., 2019).

The BOLD signal corresponding to the ROI was checked for any artifacts of intensity spikes, where only scans of the highest quality were kept and incorporated into the final dataset. These procedures were undertaken to make sure that the neural activations obtained through the behavioral plugin were true brain activations, free from any artifacts and procedural abnormalities.

4.1.12 Rationale

As fMRI is able to capture neural activity on a very precise spatial level, it enables the researcher to explore the subconscious dimensions of consumer perception and decision-making, which justifies its use in this research.

In this study, we used Region of Interest (ROI) analyses for several reasons (Yin and Lee, 2023). Performing ROI analyses has different rationales and ought to be understood as such. The first reason for ROI analyses is to have an exploratory data analysis. In very complex designs (for instance, factorial designs with several levels), it is very difficult to use an overall map to understand the pattern of activity across conditions. It helps to be able to look at the signal in ROIs for each condition or to look at the signal in conjunction with other variables of interest. The second reason is to use ROIs to control Type I error by limiting the number of statistical tests. The third reason is to restrict the analysis to a region that is functionally defined on other weaker criteria, such as a separate localizer scan or condition (Poldrack, 2007).

This analysis of ROI does focus on the ventromedial prefrontal cortex (vmPFC) because this area of the brain deals with subjective value computation and willingness to pay. Prior research in neuroeconomics has demonstrated that the vmPFC activity reflects the worth of the item to the person and involves the emotional and cognitive aspects of valuation. This pre-processing approach included a number of steps that ensured accuracy and reliability of the data collected, like spatial normalization of the images, spatial smoothing, and head motion correction (Medina et al., 2020).

In particular, Chib et al (2009) provides the most convincing evidence that the vmPFC is said

to portray the neural connection of decision values of varieties of goods. This characterizes the vmPFC as a region of the brain that is attuned to one's internal value system and the economic behavior associated with purchasing the goods. Hence, this study focuses on whether the brain value signal is intrinsic during exposure to the iPhone 17 Pro Max advertisement and whether this signal correlates with self-reported purchase intent. In plan, this makes an attempt to connect neural valuation and consumer behavior at the same time.

In the vmPFC, the attention was on the Reward/Gain area, which was important because it related to the nature of the product and the characteristics of the participants. The product is an aspirational premium one, likely to have perceptions around ownership and social reward on a high level. The Indian luxury buyer segment also internalizes value and reward on the basis of such cues. The fact that both the product and the target audience lie within a gain-oriented, status-driven framework allows us to understand why Reward/Gain was selected in the vmPFC to analyze neural activation patterns related to motivational reward.

Thus, in the context of the current study, we aim to uncover whether the advertisement's exposure results in a reward activation pattern that suggests the presence of a high motivational disposition to purchase the product and high value attribution to it.

4.1.13 Data Collection and Guardrails

System and recording

The setup for stimulus presentation was integrated with the MRI console to accurately time the visual start and onset of image capture. All scans were kept with the same acquisition parameters to enhance the reliable difference between each participant. The functional images were recorded in NIfTI format and subsequently converted for structural and functional analysis within Talairach space using Mango Viewer and its Behavioral Analysis plugin.

Neural engagement phenomena within the Reward / Gain regions of interest (ROI) defined in the ventromedial prefrontal cortex (vmPFC) were computed and represented as Z-scores by the Behavior Analysis Plugin. By using the same key variable, statistical comparison of the neutral activity across different participants became standardized and helped gain insights into the unconscious level of the consumer's behavior (Yin and Lee, 2023).

The dataset of this study is placed in Appendix B along with the meaning of the variables used.

Guardrails for Data Quality

For the purpose of maintaining the quality of the data and the analyses, multiple procedural and technical guardrails were created. The data for each participant was reviewed directly after it was collected to assess motion artifacts, incomplete volumes, and scanner artifacts to identify missing data.

Before the behavioral analyses were performed in Mango, the spatial normalization to the Talairach coordinate system was completed. The origin of each scan was validated and anatomical alignment was confirmed using the Mango software visualization tools to check and recheck each image (Lancaster et al., 2010; Zhao et al., 2024; Fascher et al., 2023). The spatial alignment of the images along the given axes of the image coordinates was completed to allow for accurate registration of the images to the defined coordinate axes for each axis. The ROI placement was consistent to maintain spatial drift and misregistration. The same ROI was used for all participants in keeping with defined working axes. This approach made sure that any variations in the neural activation of the vmPFC area were due to the subjective valuation of the participants and not any methodological inconsistencies (Knutson et al., 2007).

4.1.14 Preprocessing of Signals

Pre-processing refers to the cleaning of the data. This step is important because it helps to detect any noise or movement in the signal and reduce its impact on the data (Lindquist, 2008; Caballero-Gaudes and Reynolds, 2017). This helps to address different imaging problems that may result in artifacts and also assists in the anatomical localization of signals (Strother, 2006).

As a result, our fMRI data were preprocessed to ensure uniformity and precision, as well as consistency with the analysis software to be used in this study. Functional neuroimages were saved as NIfTI files, which are used for volumetric neuroimaging and facilitate various manipulation tasks.

The data was analysed using Mango (Multi-image Analysis GUI), a medical image viewer designed for research applications. It employs a wide range of features for the examination and manipulation of volumetric and 4D datasets, specification of analysis ROIs, and coordinates-based analysis for performing statistics (Lancaster et al., 2010; Zhao et al., 2024; Fascher et al., 2023). As discussed earlier, in this study, the Mango software was used with the Behavioral Analysis plugin.

Prior to performing any behavioral analysis, it was necessary to normalize each functional image to the Talairach brain space to ensure that all brain data from each participant aligned to a common framework. This was done using the Spatial Normalization (SN) plugin of Mango, which implements a three-step process of alignment:

1- Mid-sagittal alignment (1) – The manual transform editing tool is used in the 1st step to align the brain image mid-sagittal plain with the displayed mid-sagittal markers.

2- AC-PC and Origin alignment – The anterior commissure (AC) serves as the origin, and alignment targets, which include the corpus callosum, thalamus, superior colliculus, and cerebellum, are used to complete the AC- PC and origin alignment.

3- Scaling (3) – The bounding box is scaled to fit the Talairach standard template for final image alignment.

For any previously aligned datasets using the MNI template, Normalization was done after applying the MNI-to-Talairach transformation. After alignment, the origin point was confirmed (using Mango's "o" key) to check that it was correctly aligned as the plugin's calculations are contingent on proper spatial referencing. The signal for the ventromedial prefrontal cortex (vmPFC) ROI was characterized using the Reward/Gain category. This categorization was done using the behavioral analysis plugin of the Mango software, and it would help in the precise measurement of the neural activity linked to perceived value and decision-making processing of the brain (Fascher et al., 2023).

The only preprocessed data incorporated into the final analysis were those that satisfied all the quality and normalization constraints. Based on the preprocessing, the Z-scores were

assured to come from the Reward/Gain category for the advertisement of 25-30 seconds with active neural processing.

4.1.15 ROI (Region of Interest) Mapping

The Region of Interest (ROI) for this study was defined within the ventromedial prefrontal cortex (vmPFC), a region known for its role in representing subjective value and reward-based decision-making (Chib et al., 2009). Within the vmPFC, the focus was directed specifically toward the Reward/Gain category, which is conceptually linked to the neural encoding of desirability, value assessment, and motivational drive associated with premium products.

ROI mapping was performed on Mango Viewer after each participant's brain was spatially normalized to Talairach space (Lancaster et al., 2010; Zhao et al., 2024; Fascher et al., 2023). With Mango's ROI tool, the Reward/Gain region was manually digitized. For anatomical accuracy, the ROI was cross-verified and consistently placed for all normalized datasets.

Figure 3. ROI Mapping- vmPFC Region (Mango Viewer)

4.1.16 Key Comparisons and Analysis Focus

This study's principal analysis involved the correlation of self-reported purchase intent ratings to the vmPFC neural response. This analysis aimed to confirm if the intent to purchase the product was proportional to the neural activation in this reward-associated region of the brain. This comparison helps to complement the self-reported data and reveal the subconscious neural mechanisms that affect the purchasing decisions in the brain (Medina et al., 2020).

Each individual's z-score obtained from the Reward/Gain Region of Interest (ROI) was used as the neural metric for reward-related engagement. The Reward/Gain ROI z-scores were compared to purchase intent scores obtained right after the scan using Pearson correlation and

Spearman's rank correlation tests to assess statistical significance. The aim of using both these correlational analyses was to assess the relationship between the neural activity in the vmPFC region and the purchase intent of the individual, thus providing neurobiological validation for this behavioral value (Plassmann et al., 2007; Knutson et al., 2007). A positive correlation would imply that greater activations of the Reward/Gain vmPFC area are linked to greater motivational purchase intent.

Understanding this specific analytical lens enables the study to link neural mechanisms of valuation to actual, behavioral consumer choices, demonstrating how marketing stimulus of a certain value engages the psychological reward mechanisms of the consumer. Neural correlates of reward and gain processing suggest that the value of neural indicators is predictive of consumer preferences, particularly for high-value items.

4.1.17 Key Findings (Overview)

The analysis showed a very strong, positive correlation between the neural activation of vmPFC and the purchase intent of the iPhone 17 Pro Max. Pearson ($r = 0.93$, $p < .001$) and Spearman ($\rho = 0.96$, $p < .001$) confirmed that as the Reward/Gain area of the vmPFC was more activated, purchase intent increased as well.

The participants whose brains showed the strongest reward-related BOLD responses while the advertisement was being shown were the same ones who reported being more inclined toward purchasing the product in question. This was shown across both parametric and non-parametric analyses, confirming the validity of the results (Savva et al., 2019).

In simple terms, the brain's value system, specifically the reward system within the vmPFC, was in direct correspondence with the intention of the behavior, indicating that the advertisement activated the brain circuitry associated with the luxury consumer's desire, motivation, and reward.

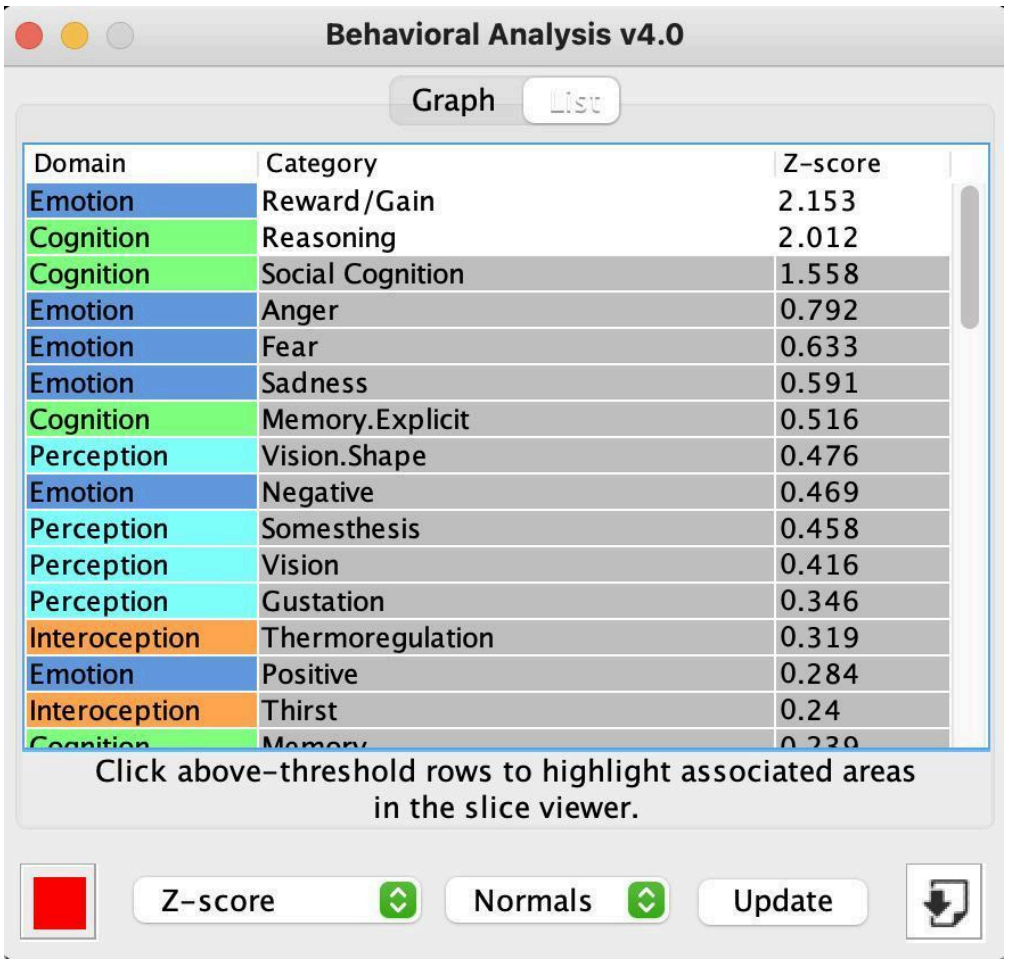

Figure 4. Behavioral Analysis Plugin (Mango Viewer) - Z-score (Reward/Gain)

4.1.18 Why This Matters

The implications of the results on consumer neuroscience and the marketing of luxury brands are clear. The vmPFC's reward and gain circuitry is instrumental in the processing of high-value product advertisements. This is evidence that luxury marketing appeals to the deeper reward system of the brain rather than the superficial aesthetics of the product. This phenomenon is validated by a study that showed the difference in the neural activity of prosocial and non-prosocial consumers when they assess the price of a product; the non-prosocial consumers showed more neural activity in the regions that are associated with value and reward, like the medial prefrontal cortex (Medina et al., 2020).

From a marketing perspective, this supports the understanding that premium consumers view premium offerings on a neurological level as a reward. In simple words, the perceived value of a product, which is influenced by cues like the price of the product and its brand, directly

affects the neural activities related to value and anticipated rewards (Medina et al., 2020). This neurological response, and its intensity, may be indicative of the effectiveness of an ad on the targeted audience. This means that when there is a psychological and a financial fit between a product and its consumer, the fit is also reflected in the reward signal in the vmPFC.

4.1.19 Limitations

The study encountered a few important limitations. To begin with, the recruitment of participants for the fMRI study was hindered due to the nature of the fMRI procedure. People in the potential study pool expressed considerable reluctance, primarily due to health risk concerns, the discomfort of remaining still for an extended period in an enclosed space, and the anxiety surrounding the overall scanning procedure. One of the most important recruitment challenges that limits the generalizability and the sample size of fMRI research is the anxiety people may experience because of the scanning procedure (Alsharif and Isa, 2024). Such practical challenges are common in fMRI. However, having a sample of eight participants is reasonable for exploratory fMRI studies, particularly for studies in neuromarketing, where the emphasis is on acquiring high-quality neuroimaging data rather than on large sample sizes.

Inherent limitations to fMRI scans include high cost, which limits sample size and repeat studies. Moreover, neural activity is indirectly measured by the BOLD signal, which provides a temporal delay that makes it important to carefully interpret the findings using accurate timings for cognitive processes (Audrin et al., 2017). The temporal resolution of fMRI is constrained by the hemodynamic response time (Glover, 2011). Furthermore, the BOLD signal is an indirect measure of neural activity because it does not directly measure neural firing, and it reflects blood oxygenation changes. fMRI also has other limitations, such as limited temporal resolution relative to other neuroimaging modalities, and the artificiality of the laboratory context is unlikely to match consumer experiences of the world.

4.1.20 Ethics

The goal of research ethics is to protect human subjects and inform them of their rights and the risks associated with their participation in a research project (Palmour et al., 2011). The study was conducted using ethical guidelines for research with humans. Informed consent was obtained after potential participants were fully briefed about the study purpose, the

procedures to be followed, and the risks involved, and were told of their right to withdraw at any time with no costs. To provide comfort to participants, breaks were allowed and the processes were explained clearly.

Research involving medical imaging often includes sensitive Protected Health Information (PHI) and Personally Identifiable Information (PII), which are regulated by the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA). Therefore, such data must be de-identified prior to use (Rempe et al., 2025). Consequently, personal data was anonymized and confidentiality was protected.

The study worked under the frameworks for safety, data protection, and the ethical treatment of human subjects. Attempts to ease discomfort and possible anxiety around the scan were part of the protocol. As anxiety and tight muscles can hinder the scan process, practical measures for easing the participant's nerves can be very helpful for achieving the required relaxation. This focus on participant comfort is important to avoid unwanted deteriorating motion artifacts on the images and to enhance the positive research experience for the participant (Davis et al., 2022).

4.1.21 Statistical Analysis

This section describes the statistical procedures used to examine the link between neural responses in the ventromedial prefrontal cortex (vmPFC) and self-reported intent to purchase. Initially, the descriptive statistics were calculated to capture the essential features of the sample. Further analyses were conducted using Pearson and Spearman correlation. All analyses were performed using IBM® SPSS® Statistics (the IBM® SPSS® software suite offers powerful statistical analysis).

The rationale for using both is that the z-score is continuous, whereas purchase intent is a variable assessed on a 7-point ordinal scale. Moreover, the responses given by a sample of participants did not satisfy the requirements of normality and linearity. As stated in Rovetta (2020), in cases of numerous distributions, both the Pearson and the Spearman correlation measures should be used.

4.1.22 Descriptive Statistics

Regarding Descriptive Statistics, we analyzed the distribution of both reward-gain z-scores for the vmPFC and the z-scores for the purchase intent ratings. We calculated the mean, median, mode, and standard deviation, as well as the minimum and maximum values, for a complete understanding of the variables in question. These summaries provided the necessary details for the forthcoming analysis of correlations to be undertaken, as central tendency and variability in the data had been established and would serve to infer the relationships that might exist between neural activation and purchase behavior. Audrin et al. (2017) focused on a similar descriptive approach by using average percentage signal changes and median splits to assess the neural activity of the participants during fMRI research.

	reward_gain_zscore	**purchase_intent_1_7**
Mean	2	5.75
Median	1.99	6
Mode	1.05	7
Std. Deviation	0.68	1.39
Minimum	1.05	3
Maximum	2.94	7

Table 1. Descriptive Statistics - fMRI Study

4.1.23 Pearson Correlation Analysis

A Pearson correlation was carried out to establish the existence of a positive correlation between the variables reward_gain_zscore and purchase_intent_1_7. The result indicated a positive correlation with a value of r = 0.93 and denoted a very strong association between the variables reward_gain_zscore and purchase_intent_1_7.

This means that, based on the sample provided in this study, reward_gain_zscore and purchase_intent_1_7 are positively and strongly associated.

In summary, the result of the Pearson correlation demonstrated that reward_gain_zscore was positively associated with purchase_intent_1_7, r(6) = 0.93, p = <.001.

Strength of correlation

The value of the correlation coefficient (r) indicates the strength of the relationship between two variables, i.e., very weak, weak, moderate, strong, and very strong.

Amount of r	**Strength of the correlation**
0.0 < 0.1	no correlation
0.1 < 0.3	low correlation
0.3 < 0.5	medium correlation
0.5 < 0.7	high correlation
0.7 < 1	very high correlation

Table 2. Strength of Correlation - fMRI Study

Hypotheses

The null hypothesis (no positive relationship) and the alternative hypothesis (positive relationship) are tested and summarized in this table.

Null hypothesis	**Alternative hypothesis**

There is no or a negative association between reward_gain_zscore and purchase_intent_1_7	There is a positive association between reward_gain_zscore and purchase_intent_1_7

Table 3. Hypothesis - fMRI Study

Correlation

Tables showed that the Pearson Correlation Coefficient (r) and the significance value (p) represented the strength and significance of the relationship between reward_gain_zscore and purchase_intent_1_7. Results showed that there is a very strong positive correlation, $r = .93$, $df = 6$, $p < .001$. Thus, the result indicates that the level of reward/gain activation in the vmPFC during ad viewing is positively linearly associated with self-reported purchase intent.

	r	**p**
reward_gain_zscore and purchase_intent_1_7	0.93	<.001

Table 4. Pearson Correlation Coefficient- fMRI Study

Interpretation

The effect size is large ($r^2 \approx .87$), meaning that 87% of the variance in purchase intent is explained by the variance in the Reward/Gain Z-score in this sample.

Together with the non-parametric Spearman result, these findings suggest that the vmPFC reward-value stronger signals suggest that there is greater purchase motivation toward a premium product among luxury buyers.

4.1.24 Spearman Correlation Analysis

This Spearman correlation coefficient can help to assess the interrelationship between two random variables in non-linear data (Thompson & Fransson, 2015; Savva et al., 201). This correlation, ρ (rho), was conducted to assess the strength of the correlation between reward_gain_zscore and purchase_intent_1_7. The correlation was found to be very strong and positive, with r = 0.96.

The result of the Spearman correlation determined the existence of a positive correlation between reward_gain_zscore and purchase_intent_1_7, r(6) = 0.96, p = <.001.

Correlation

Spearman's rank-order correlation was used to determine the monotonic association between reward_gain_zscore and purchase_intent_1_7. As the correlation was performed, a very strong positive correlation was found to be true, r□ = .96, df = 6, p < .001. This suggests that higher reward/gain activation in the vmPFC reliably corresponds to higher purchase intent across ranked observations. Given the small sample (n = 8) and the ordinal nature of the purchase-intent scale, this non-parametric result provides convergent support for the Pearson finding and is robust to normality assumptions.

	r	**p**
reward_gain_zscore and purchase_intent_1_7	0.96	<.001

Table 5. Spearman Correlation Coefficient - fMRI Study

Interpretation

The value of r□ = .96 is categorized as strong, which strengthens the hypothesis that those participants with higher Reward/Gain Z-scores indicated higher intent to purchase which further reinforces the hypothesis that the vmPFC reward valuation is an extent of consumer motivation to purchase a premium product.

4.1.25 Conclusion

This study attempted to answer a somewhat straightforward question: Does a premium audience exhibit stronger value signals in the brain when they look at a premium product advertisement, and does it correlate with their purported purchase intent? Prior works of research have shown how the vmPFC influences the subjective value by predicting purchase decisions (Knutson et al., 2007; Plassmann et al., 2008), and similar findings have been seen in luxury branding contexts (Audrin et al., 2017; Erk et al., 2002). We performed fMRI scans on eight Indian luxury buyers when they were shown a single advertisement of the iPhone 17 Pro Max (which lasts 25 to 30 seconds) and collected a purchase intent rating on a scale of 1 to 7, which was recorded post the scanning session, consistent with prior studies (Medina et al., 2020). The images were normalized to Talairach space and analyzed using the Behavior Analysis plugin to extract Reward/Gain Z-scores from a predetermined ROI of the vmPFC. These Z-scores represented the value ascribed by the participants to the advertisement as measured in neural activity.

The findings were unequivocal. The strong positive relationship between vmPFC Reward/Gain activation and purchase intent (Pearson $r = .93$ ($df = 6$, $p < .001$), Spearman $r = .96$ ($df = 6$, $p < .001$)) means that the more an ad registered as gain in the vmPFC, the higher the participant's stated purchase likelihood. This is consistent with the function of the VMPFC with respect to subjective value, willingness-to-pay, and the premium–premium match phenomenon (Chib et al., 2009). In this context, premium cues serve as reward-predictive signals for this cohort (luxury buyers × flagship products), and the vmPFC encodes that appraisal.

4.2 Study 2- Eye Tracking

4.2.1 Study Objective and Research Question

Eye-tracking refers to the recording of gaze points while observing stimuli or performing a task (Eye Tracking: A comprehensive guide to methods and measures). Systems that employ eye tracking determine Areas of Interest (AOIs) by analyzing a user's eye position, movement, and pupil size at a certain instant in time (Hasse and Bruder, 2015).

This eye-tracking study aims to examine how consumers scan customer reviews in online ads and the implications for their attention, perception, and purchase behavior. There are studies

in the past that have relied on respondents' self-reported data, which often overlook the unconscious cognitive aspects and the attention drives decision-making processes.

Within the framework of neuromarketing, eye-tracking in detail explains the quantitative aspects of attention, including fixation length and gaze sequence, which traditional methods do not capture. In simple words, Eye Tracking technology helps to understand where people actually look at when they see an ad rather than what they say they look at. This, in turn provides crucial insights into the processing of humans and their response to visual marketing stimuli (Suurmets, 2019; Henderson and Ferreira, 2004).

This study is focused on the Fastrack Limitless FS2 Pro Smartwatch ads shown in 2 different formats to the participants-

1- One will be a review ad, with a visible star rating and number of reviews.

2- The other ad will be a no-review ad, without any review callout.

The study was executed with a within-subjects approach, which means that each participant was shown both versions of the ads. Although prior research has studied how different ad components can affect consumer attention (Shen et al., 2020), this study specifically studies how customer reviews capture the attention of the people particularly within the context of smart watch

In this regard, the study will seek to answer:

Does the presence of customer reviews in advertisements increase their dwell time and intent to purchase when compared to ads without any reviews?

The main objective of the study is to see if reviews on ads impact the attention people give to the ad and whether they increase the intent to purchase or not.

4.2.2 Participants

In total, there were 45 participants in this study. The participants' ages ranged from 18 to 39, with an average age of 28.22 years (SD = 5.88). There was a reasonably equitable gender distribution (23 females, 22 males). To maintain the recruiting process practical while still capturing the audience of urban online shoppers, participants were selected from 3 cities in

India, namely, Hyderabad, Bengaluru and Mumbai. Each subject completed both versions of the task as part of a within-participant design.

Each subject viewed ads with customer reviews and then the same ads without reviews. Thus, the analyses pertain to the same individual rather than different groups. The main aim of this within-participant approach is to prevent any inter-individual differences. This further ensures that any differences in the visual attention and purchase intent are solely due to the digital cues presented in this experiment rather than the factors related to different subjects (Lee et al., 2025).

Viewing behavior was affected by covariates that were collected using a questionnaire made on Google Forms and used as demographics. The demographic factors include income (measured in 4 income brackets), total online shopping frequency on a 7-point scale, and price sensitivity on a 7-point scale.

The sample size was pre-set to fit the constraints of the neuromarketing lab while still retaining adequate power within subjects for the experimental conditions of the study. The participants gave informed consent, and all sessions made sure that participants' comfort, privacy, and withdrawal at any time was respected. Data were anonymized and stored by numeric participant ID only to protect confidentiality and to comply with ethical research practices. For the analysis, 7 participants were omitted because their dwell time was above the ceiling of 3 seconds; hence, the paired analysis set consisted of 38 participants (76 trials).

This unique sample remains salient and helps sustain the ecological and experimental validity of the study while still allowing for the research of consumer attention to digital ads.

4.2.3 Inclusion criteria

Available participants are those aged between 18 and 39, who are frequent users of digital media, and are purchasing from online retail platforms on a regular basis. Participants also had to have normal vision.

Participants wearing glasses were excluded from the study, but those with contact lenses were permitted (Trabulsi et al., 2021). Moreover, ethical guidelines were followed during the entire

study and data integrity was also maintained as per the procedures.(Medina et al., 2020; Egger and Florack, 2022; Zhou et al., 2020). As a result of this, all the participants provided informed consent before their participation and after they were told about the purpose and procedures of the study (Bagdziunaite, 2018; Escandón‐Barbosa et al., 2025).

4.2.4 Exclusion criteria

Exclusion was based on self-reported neurological or visual conditions capable of reducing eye-tracking accuracy, prior experience in marketing or design, and those unwilling to give informed consent. Furthermore, the accuracy of the data was ensured by excluding any participants who had excessive head movements during the calibration phase that resulted in irregular and inconsistent gaze patterns (Bagdziunaite, 2018).

These criteria were established to maintain an ideal sample of effortless consumer behavior and to maintain the quality of the data collected.

4.2.5 Lab and Experimental Setup

An enclosed room was used to conduct the eye-tracking study. This setup allowed for maintaining standard conditions and minimizing external distractions. Lighting was also maintained to minimize glare or shadows on the display screen, and ambient noise was also kept to a minimum so that participants could maintain focus throughout the entire session. The participants were allowed to sit in an adjustable chair that was set 60 centimeters away from a high-resolution monitor. This distance enabled movements that were comfortable, natural, and allowed to see all the elements on screen clearly.

Eye tracking at the time of the study was performed through a designated and secured tool called GazeRecorder, which is a video camera-based system for monitoring real-time gaze movement through the use of standard cameras. Both within academia and the office, systems have relied on GazeRecorder for ease of implementation in advertising, interface design, or cognitive analysis, providing adequate fixation and dwell time estimates without any fixation or tracking systems.

Before the main study, participants completed the calibration process, where they were expected to spend a period of two minutes in order for the software to be able to screen-eye position coordinates for tracker purposes (Boardman and McCormick, 2022). Calibration was done in case of any tracking instability for the sake of uniformly spatial data and general internal data quality (Trabulsi et al., 2021). This system was able to capture the fixation placement in addition to the duration of fixation, thus providing a time-oriented framework for each instance of monitoring the physical gaze.

The stimuli were on a 15.3-inch screen with a 2880 x 1864 resolution, a 60Hz refresh rate. The laptop's camera to perform the study was a 1080p FaceTime HD camera. Such parameters guaranteed smooth presentations and optimal timing. To facilitate unbiased data collection and remove any order effects, the participants were shown the advertisements in a random order (Trabulsi et al., 2021).

The tracking quality was also checked during the session to ensure proper alignment with the recording.

The process of validation and calibration is highly crucial in our study because utmost accuracy and precision is required when the main inference of our study relies on subtle differences in the visual attention and gaze patterns (Padikal et al., 2025). For the same reason, the calibration process was performed very carefully and it was repeated up to two additional times in case the first attempt was unsuccessful. At the same time, the participants were also instructed to be in a comfortable position so as to optimize the accuracy of the calibration (Bue, 2020).

The procedures outlined above ensured both comfort and control for the participants, provided homogeneous metrics for the entire cohort, and ensured that the data capture for the gaze behavior was unencumbered by undue technical detail.

4.2.6 Materials

The set of materials relied on two separate digital advertisements of the same product, the *Fastrack Limitless FS2 Pro Smartwatch*. These digital ads were portrayed within the scope of a realistic shopping task.

All participants were exposed to both versions of each ad. In the Review condition, the participants were exposed to the same product image and branding, but there was a star rating with the number of reviews within a specified target region. In the No-review condition, the participants were exposed to the same product image and branding, but this same area was left completely blank, with no review callout within the same region. All other elements were held constant, like image, brand logo, price block, and the ads' overall layout, so that any difference in attention was drawn to the target region rather than to other visual changes.

Figure 5. Review Ad - Fastrack Limitless FS2 Pro Smartwatch

Figure 6. No Review Ad - Fastrack Limitless FS2 Pro Smartwatch

To make sure that the results of our study solely relied on the effect of our digital cue, i.e., reviews, each ad was presented to the participants for a fixed time, after which an inter-stimulus interval was introduced to recenter the gaze of the participants. This also helped reduce any carryover effects in the study (Yin and Lee, 2023). Data reliability and integrity were further maintained by continuously monitoring the accuracy of each fixation and re-performing the calibration process again if there were any validation errors (Griffith et al., 2021; Shukla et al., 2018).

The target region was within the same location and orientation on both ads and was the same size on both ads, allowing for a direct measure of attention to “where the reviews would be”. Stimuli were held constant in on-screen resolution, uniform typography, and color palette. These assets were exported with matched pixel density to eliminate differences in sharpness and contrast that would affect salience differences. The two ads were presented in a random order within a single session so that no version was systematically or consistently presented first.
Subjects were told to evaluate the product in the context of a possible purchase.

4.2.7 Participant Instructions

Before the experiment started, participants were thoroughly informed about the functioning of the sensors and were also asked to be relaxed without changing their position during the study.

They were asked to remain still, as any movements of the head and the eyes would contaminate the gaze signal (Pauszek, 2023). Participants were free to take breaks between ads, and they had the option to cease participation any time they wished. In order to reduce response bias, participants were told that the study aimed to observe their natural viewing and decision behavior, and that there were no right or wrong answers. This instruction was highly important to be told because it made sure that the study was capturing authentic cognitive processes of the individuals and enhancing the ecological validity of the data collected (Suurmets, 2019).

They were told to look through each product ad as if buying something online. After each ad, they had to assess the likelihood of purchase on a scale from 1 to 7, where 1 means “not at all likely to purchase” and 7 means “extremely likely to purchase.”

4.2.8 Procedure

Each participant attended a one-on-one session of about 5 minutes duration, which included eye-tracker setup and calibration. Each session started with a 2-minute calibration phase during which participants used the GazeRecorder system and tried to align their gaze with the screen coordinates by following on-screen markers. Recalibration was done to eliminate any drift in eye-tracking accuracy (Sulikowski et al., 2022; Bue, 2020).

After this, participants received and viewed two versions of the same advertisement (Fastrack Limitless FS2 Pro Smartwatch): one version contained visible customer reviews, while the other did not. The order of ads presented was randomized to all participants to counter order effects.

Each advertisement appeared on the screen for a set time interval of ten to fifteen seconds. Once the participants viewed the advertisement, they rated their purchase intent on a scale of 1 to 7, where 1 meant “not at all likely to purchase” and 7 meant “extremely likely to purchase.”

This structure made sure that all participants were visually engaged in real-time, and their reactions were captured in real-time, with no lag and no prospective memory interference. The researcher facilitated the entire session to provide consistency in the rationale for the instruction, quality of the data, and the comfort of the participants.

4.2.9 Eye-Tracking Measures

This study utilized GazeRecorder to measure the eye-tracking data. It is a gaze tool that follows the gaze of users on particular, custom-defined, user-specified target areas on an image. For this study, the target area was the same for both versions of the advertisement. This helped to explore how eye-tracking can not just sustain consumer attention but can also attract more of it (Azmy et al., 2023).

It was the precise area where customer reviews appeared in the Review ad. In the No-review ad, this same area was empty, visually, but, for tracking purposes, was still the focus area. GazeRecorder captures gaze data only in the target-defined areas, and so the data analyzed in this study is relative to the matched region in both advertisements, referred to as the target region.

The main focus of analysis is Dwell Time, and for our purposes, we define it as the total time (in seconds) the participant’s eyes remained within this boundary during the display of the ad. This also serves as our primary variable for visual attention.

A secondary variable is First View, which measures the duration (in seconds) it takes for the participant’s gaze to enter the region after the ad is displayed. If the participant does not pay

attention to the region at all for the given condition, Dwell Time and First View will be recorded as 0.00 seconds. This serves as a reference point for the user interface and is thus not considered for statistical analysis.

Additionally, we also present Viewed By, which is the total number of users who at least once fixated within the given region of interest. This is done by counting all the participants whose Dwell Time was greater than 0 for a given condition:

- Viewed By (Review condition): 38 out of 40 participants (95.0%)
- Viewed By (No-review condition): 30 out of 40 participants (75.0%)

This indicates a wider capture of attention to the region of interest, revealing the total number of users who actually attempted to engage with the region of interest.

4.2.10 Behavioral Measure

After viewing each ad, participants were asked to rate how likely they would be to purchase the product using a scale from 1 to 7, with 1 meaning ‘not at all likely to purchase’ and 7 meaning ‘ extremely likely to purchase.’ In order to avoid memory bias and to be certain the answer given was based on an immediate impression, ratings were taken right after the participants viewed each ad.

Each participant gave one rating per condition (Review and No-review). This measure is a behavioral outcome, which allows us to explore how visual attention is related to interest in buying the product.

Though the self-reported purchase intent helps us know the immediate reactions of the participants, it does not always align with real-world behavior. Self-reported actions or behavior can never be equated with actual purchase or behavior (Viglia et al., 2021). This is what is referred to as the ‘attitude-behavior gap’, which can be defined as “the differences between what people say and what people do”. In fact, there has even been an explanation for this attitude-behavior gap, which is the tendency of the participants to give their response in a

manner that will be considered favorable by the people, just to adhere to the social desirability norm (Grimm, 2010).

4.2.11 Quality Control

To prevent irrelevant values, we applied an upper limit to the dwell time. Any participant whose gaze duration in the target region exceeded 3.00 s was excluded from confirmatory analyses. The simple reason behind doing this was that such long dwell times may probably refer to an error in the tracking data or a disengagement from the participant's side, rather than longer attention (Gulhan et al., 2021). This led to the removal of 7 participants (pid 4, 9, 15, 23, 30, 36, and 41). Thus, the final set for statistical analysis consists of 38 participants (76 trials).

A participant was said to have not viewed the target region in a condition when dwell time and First view are 0.00 s. These zeros were treated as valid data. As a result, the review target region was viewed by 43 participants out of 45, whereas the non-review (descriptive) target region was viewed by 35 participants out of 45.

4.2.12 Rationale

Perception and eye tracking have always been interrelated and eye tracking has been the focus of various perceptual studies (Lima and Ventura, 2023).

The eyes don't just help us see but can also convey information (Wu et al., 2014). Yarbus, in his book Eye Movements and Vision (1968), spends 4 out of 7 chapters on the relation between the features of stimuli and eye movements.

Hence, eye tracking is quite important as research in this neuromarketing field adds a variety of new ways to collect data to learn how humans experience the world through their lens (Tatler, 2014). The main variable of eye tracking, which is visual attention, should not just be considered a gateway of information regarding higher-order cognitive processing, but also the main coordinating mechanism to process this information over time (LaBerge, 1995; Wedel & Pieters, 2008).

Following this line of research, the present study used eye tracking to understand the effect of a specific stimulus, a review and its absence, on visual attention.

But in order to capture this relationship in a meaningful way, a number of quality thresholds in the data must be set. These rules were set in our study to maintain the clarity and defensibility of the results. While interpreting the raw gaze data of eye tracking, the inclusion of any noise can distort it and lead to unreliable results. Hence, a minimum threshold was required to maintain the accuracy of the results (Morando et al., 2019).

The 3.00 s upper limit on Dwell time eliminates excessive durations spent gazing, which is predominantly due to tracking malfunction or abnormal fixation that tends to skew comparisons. This exclusion is to safeguard the estimate of how much attention the target region receives during typical viewing. Longer gaze times, anyhow, reflect a disengagement from the task or an error in the tracking data and not sustained attention (Gulhan et al., 2021).

Our approach was a within-participant comparison. Data were treated as within participants because each person was shown both versions (Review and No-review), and the most appropriate comparison is to have that participant compared to themselves for each version. If one condition for a participant is invalid, then that pair is not appropriate for the confirmatory test and the pair is not suitable for the confirmatory test.

The need for complete pairs ensures that the differences reported pertain to the same individuals across conditions and that the statistical comparisons are clear and interpretable. This pairing approach ensures that the statistical analysis reflects within-person variations and does not reflect any biases from comparing across unmatched participants.

4.2.13 Data Collection and Guardrails

System and recording

The software GazeRecorder enables tracking gaze direction via the laptop camera. In each of two conditions for each advertisement, gaze was confined to a single area of interest (AOI), known as the target region.

The dataset contains 3 gaze measures from the software, out of which 1 is the main variable used for statistical analysis, namely Dwell Time, and the other ones are secondary variables used for descriptive analysis only, namely First View and Viewed By.

The variable, ‘Dwell time’, measures the duration a gaze remains fixated within the area of interest; hence, it is the primary outcome. The measure ‘First View’ captures the time interval from the start of the ad to the instance the ad is first looked at within the AOI target region (lower values indicate faster orienting). We also look at ‘Viewed By’ as a descriptive measure to report the number of participants for whom the AOI target region was looked at at least once during each condition (this has been prepared for the entire recruited sample).

The additional metrics used in the eye tracking study help us know about the cognitive processing of participants and how it shifts their attention across the eye (Cortiñas et al., 2019). The basic idea behind this Eye-Mind Hypothesis is very simple. If people look at a particular spot and fixate their eyes on it, it simply means that their attention and even cognitive processing are focused on it (Boardman and McCormick, 2022).

The dataset of this study is placed in Appendix C along with the meaning of the variables used.

Guardrails for data quality

Each session started with calibration and validation, which took less than 2 minutes.

Calibration refers to the process by which an eye tracking system assigns a mapping function to the coordinates associated with the gaze of the eye and the coordinates of a gaze point in the visual field (Harezlak et al., 2014). In this case, the mapping function is where the user has to fixate continuously on a given target for a full period the target is displayed, owing to the engagement and cooperation of the user in the calibration procedure. Most eye tracking use cases must be user calibrated owing to differences in eye attributes and geometrical parameters of an eye tracking system (Adhanom et al., 2023).

In our study, the participants performed calibration and re-calibration by following targets on screens. Subjects sat in a chair with a headrest, so that the eye-tracking could map the position of the eyes with the limited movements of the head. After the targets were moved on

the screen, brief movements of the head were made to check, and head movements were done only after calibration was done. Re-calibration was done whenever there was a drift. (Sulikowski et al., 2022; Bue, 2020).

For the exclusion rule, unusually long looks were flagged. Any trial with more than 3 seconds of dwell time was excluded from the confirmatory analyses. No other data was processed in any other way, except under numeric participant IDs, which were stored on the encrypted lab. The typical viewing distance of about 60 cm was used as it was within the recommended range for the system to work with (40-95 cm).

4.2.14 AOI Mapping

In our work, all valid fixations were mapped to the AOI target region, which occupies identical coordinates across both ads. From these fixations, we mapped the different metrics computed for each ad. After applying the rules in the exclusion criteria, the cleaned dataset retained observations for both conditions, one for the Review ad, and the other for the No-review ad. No other spatial smoothing or resampling was done, other than the artifact handling described here, retaining the temporal resolution for the analysis.

4.2.15 Key Comparisons and Analysis Focus

In this case, the confirmatory contrast focused on whether placing reviews on the AOI target region captured a statistically significant difference in the viewing attention (Šola, Qureshi and Khawaja, 2024).

The design was within participants, and so paired comparisons were run on the cleaned dataset (38 participants, 76 trials), and condition-wise descriptives were reported separately. For context, Viewed By is reported on the full recruited sample and describes how many participants looked at the AOI target region at least once. Moreover, ‘Viewed By’ and ‘First View’ are descriptive in nature and have no value in inferential testing. Covariates (income bracket, shopping frequency, price sensitivity, city) were retained for potential exploratory reads and were not part of the confirmatory tests.

4.2.16 Key Findings (Overview)

The findings of this study are quite evident. It shows that customer reviews, when placed in digital ads, can significantly amplify the visual attention given to the ad as well as increase the purchase intent. Across all the participants, the dwell time in the review region was significantly higher when compared to the dwell time in the no-review region. This is enough to substantiate the fact that sustained user attention is given to the area with the reviews. In simple words, if the dwell time at a particular region is high, then it means that the subject paid greater attention to that particular area (*Analysis of Visual Strategy and Advertising Effectiveness on Streaming Esports Viewers*, 2024).

At the same time, the Purchase Intent ratings were higher for the Review Condition when compared to the No Review Condition. Moreover, effect sizes, according to Cohen (1988), were large in both Dwell Time and Purchase Intent statistical tests, which confirms that the influence of reviews is not just significant but also meaningful in practical life.

Moreover, the first view duration did not differ significantly between conditions because it was skewed by the higher number of zeros in the no-review condition. The reason behind this is that 10 participants did not view the no-review condition at all. As a result, their zeroes in the First view gave the perception that people looked at the no-review AOI quicker when compared to the review region.

Other than this, the overall visibility of the review area was comparatively higher when compared to the no-review version. Together, these findings show that reviews not just attract more viewers but also hold consumers' attention for a longer time, thus increasing the likelihood of purchasing the product.

Figure 7. Review Ad Result - Dwell Time, First View & Viewed By

Figure 8. Review Ad Result - Heatmap

Figure 9. No-Review Ad Result - Dwell Time, First View & Viewed By

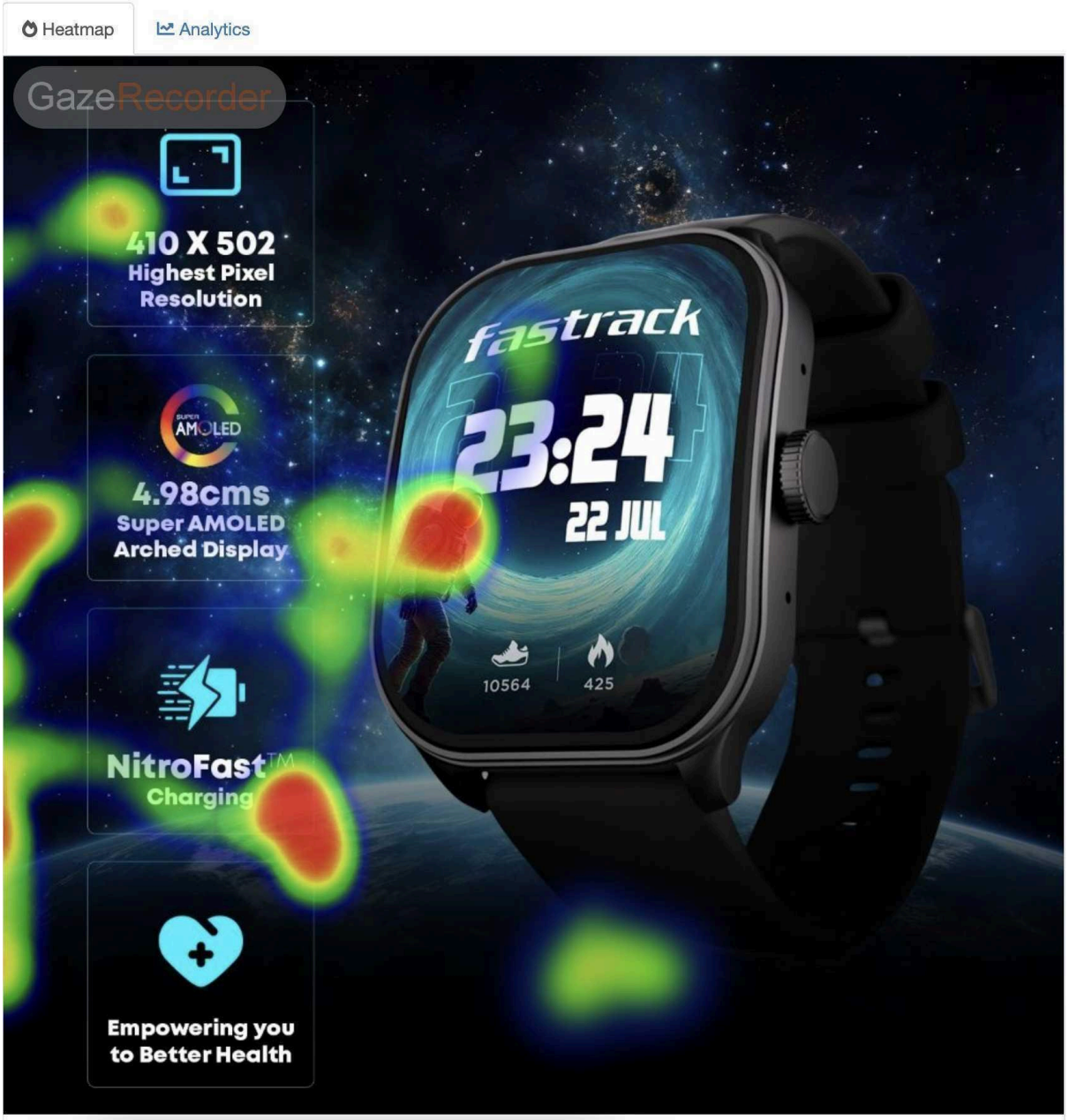

Figure 10. No-Review Ad Result - Heatmap

4.2.17 Why This Matters

From rapid evaluations on the internet, it's understood that even fractions of a second can determine what is given attention (Lindgaard et al., 2006). In e-commerce and digital ads, these micro-decisions can impact larger outcomes.

Apart from helping us see, the movement of the eyes also performs the function of comprehension. In other words, during conversation, the ability to move the eyes is not only

important for an individual to focus on a person or an object, but can also convey a message (Gobel et al., 2015).

In our context, reviews located in a prominent position on a screen led to greater purchase intentions and increased the percentage of viewers who fixated on that area at least once. The timing of the ‘First view’ did not change, but the overall effect was practical. This inference is further supported by Riswanto et al. (2024), who found that elements in the ads related to product information or promotional content can help increase engagement and fixation duration, thus showing how these cues incentivise purchase intention.

Thus, it is advisable to place the reviews in a highlighted area rather than leaving the place blank. This choice of design improves engagement in areas where it is needed the most and provides support to conversion-relevant signals.

This implies that the social proof on digital ads is not merely for decoration. It also affects the behavior of the viewers. It guides the eyes and influences choices, even within a brief 10–15 second window of time. The lesson for marketers and UX designers is obvious. Always position the star rating and review amount in the ad in a constant and high-visibility area, and do not leave that space empty. Let the reviews be seen and immediately acted on. This helps improve the viewers' attention span, which in turn improves their visibility and relevance of conversion.

4.2.18 Limitations

While the research provides a compelling case for the impact of reviews in digital advertising, there are research gaps that need to be addressed.

The research sample had image static ads that did not scroll and had no interaction. User attention during natural browsing phases tends to be segmented due to the presence of interactivity, the browsing surface, and self-tasking. This is what makes it difficult to keep a controlled environment.

Second, the duration of exposure was limited to a range of 10–15 seconds. Although it standardizes exposure, it restricts the range of natural viewing behaviors, where a user might spend less than a second or much longer, depending on the context and situation.

Third, there was only one product tested across two ad formats. Other categories of products, such as high-involvement or emotional products, and different advertising formats could elicit different patterns of gaze and corresponding behaviors.

Fourth, the rating of purchase intent was self-reported and done immediately after each advertisement. Although this eliminates the effects of recall bias, it is still a theoretical intent and does not reflect actual behavior (Boardman and McCormick, 2022; Viglia et al., 2021). More realistic purchasing tendencies could be measured by including clicks, actual choices, or decisions framed in a way that simulates purchasing behavior.

Fifth, the sample consisted only of urban Indians, 18 to 39 years of age, and so the results may not apply to older, rural Indians or to other cultures. The product category (smartwatch) also places limitations on interpretation. As a result, future studies should be conducted using a wide array of product categories, including both hedonic and utilitarian products. This will help explore how the testimonials can affect purchase intent and visual attention in different categories of the products (Riswanto et al., 2024).

Finally, the confirmatory analysis of 7 participants was lost due to their Dwell Time (>3.00 s) being extremely high, which in turn eliminates a portion of the sample. Regardless, the within-subject design maintained the level of statistical power.

4.2.19 Ethics

The majority of users do not understand how sensitive their gaze data is or the implications their actions, preferences, or emotions can correlate with eye movement data (Alsakar et al., 2023). As a result, we made it a priority to raise awareness amongst the participants and inform them about the nature of eye tracking. Once this was done, we asked the participants to provide informed consent for the same.

Furthermore, participants were told that they have the ability to pause or withdraw from the study without any consequences truly anytime.

This approach to consent is just one part of a broader ethical obligation. In the age of data as currency, we should use techniques of privacy to preserve user data and ensure there is minimal user harm.

Differential privacy, localised processing, and data anonymization are examples of techniques that can greatly mitigate risk exposure and are already proving to be effective (Agrawal and Srikant, 2000; Steil et al., 2019; Bozkir et al., 2021).

As a result, the data set was anonymized and could only be accessed in encrypted storage systems with restricted access, where only aggregated data were reported. The materials used were neutral in context regarding the consumers. The total duration of the session was approximately 5 minutes and the participants had the freedom to rest to reduce eye strain. There was no deception in the process.

4.2.20 Statistical Analysis

All statistics were evaluated to determine the effect of a customer review on a digital ad's dwell time (visual attention) and Purchase Intent. Each subject was assigned to two ad conditions (review present and review absent), thus allowing for within-subject comparisons of both scenarios. As discussed earlier, the within-subject approach reduces any inter-participant variability so that the results are solely the effect of the digital cue and stimulus of the study (Viglia et al., 2021).

Two important variables were analyzed. First, Dwell Time, which is used to indicate visual attention and is measured using eye-tracking technology, and second, Purchase Intent, which is assessed through self-reporting. Given that both conditions were evaluated from the same respondent, dependent sample comparisons were utilized.

The data set was examined for outliers. 7 subjects (participant IDs 4, 9, 15, 23, 30, 36, and 41) were removed from the sample because their Dwell Time metrics for one or both conditions exceeded 3 seconds, which indicates a potential technological disconnect or irregular interaction with the ad.

The final statistical analysis for 38 subjects used the Wilcoxon signed-rank test to determine differences in the Review and No Review conditions for both dependent variables. All

statistical analyses were performed on the dataset using the IBM® SPSS® platform (the IBM SPSS software platform offers enhanced statistical analysis tools).

4.2.21 Descriptive Statistics

	DwellTime_Review	**FirstView_Review**	**PurchaseIntent_Review**	**DwellTime_NoReview**	**FirstView_NoReview**	**PurchaseIntent_NoReview**
Mean	1.47	0.74	4.76	0.49	0.61	3.87
Median	1.53	0.82	5	0.43	0.74	4
Mode	1.41	0	5	0	0	4
Std. Deviation	0.48	0.29	1.15	0.45	0.41	0.88
Minimum	0	0	3	0	0	2
Maximum	2.47	1.17	7	1.36	1.32	5

Table 6. Descriptive Statistics - Eye-Tracking Study

The descriptive statistics of the variables of consideration in this study, encompassing Dwell Time, First View Duration, and Purchase Intent, for both the Review and No Review conditions are shown in Table 1. This is the final dataset of 38 valid participants, excluding Participant IDs 4, 9, 15, 23, 30, 36 and 41, who were considered outliers owing to Dwell time exceeding three seconds.

The table illustrates that on average, participants looked at the ad with reviews more (M = 1.47, SD = 0.48) than the one without reviews (M = 0.49, SD = 0.46). This means that there was more visual attention towards the ad with the reviews. In addition, the mean Purchase intent was also higher in the Review condition (M = 4.76, SD = 1.15) than in the No Review

condition (M = 3.87, SD = 0.88). This shows that reviews contributed positively to the participants' Purchase Intent.

Moreover, as we can see, the FirstView_Review mean is 0.74 and the FirstView_NoReview mean is 0.61. Now, since the FirstView_NoReview mean is lower than the FirstView_Review mean, we get the perception that people looked at the no-review AOI quicker when compared to the review region. However, this is incorrect because 10 participants didn't even look at the no-review region even once. As a result of this, the FirstView_NoReview times of these 10 participants were 0.

These zeroes were responsible for bringing down the value of the mean, and hence, the mean is skewed by them. On the other hand, more participants looked at the review region (only 2 did not), as a result of which, the FirstView_Review is higher.

Condition	**Viewed_by**	**Total**	**Percent**
Review	43	45	95.6%
NoReview	35	45	77.8%

Table 7. 'Viewed By' - Eye Tracking Study

Descriptive statistics of how many participants viewed the target area of interest (AOI) in the various ad conditions are provided in Table 2. This table includes all 45 participants, including the 7 participants who were eventually eliminated from inferential statistical analyses. This is to give a total view of the visibility of the stimulus. Dwell time/ First view zeros correspond to the participants who didn't view the ad.

According to the findings, 95.6% of the subjects watched the ad with the review, while only 77.8% watched the ad without the review. This indicates that review ads not only attracted more viewers but also enjoyed better visibility in the entire sample.

4.2.22 Wilcoxon Signed-Rank Test – Dwell Time

The Wilcoxon signed rank test is a non-parametric statistical method that is used for the analysis of two related or matched samples (Rosner, Glynn and Lee, 2006). The test focuses on the paired observations and assesses the statistically meaningful median difference. This test is particularly useful when the data do not comply with the normality conditions required for a paired sample t-test. Instead of the raw values, this method involves the ranks of the differences between pairs, making it a powerful method against outliers and skewed distributions.

Test Rationale

The purpose of this analysis was to find out whether customer reviews in digital advertisements increased Dwell Time.

Dwell Time refers to the total amount of time (in seconds) that any given user spent looking at the advertisement within the defined target AOIs. The greater the dwell time, the more attention and deeper visual focus was given to the content of the advertisement (*Analysis of Visual Strategy and Advertising Effectiveness on Streaming Esports Viewers*, 2024)

Since each participant was exposed to both ad conditions (Review and No-Review), the study was within-subjects and the Wilcoxon signed-rank was employed to analyze the paired samples.

Hypothesis

Null hypothesis	**Alternative hypothesis**
The variable *DwellTime_Review* has smaller or equal values than the variable *DwellTime_NoReview*.	The variable *DwellTime_Review* has larger values than the variable *DwellTime_NoReview*.

Table 8. Dwell Time Hypothesis - Eye Tracking Study

Ranks

		N	Mean Rank	Sum of Ranks
DwellTime_Review - DwellTime_NoReview	Negative Ranks	1	25	25
	Positive Ranks	36	18.83	678
	Ties	1		
	Total	38		

Table 9. Wilcoxon Signed-Rank (Dwell Time) - Eye Tracking Study

The analysis compared Dwell Time across both conditions (Review and No-Review).

- **Positive Ranks:** DwellTime_Review > DwellTime_NoReview

  Positive ranks suggest that the participant's gaze was directed to the ad longer in the Review condition.

- **Negative Ranks**: DwellTime_Review < DwellTime_NoReview

  Negative ranks suggest that the participant had longer gaze times in the No-Review condition.

- **Ties:** DwellTime_Review = DwellTime_NoReview

  Ties indicate both conditions had equivalent gaze dwell times.

As discussed earlier, the analysis included 38 participants, having excluded Participant IDs 4, 9, 15, 23, 30, 36, and 41. Of the 38 participants, 36 had greater dwell times in the Review

condition (Positive Ranks), 1 had greater dwell times in the No-Review condition (Negative Rank), and 1 participant had equal dwell times (tie).

Effect size

The effect size r is 0.8.

|r| < 0.1	no effect / very small effect
|r| = 0.1	small effect
|r| = 0.3	medium effect
|r| = 0.5	large effect

Table 10. Effect Size r According to Cohen (1988)

Results of the test

	+W	**z**	**p**	**r**
DwellTime_Review - DwellTime_NoReview	678	4.93	<.001	0.8

Table 11. Wilcoxon Signed-Rank Test - Dwell Time Results

The test was statistically significant, with W = 678, z = 4.93, p <.001, and a large effect size, r = 0.8.

- W refers to a Wilcoxon test statistic, which denotes the sum of ranks for the less frequent condition.

- Z denotes the standardized test statistic, which shows the extent to which a particular result diverges from the null hypothesis, under a standard normal distribution.
- P is the argument of the probability value; statistically, the result is significant when p is less than .05.
- While r in effect size is defined as the strength or magnitude of difference that is observed as a result.

According to the book, Statistical power analysis for the behavioral sciences by Cohen (1988), Small effects have an r value of 0.1, a medium effect is 0.3, a large effect is 0.5 and above. In this light, r = 0.8 is taken to mean a large effect. So, the difference between the two ad conditions was large and of practical significance.

Participants spent more time on ads which included customer reviews as evidenced by the longer dwell time in the Review condition (Median= 1.53) compared to the No-Review condition (Median = 0.44).

Interpretation

The data clearly demonstrate that customer reviews increased attention toward the digital advertisement. The effect size suggests that this is not only statistically significant, but that this difference is also substantial.

Simply put, people spent more attention on ads that included customer reviews, which indicates that these elements are important for audience attention engagement.

4.2.23 Wilcoxon Signed-Rank Test - Purchase intent

The Wilcoxon test has been used in this study because prior research shows that the dwell times of non-normally distributed ocular data can be most appropriately analyzed using non-parametric methods like this Wilcoxon test (Mandolfo et al., 2024; Ruytenbeek et al., 2021). When compared to other non-parametric tests, the Wilcoxon Signed Rank Test is given priority because it has a higher statistical power and can help to test the magnitude of differences between paired observations.

Test Rationale

The aim of this analysis is to assess whether customer reviews included in digital advertisements increased the purchase intent of the participants.

Purchase intent was assessed using participants' self-rated likelihood of buying the advertised product on a 7-point Likert scale. Higher values reflect higher purchase motivation or willingness to buy the product.

Given that every participant rated both ad conditions (Review and No Review), the Wilcoxon signed rank test was again used to assess the paired observations.

Hypotheses

Null hypothesis	**Alternative hypothesis**
The variable *PurchaseIntent_Review* has smaller or equal values than the variable *PurchaseIntent_NoReview*.	The variable *PurchaseIntent_Review* has larger values than the variable *PurchaseIntent_NoReview*.

Table 12. Purchase Intent Hypothesis - Eye Tracking Study

Ranks

		N	Mean Rank	Sum of Ranks
PurchaseIntent_Review - PurchaseIntent_NoReview	Negative Ranks	4	15.5	62
	Positive Ranks	25	14.92	373
	Ties	9		
	Total	38		

Table 13. Wilcoxon Signed-Rank (Purchase Intent) - Eye Tracking Study

The analysis assessed Purchase Intent scores in the Review and No Review conditions for all participants (N = 38).

- Positive Ranks: PurchaseIntent_Review > PurchaseIntent_NoReview
  Positive ranks show participants who indicated higher purchase intent for the Review ad.
- Negative Ranks: PurchaseIntent_Review < PurchaseIntent_NoReview
  Negative ranks suggest an increased level of purchase intent for the No Review advertisement.
- Ties: PurchaseIntent_Review = PurchaseIntent_NoReview
  Ties show that both conditions received the same rating.

Of the 38 participants, 25 subjects' intent was greater to purchase the product in the Review condition, 4 subjects' intent was greater in the No Review condition, and 9 had no difference between the two.

Effect size

The effect size *r* is 0.56.

Results Of The Test

	W	z	p	r
PurchaseIntent_Review - PurchaseIntent_NoReview	373	3.47	<.001	0.56

Table 14. Wilcoxon Signed-Rank Test - Purchase Intent Results

Results

The Wilcoxon signed-rank test showed that the Review and No Review conditions differed significantly, W = 373, z = 3.47, p < .001. Effect size, r, is 0.56.

The obtained result reinforces the conclusion that not only is the difference between the two conditions statistically significant, the difference is large enough to be of practical importance.

This difference adds to the finding in this study that a median Purchase Intent for the Review condition (Mdn = 5) is greater than the No-Review condition (Mdn = 4) indicating that participants purchase more when ads show customer reviews.

Interpretation

The findings corroborate that participants' intent to buy was significantly increased through customer reviews. Compared to ads without reviews, ads that contained customer reviews were far more convincing and impactful in driving purchase intent. The sizable effect further emphasizes that reviews profoundly and materially shape consumer behavior.

Prior research in consumer psychology has also shown that due to the phenomenon of "social proof", people tend to trust what others say, especially in relatable cases. As a result, they may look for feedback from others so as to guide their own decision-making. Considering this in the context of online shopping, feedback in the form of customer testimonials and reviews serves as this social proof, which can help reduce any uncertainty during the buying decision and thus give a sense of reassurance to the consumers (Saikiran, 2025).

4.2.24 Conclusion

What this study set out to achieve was quite straightforward. It tested the hypothesis that whether reviews that appear on a product advertisement change the way people interact with an advertisement and does that change affect what they claim they 'would purchase'? From a within-participant design study, the answer is pretty much affirmative and conclusive. The people that viewed reviews appeared to spend more time engaged with the ad and were more likely to purchase the product (Riswanto et al., 2024; Chen et al., 2022).

As a general trend, median dwell time was more in the Review condition (1.53 seconds) when compared to the No-Review condition (0.44 seconds). This was verified by the Wilcoxon signed-rank test as the difference was statistically significant **(**$W = 678$, $z = 4.93$, $p < .001$, $r = 0.8$).

It should also be noted that the visibility of the review area was more than the no-review region. 43 out of 45 participants (95.6%) with the reviews looked at the target region at least once, whereas 35 out of 45 (or 77.8%) without them looked at the area. This is another clear sign that shows how reviews not only attract attention for a longer time but are also more likely to be noticed in the first instance itself.

As a result of this study, the implications for design practice are quite conclusive. For better user engagement, put a star rating and number of reviews in a key visual area. When reviews are visible at a glance, they amplify sustained attention and also show a meaningful increase in claimed purchase intent.

These conclusions exist with well-defined boundaries. This study aimed to analyse whether a single exposure to a single product, which in this study was the Fastrack Limitless FS2 Pro Smartwatch, could influence the self-reported purchase in individuals. However, self-reported intent cannot be considered equal to actual buying behavior. Hence, the approach was digital, and the generalization would be similar in nature.

The interpretation from this study is quite obvious. First, the same setup with an incentivized or real choice, to measure whether the intent lift converts, has to be done to understand action from attention. Then the placement and content should be tested. Measure the change in the size and placement of review elements, the number of reviews for different products, and the number of exposures to understand design elements that bias attention and intent.

In simple words, sets of reviews being visible instantly increases sustained attention on the region of interest and increases the likelihood of purchase. The timing of the very first look did not change reliably here, but more people looked where reviews appeared, and those who did tended to stay longer.

4.3 Study 3- GSR (Galvanic Skin Response)

4.3.1 Study Objective and Research Question

Galvanic skin response, GSR, or electrodermal activity, measures the variations in the electrical conductance of the skin as a result of the activity in the eccrine-sweat gland of the body. Since this activity is regulated by the Sympathetic Nervous System, GSR is a very

reliable indicator of emotional regulation and physiological arousal (Sharma et al., 2019; Villanueva et al., 2016).

In simple words, if there is an increase in the activity of the Sympathetic Nervous System, it will result in an amplified secretion of the sweat glands, which in turn will reduce the resistance of the skin and enhance the electrodermal activity (Holper et al., 2014; Mee et al., 2021).

The process of GSR can be better understood by understanding the science behind it. If any stimulus, be it a living or a non-living cue, is of significance to the human body, then it results in an amplified emotional arousal. This happens because the brain sends a signal to the eccrine sweat glands using the sympathetic branch of the autonomic nervous system to activate them (Dawson et al., 2007). GSR can be determined when the skin is subjected to a small electric current and the skin's resistance to the current is gauged between two electrodes (Can et al., 2019).

The aim of this study is to investigate the processes involved in emotional arousal when participants view an advertisement for Samsung Galaxy M06 5G, and the advertisement includes discount and time-limited offer cues.

Emotional arousal in this study was quantified using the Grove GSR Sensor, which measures skin resistance through an analog voltage signal. These resistance values are then converted into skin conductance, known as Skin Conductance level (SCL), which has proven to be one of the most reliable measures of the activity of the sympathetic nervous system and emotional arousal.

The value of this approach is in the attempt to measure non-conscious emotional responses that people may not express through words or facial expressions and are often absent from conscious self-reports. This study's intention is to find out whether discounts and time-limited promotional offers create more promotional emotional responses, and whether there is a higher intention to purchase the product associated with stronger emotional responses. GSR is a non-invasive physiological process that can give detailed insights into the emotional processing of the human body, which otherwise might have remained undetected (Caruelle et al., 2019).

This study seeks to answer the following question-

Is there a higher Skin Conductance Level (SCL) in the participants when viewing the Samsung Galaxy M06 5G advertisement with a discount and a limited-time offer, and does this increase in physiological arousal relate positively to self-reported purchase intent?

4.3.2 Participants

The sample consisted of 23 participants (n = 23), aged between 20 and 35 years (M = 27.2, SD = 4.8). Each of the participants was screened to ensure they satisfied the nominal inclusion criteria and were willing to take part in a neuromarketing study. The recruitment strategy used was voluntary and was based on self-selection, where no previous technical or marketing experience was needed.

Before the experiment, relevant demographic and behavioral data were self-reported by each participant on a pre-screening questionnaire designed on Google Forms. The questionnaire captured data such as income (which was categorized into four income brackets), frequency of online shopping (which was assessed on a seven-point scale), and sensitivity to price (which was assessed on a seven-point scale). This data was aimed towards building the participant profile and ascertaining that the sample constituted active users of the internet who were exposed to digital advertisements regularly.

Every participant in the study viewed the same advertisement, the promotional advertisement for the Samsung Galaxy M06 5G**,** which included discount and limited-time offer elements. Two participants were out of the analysis because of data quality. One was considered an outlier because of extremely high SCL with an abnormal physiological state (Participant ID 19, 29.01 microsiemens), and the other was due to the absence of any measurable response (Participant ID 22; near-calibration readings throughout). Pre-processing and synchronizing the data is crucial to ensure data reliability so that the relationship between the marketing cue (urgency in our case) and the physiological responses is 100% accurate (Strle et al., 2023). The final analytic sample consisted of n=21.

Figure 11. Samsung Galaxy M06 5G Ad - GSR Study Stimulus

4.3.3 Inclusion Criteria

The sample for this study was confined to participants within certain parameters to enhance the validity of the GSR readings and the uniformity of the behavioral records. Individuals within the age limit of 20 and 35 were included to portray a segment of the consumer population who are young adults and active smartphone users and digital advertisement consumers. Only participants who indicated regular exposure to advertising and were familiar with e-commerce were included in the study, since this guaranteed relevance to the advertisement content being evaluated.

The participants were also required to be healthy individuals (Walla et al., 2011) since the GSR electrodes were to be placed on the index and the middle fingers of one hand in order to

respond to the electrical signals emanating from the skin surface. Participants were required to be free from certain pathologies (e.g., schizophrenia, anxiety) that could influence perspiration or skin conductance (Boucsein, 2012). Also, participants were asked to refrain from having any caffeinated or alcoholic drinks for a period of not less than two hours to the start of the session because those things affect the physiological arousal condition and the skin temperature (Sonkusare et al., 2021).

For all the participants, there was a mandatory requirement to provide an informed consent form prior to the session, and they were asked to obey all instructions that governed the conduct of that session.

4.3.4 Exclusion Criteria

Participants were excluded from the study if they were unable to participate due to any medical or psychological conditions that might affect the precision of the emotional responses or the measurements taken during GSR. These all included persons who possessed skin ailments such as skin allergies, open wounds, or hyperhidrosis (excessive sweating) of the hands, as these were known to interfere with the psychophysiological phenomena of galvanic skin responses (GSR). Furthermore, participants who were on medications were excluded from the study to avoid any external factors from influencing the arousal and skin conductance measurements (Thuillard and Dan‐Glauser, 2017).

Participants with any past or present neuropsychiatric conditions, as well as individuals with autonomic pharmacology, were screened out in order to minimize the unwanted emotional and physiological biases of arousal in emotional response measurement. In simple words, participants with good health were only selected (Thuillard and Dan‐Glauser, 2017).

Participants who experienced sensor discomfort, those who were anxious in laboratory settings, or unable to hold still for the duration of the short measurement period were excluded from the study as well. Also, those who did not follow the pre-session guidelines, such as not refraining from alcohol or caffeine before attending the session, were not considered for the final data set in order to enhance the data integrity and control of the experiment.

4.3.5 Lab and Experimental Setup

The experiment was carried out in a quiet room that was specifically constructed to avoid any distractions or external physical interferences. All the way throughout the various laboratory sessions, the room had stable temperature and humidity conditions to avoid variations in the different environmental parameters in relation to the physical responses to be measured (Bartolo et al., 2019; Sonkusare et al., 2021).

Each participant was comfortably seated on a chair that faced a laptop screen set roughly 60-80 cm away for optimum visibility of the advertisement (Mandolfo et al., 2024). The ad was displayed on this laptop with a 15.3-inch screen, 2880x1864 resolution, and a 60Hz refresh rate. The advertisement remained static with no flickers or sounds in the background during the presentation. This was done to ensure that any changes in the skin resistance during the shift of focus were not attributed to external arousing stimuli.

All the sessions were done individually, each with supervision from the researcher. This was done to make sure that the data, along with the quality, was consistent throughout the participants.

4.3.6 Materials

These include the advertising stimulus and the equipment necessary for collecting data to measure physiological arousal by skin conductance.

Participants viewed the advertising stimulus in the form of a static advertisement for the Samsung Galaxy M06 5G intended to evoke emotional and motivational states reflecting the anticipation of reward and urgency (“FLAT 20% OFF” and “Limited-Time Offer” to stimulate excitement, curiosity, and purchase-oriented behavior). This advertisement was the only stimulus for all participants and was viewed on a large screen projector. The GSR data was collected using a tool that could help to quantify the electrodermal activity. As a result, it was a physiological indicator of the emotional arousal of the participants (Hansen et al., 2017; Markiewicz et al., 2022).

The Grove – GSR (Galvanic Skin Response) Sensor, which is a skin-resistor device with a nickel-based electrode, is used for collecting physiological data and measures the skin resistance, which changes as the activity of the sweat glands changes. The device is powered by a 3.3V/5V input voltage, where its output voltage is in the analog form and reflects skin

resistance fluctuations, which are later used in the computation of skin conductance value (SCR level). The device is equipped with a potentiometer, which is used to control the level of the sensor's sensitivity.

Following the instructions in the official Seeed Studio user guide, the sensor was directly connected to an Arduino Uno as per the standard operating procedure for GSR to Arduino integration.

1. **Electrode placement:** Finger sensors were fitted with electrodes and placed on one hand on the index and middle fingers of a participant, while the flex straps placed on the electrodes were well adjusted to make contact without moving.
2. **Power & wiring check:** Verified 5V and GND lines; signal read on A0 via Arduino IDE Serial Monitor.
3. **Calibration (Serial_calibration):** With a small screwdriver, the potentiometer was turned on the board till the serial output became stable, which had a value of 512, which was used with all the participants. The calibration ensured that a consistent baseline measurement was followed for all subjects, which is very important for accurate comparisons of physiological arousal (Bagdziunaite, 2018).
4. **Recording:** Values which were recorded on the Serial Monitor ranged between 0 and 1023 and were obtained during the time the ad was displayed. These values were stored at a sampling rate of 10 Hz, capturing 40 readings over the first 4 seconds from when the stimulus was turned on.

4.3.7 Participant Instructions

During the preparatory stage of the study, participants were given information about the underlying aim of the research, including procedures planned for the recording of the physiological parameters of the skin response associated with the use of the Grove GSR apparatus. They received the information that the purpose of the experiment was to study the changes in emotions to a certain marketing advertisement and that the devices would measure the skin resistance of participants during the viewing of the stimulus.

In the experiment, participants were requested to sit in a comfortable position in front of a projector screen and to avoid moving, with the GSR electrodes on the hand being the focus of special attention, for the entire duration of the session. This ensured that extraneous movements did not introduce artifacts into the electrodermal activity recordings, which could

otherwise confound the interpretation of physiological arousal (Hansen et al., 2017; Mandolfo et al., 2024). They were instructed on the need to avoid dialogue, excessive movements, and expressions as much as possible to further evade any interference to avoid any interference in the sensor readings.

All individual participants were informed that they were going to watch an advertisement, and they were told to 'view it' as they would in everyday situations, that is, having come across any form of promotion online.

After viewing the advertisement, the participants were asked to indicate their purchase intent for the product on a Likert scale from 1 to 7, with 1 being "not at all likely to purchase" and 7 being "extremely likely to purchase." They were told that there were no right or wrong answers and that their comfort and truthfulness were the priority. They were also told that participation was voluntary and that they could withdraw from the study at any time with no penalty.

4.3.8 Procedure

In the study, participants took part individually in a 1–1 arrangement in a designated quiet room. The GSR recording system was set up on a nearby desk. The cables were set up in a way that avoided discomfort and restriction of movement for the participant, while also helping to capture data.

Prior to starting the recording, the Grove GSR sensor was calibrated, and the onboard potentiometer was turned until the Serial_calibration value was stable, thus capturing a baseline expectation of resistance, which is a sufficient value for the measurement. After calibration, participants were told to sit still in a defined area.

Electrodes were attached to the index and middle fingers of the same hand and secured with Velcro straps. The contact area was cleaned with alcohol wipes before the session to ensure effective signal contact is maintained (Jang et al., 2019). The recording of the participants was done in a stationary position with relaxed hands to avoid any motion or muscle-caused artifact.

In order to acquire stable values of skin conductance prior to stimulus exposure, participants even spent a 5-10 minute sitting in a designated area in which they were provided with

noise-canceling headphones and were told to close their eyes (waiting period). They were instructed to open their eyes 20 seconds prior to the advertisement being shown (pre-stimulus period) (Sugimine et al., 2020).

The screen was then turned to the advertisement for the new Samsung Galaxy M06 5G phone. In relation to the objectives of this study, GSR readings were taken in the first four seconds in relation to the start of the stimulus. Prior studies show that skin conductance responses to stimulus initiate in this window. Juuse et al., (2024) specifically mentions that a 1-4 second response window is preferable in order to obtain vital responses owing to sluggish signal processing. Other researchers also agree on the 1–4 seconds window (Boucsein et al., 2012), while some studies argue for a tighter window of 1-3 seconds to exclude non-stimulus SCR (Sjouwerman & Lonsdorf, 2019). As a result, we have taken the first 4-second window to avoid missing any SCR.

The GSR data were recorded in the Arduino IDE Serial Monitor in the form of sensor values. For later purposes, the conductance and resistance values were computed from the captured analog voltage.

Participants were requested to rate their intent to purchase the Samsung Galaxy M06 5G right after the advertisement was viewed. They were given a Likert scale from 1 to 7, whereby 1 meant ‘not at all likely to purchase’ and 7 meant ‘extremely likely to purchase.’

The duration of each experimental session, which included the setup, troubleshooting, ad viewing, and the associated waiting times, as well as the pre- and post-rating periods, was about 15-20 minutes for each participant. As a means to achieve reliability and consistency, all participants were given the same order of activities and overall duration for each session.

4.3.9 GSR Measures

This study used skin conductance level (SCL) as an indicator of physiological arousal and emotional response, which is captured by the Grove GSR sensor. The skin GSR sensor records readings in the form of sensor values.

These readings were later used to compute human resistance (in ohms) using the manufacturer's formula. With these resistance values, conductance in microsiemens (μS) was found for each individual.

In this particular study, average values of the skin conductance readings within the first 1–4 seconds capture the reflex responses to the stimulus and is considerably accepted in the field of psychophysiology (Juuse et al., 2024; Boucsein et al., 2012; Sjouwerman & Lonsdorf 2019).

An averaged phasic driver within this response window was used as the measure of Skin Conductance Level (SCL), following the approach described by Juuse et al., (2024), where the average within the response window represents the participant's phasic arousal intensity for that trial. This averaging method provides a stable and representative figure of emotional arousal while truncating noise from any external or non-stimulus variations.

4.3.10 Behavioral Measure

The behavioral measure used in this study was purchase intent, which was captured immediately after the participant was exposed to the ad. Each participant was asked to rate how likely they would be to purchase the Samsung Galaxy M06 5G smartphone and respond on a 7-point Likert scale, whereby 1 represents "not at all likely to purchase" and 7 equals "extremely likely to purchase."

Self-reports refer to the measures given by the subjects from their conscious minds. As a result, there's always a chance that the individuals can give these self-reports based on the manner they want to represent themselves (Villanueva et al., 2016).

As a result, this self-reported purchase intent was subsequently analyzed alongside participants' SCL data. Pearson and Spearman's correlation analysis was conducted to assess the extent of the emotional tension (measured by the amount of sweating), and the purchase intent to determine the degree to which subconscious physiological activity aligns with conscious decision-making.

4.3.11 Quality Control

Quality control procedures were conducted to enhance the precision and dependability of the GSR readings. Prior to data collection, each individual had the GSR sensor calibrated with a

Serial_calibration value configured by the on-board potentiometer and constructed to be stable. To maintain consistent conductivity and a reliable signal, the electrodes were secured to the participant's right index and middle fingers.

Across the scheduled sessions, the same environmental factors were preserved. There is evidence that EDA signals may also be affected by temperature and humidity. According to Jukiewicz and Marcinkowska (2025), GSR assessments should never be carried out in cold conditions, as the cooling of the skin may lower the response amplitude and obscure meaningful differences.

Kapp et al., (2014) also state that in the subjective experience of extreme temperatures, the non-specific skin conductance response often increases in frequency, and this increases the likelihood of distortion to the underlying emotional signal. Under real-life conditions, elevated ambient temperature has also been shown to increase non-specific fluctuations in EDA (Electrodermal Activity) (Doberenz et al., 2011). To mitigate these factors, the study sessions in this research were conducted in a room with stable environmental conditions.

While collecting data, participants were instructed to sit still and be quiet. This was done to reduce the amount of channel noise and movement that could compromise the readings. Any loss or abnormal signal was checked against calibration stability, and the signal stream from the Arduino was monitored in real time to catch any signal dropouts.

Following each session, every single dataset was checked for motion artifacts, signal spikes, and baselines that were unstable. As stated in Boucsein et al., (2012), it is helpful to analyze a record visually, so that parts with artifacts can be removed from the analysis. This was to make sure that the dataset only contained responses that were clean and valid physiologically.

Two participants were removed from the study because of the quality assessments. One participant had an exceedingly higher conductance value (29.01 μS) than the rest of the participants, which could be due to a physical condition, such as excessive sweating, or a technical condition, for instance, unstable contact of the electrodes. The other participant provided flat near calibration readings for the entire length of the trial, which can suggest almost physiological non-responsiveness. This can be caused by distraction, disinterest, or a low state of arousal. The quality of the data was preserved by these exclusions in addition to the amount of noise in the final assessment.

4.3.12 Rationale

The GSR tool was selected for this study because it is a sensitive, real-time, and non-invasive measure of emotional arousal, and it also complements traditional self-report data. It is a useful tool in neuromarketing research as it helps to assess the emotional responses to different marketing stimuli that are subconscious and cannot be known by rational thought. Individuals have a slight control over what they are looking at, or can even control their facial expressions, but what they cannot control is the function of their sweat glands. Due to the same reason, GSR is a reliable tool. People may be feeling something or may even be disconnected from their emotions and be unaware of it, and still, GSR can detect their arousal (Albert and Tullis, 2013).

Moreover, measuring skin conductance response (SCR) is regarded as one of the most accurate indicators of sympathetic arousal, because when compared to other measurements like pupil dilation or heart rate, it has the advantage of being uncontaminated by parasympathetic activity (Figner and Murphy, 2011). In simple words, EDA or Electrodermal Activity helps to assess the reactions of consumers and predict their purchase decisions by studying their skin's arousal (Bell et al., 2018).

Thus, this approach is pertinent to ads with scarcity-based and reward elements, for instance, discount and time-limited offers. These prompts aim to produce urgency, pleasure, and value expectation, emotions that are closely connected and correlate with the sympathetic nervous system. GSR is effective for measuring emotions' intensity because it records these rapid and subtle changes in the body via changes in skin conductance.

Employing GSR in such circumstances enables researchers to understand the disconnect between the consumer's responses and the automatic physiological reactions that accompany them. GSR reveals the effect of promotional materials with time restrictions on more general arousal, and whether this translates to purchasing behavior. Respondents cannot give false data as the GSR response measures the increase in electrodermal activity due to sweating brought about by sad, threatening, exciting, and other stimulating events (Sharma et al., 2021).

4.3.13 Data Collection and Guardrails

System and recording

Physiological data was collected using a Grove GSR Sensor connected to an Arduino Uno. The data sensors were streamed live onto a Serial Monitor, where they produced a continuous analog signal reflecting the changes in skin resistance.

The system was pre-calibrated before each session using the onboard potentiometer. For this study, the Serial_calibration value was 512, which was typical across participants.

In this study, the data were sampled at 10 Hz, and the first 4 seconds of analysis were used after the onset of the stimulus, a response window that is documented for stimulus-induced SCRs, as has been discussed (Juuse et al. 2024; Boucsein et al. 2012; Sjouwerman & Lonsdorf 2019).

The data sampling was done using the following custom Arduino code, which enabled a sampling frequency of 10 Hz. This method means that there is a greater likelihood that the signals that were analyzed pertained to the immediate emotional engagement rather than any delayed responses.

Code-

```
const int GSR = A0;          // GSR sensor connected to analog pin A0

int sensorValue = 0;

void setup() {

  Serial.begin(9600);        // Start serial communication at 9600 baud

}

void loop() {

  sensorValue = analogRead(GSR);  // Read raw GSR sensor value

  Serial.println(sensorValue);    // Print to Serial Monitor

  delay(100);                     // Wait 100 ms → 10 Hz sampling rate

}
```

So, for every 1 second, the system captured 10 values. Therefore, each participant had 40 sensor values to record and analyze.

An averaged phasic driver within this response window was used, following the approach described by Juuse et al., (2024), where the average within the response window represents the participant's phasic arousal intensity for that trial**.** This averaging method provides a stable and representative figure of emotional arousal while truncating noise from any external or non-stimulus variations.

Hence, the average sensor value, also known as the Average_Serial_Port_Reading, was calculated from the 40 values for each participant. The formula to calculate the average sensor value was:

Average_Serial_Port_Reading (Average Sensor Value) = Sensor Value 1 + Sensor Value 2 + Sensor Value 3…….Sensor Value 40 / 40

This reading was later used to compute human resistance (in ohms) using the manufacturer's formula.

Human Resistance (Ω)=

$$((1024+2\times Average\_Serial\_Port\_Reading)\times 10000) \; / \; (Serial\_calibration-Average\_Serial\_Port\_Reading)$$

Lower resistance values indicated higher skin conductance and, therefore, greater emotional arousal in response to the advertisement.

Conductance (μS) = 1,000,000 / R(Ω)

Or

Conductance (Siemens)=1 / Resistance (Ohms)

The dataset of this study is placed in Appendix D along with the meaning of the variables used.

Guardrails for Data Quality

To sustain recording consistency and preserve any associated data, multiple operational precautions had to be taken. GND and 5V wiring were checked and confirmed for power and signal consistency prior to each session. The Serial Port connection was checked, and any signal lag and drops on the Arduino IDE were resolved before the recording phase started.

Electrodes were attached to the participants' skin, which had to be clean and dry. Before the attachment of the electrodes, the skin surfaces were cleaned with alcohol swabs and cotton pads (Jang et al., 2019). Participants were also instructed to keep moving to a minimum and remain as relaxed as possible to avoid motion artifacts during the entire duration of the recording session. During each recording, real-time sensor values were displayed and actively monitored to check for abrupt changes like outliers and flatlining during the active window.

These guardrails helped ensure that all recordings were true physiological changes and not affected by noise, technical errors, or external factors.

4.3.14 Preprocessing of Signals

Raw sensor values were extracted in real-time during the entirety of the experiment from the Arduino Serial Monitor. Each sensor value signified the voltage pertaining to skin resistance in analog form, held at a frequency of 10 Hz (meaning 10 values in the span of a second). This ultimately summed up to 40 values for every participant during the 4-second window of the Stimulus.

These raw values were then converted into electrical resistance (Ohms) using the formula provided by Seeed Studio. Next, the resulting resistance was converted into skin conductance (μS) using the formula:

Conductance (μS) = 1,000,000 / Resistance (Ω)

The output for each participant was taken as a physiological index for emotional arousal for each individual for that particular advertisement.

4.3.15 Key Comparisons and Analysis Focus

The main analysis aimed to assess whether a participant's physiological arousal during the advertisement was relevant to their claimed intent to buy the product. The independent

variable was the skin conductance value the participant attained, calculated as the average skin conductance across the 40 sensor readings taken during the 4-second post-stimulus period. The dependent variable was the self-reported score for purchase intent, which was gathered immediately after the participant viewed the advertisement. The comparison between the skin arousal and self-reported purchase intent helped to study the attitude-behavior gap, which states that the self-reported consumer intentions may not always match with the physiological responses (Viglia et al., 2021).

In order to quantify the degree and type of linkage for these two variables, Pearson and Spearman's correlations were both performed. Pearson's r was used to assess the degree of association between the physiological arousal and the purchase intent, considering them as interval-scale data. Spearman's correlation, when considering the data as ranked, serves as a non-parametric correlational alternative to accommodate non-linear, but monotonic, tendencies in the data. Used in conjunction, these techniques provided a better assessment of whether or not emotional arousal, as recorded and calculated, was congruent with the participants' self-reported desire to make a purchase.

4.3.16 Key Findings (Overview)

The findings for this study demonstrated a significant correlation between participants' emotional arousal and their self-reported intentions of buying the product that was presented to them. The Pearson correlation demonstrated a statistically significant positive correlation between the skin conductance and purchase intent.

On the other hand, the Spearman correlation, although positive, did not achieve statistical significance. In other words, while there was a degree of emotional arousal and purchase intent, there was also a lack of a ranked order agreement among the participants regarding this relationship.

With everything put together, it can be concluded that emotional engagement, as measured in the initial moments of advertisement viewing, has an association with consumer attention. Though it is not conclusive or definitive, the physiological signal offers additional insight into individual reactions toward persuasive messaging, especially toward advertisements designed to trigger urgency or scarcity.

This aligns with previous works that relate how electrodermal activity is an accurate measurement of emotional arousal, and both of which can help to predict the subsequent behaviors of individuals, like purchasing in an unbiased way (Sato et al., 2020). Apart from this, prior works also showed that using electrodermal activity as a stand-alone measure may give mixed results in predicting engagement. This suggests that if you want to capture the consumer responses in an accurate way, then you need to follow a multi-modal approach (Nandipati et al., 2024).

4.3.17 Why This Matters

David Ogilvy strongly stated, “People don’t think what they feel, don’t say what they think, and don’t do what they say.” Thus, it can be concluded that people are not rational beings (Cartocci et al, 2017).

This claim is validated by the fact that many economic decisions go with automatic thought rather than being directly willed to be made (Bargh and Chartrand, 1999). Hence, what guides them often when making choices is internal conditions rather than explicit reasoning.

That is the reason why traditional advertisers usually fail because the success of their plans is based on what people say they will do. Intent does not equate to feeling, and it is emotion that often governs action long before logic is ever considered. This study is physiological, which goes beyond self-report to the body’s nonconscious, automatic reactions. It captures what participants may not even be aware of, which is the emotional response to the stimulus, that gets recorded long before words are formed.

Through the use of GSR, it was recognized that urgency-based promotional cues, including discounts on the price and time-limited offers, trigger emotional surges. If the emotional spikes are shown to have a relationship with the intent to purchase, then it is evident that they have been emotionally primed. It rationalizes the notion that emotionally designed content is just as important as price, visual layout, or emotional draws. In the modern world filled with a multitude of ads, what is important is not only what people remember, but what they feel in that moment.

4.3.18 Limitations

Despite the key insights this research has provided concerning emotional arousal and stated purchase intention, wider boundaries of its scope are equally important. An experimental setting, which is crucially important for data quality, does not bear the intricacies of a consumer situation. These environments may not be able to simulate the real world in the best manner because they oversimplify the individual and contextual factors used in real-world decision-making (Spelt et al., 2022).

In real life, individuals encounter competing stimulus options, social signals, and a range of distractors that were not a consideration for this study. While the test was devised to mimic real product page design, the participants were not subjected to real-life purchase pressure, nor were they making genuine spending decisions.

This is relevant because GSR is influenced by various outer physical factors like air temperatures and humidity, and internal elements, for instance, the activity of the sweat glands and different underlying pathologies (Nechyporenko et al., 2024).

Moreover, purchase intention, which of course is a behavioral indicator, is a proximal measure and just reflects interest and not action (Villanueva et al., 2016). Emotional responses which are exhibited in a laboratory setup are unlikely to translate in part, or at all in, dynamic online situations where the decision-making process is influenced by urgency, social proofing, financial limits, and the design of the user interface.

Additionally, this study focused only on immediate emotional arousal in the moment, as opposed to long-term memory or delayed decision-making. Future studies may want to determine whether the responses measured here are predictive of more downstream behaviors, such as recall, click-throughs, or actual purchases over time.

4.3.19 Ethics

This study was completed in compliance with the ethics of research involving human subjects. All participants were informed of the research, its aims, and the procedure in which the GSR sensor would be used non-invasively. Their decision to participate was voluntary, and they were asked to give informed consent in writing. Participants were briefed on the study’s purpose and the use of electrodermal activity (EDA) as a physiological measure of

emotional arousal, consistent with established ethical practices in psychophysiological research (Caruelle et al., 2019; Bagdziunaite, 2018).

Participants had the opportunity to withdraw from the study at any time and for any reason without any negative repercussions. All physiological measurements were anonymized, and demographic data were stored securely to minimize the risk of identification. There were no physical or psychological risks involved, and all participants were offered a debriefing after the completion of their session. There was no breach of any integrity with respect to the psychological and consumer neuroscience ethical frameworks for research in regards to the design, data handling, and communication with participants.

4.3.20 Statistical Analysis

The purpose of the statistical analysis was to understand the impact of the advertisement on the participants' physiological responses and the self-reported behavioral intent to buy after the exposure. The dataset captured 2 major variables under consideration. The first one was the average skin conductance level (μS), and the second was the purchase intent ratings on 7-point Likert scale.

All statistical analyzes were performed on the dataset using the IBM® SPSS® platform (the IBM SPSS software platform offers enhanced statistical analysis tools). Moreover, as discussed, the calculations were performed after excluding the 2 outlier data (Participant IDs 19 and 22).

The first step in the analysis was to calculate descriptive statistics on each variable. This included measures of central tendency (the mean, median, and mode), measures of dispersion (the standard deviation), and range indicators (the minimum and maximum values). This gave an initial understanding of the distribution of behavioral and physiological responses within the sample.

Then, both Pearson's correlation coefficient and Spearman's Rank Order Correlation were performed to determine the strength and direction of the association between purchase intent and emotional arousal. Pearson's method is used for the data with a linear relationship, whereas Spearman's method is for data with a monotonic but not linear relationship. As suggested by Rovetta (2020), when data distributions are numerous, it is recommended to calculate both the Pearson and Spearman correlations.

Other studies also suggest that it is a good practice to report both Pearson and Spearman correlation coefficients because of the potential of outliers, non-normality, and non-linearity in the data. A mix of both these correlations will help to give a reliable and accurate assessment of the relationship.

4.3.21 Descriptive Statistics

In the descriptive statistics, we report the core summary measures for both average SCL and purchase intent. For each variable, the mean value represents the average response overall, while the median and mode help demonstrate central tendency. Standard deviation measures the amount of variability in responses across participants. Moreover, the minimum and maximum values demonstrate the range of the data without assuming any range that has been computed. These statistics give the first and fundamental picture of the emotional and behavioral response patterns triggered by the stimulus.

	average_skin_conductance_level	**purchase_intent_1_7**
Mean	2.71	5.14
Median	2.46	5
Mode	2.46	4
Std. Deviation	0.53	1.2
Minimum	2.09	4
Maximum	3.84	7

Table 15. Descriptive Statistics - GSR Study

4.3.22 Pearson Correlation Analysis

Pearson's correlation coefficient is calculated when the relationship between the variables is linear and both the sets of variables are normally distributed. This table defines how the value of the correlation coefficient (r) maps to the strength of the relationship between two

variables in terms of very weak correlation, weak, moderate, strong, and very strong correlation.

Strength of Correlation

The value of the correlation coefficient (r) indicates the strength of the relationship between two variables, i.e., very weak, weak, moderate, strong, and very strong.

Amount of r	**Strength of the correlation**
0.0 < 0.1	no correlation
0.1 < 0.3	low correlation
0.3 < 0.5	medium correlation
0.5 < 0.7	high correlation
0.7 < 1	very high correlation

Table 16. Strength of Correlation - GSR Study

Hypotheses

This table presents the summary of the null hypothesis (no positive relationship) and the alternative hypothesis (a positive relationship) in this analysis and argues against each other.

Null hypothesis	**Alternative hypothesis**
There is no or a negative association between average_skin_conductance_level and purchase_intent_1_7	There is a positive association between average_skin_conductance_level and purchase_intent_1_7

Table 17. Hypothesis- GSR Study

Correlation

To find the relationship between average_skin_conductance_level and purchase_intent_1_7, a Pearson correlation analysis was conducted. The average skin_conductance_level variable reflects the participant's emotional arousal while exposed to the advertisement, and it is measured during a 4-second period where 40 GSR readings are recorded. Purchase_intent_1_7 is a 7-level self-reported scale where respondents indicated their willingness to purchase the product, with 1 signifying “not at all likely” and 7 signifying “extremely likely.”

The result of the analysis was:
$r(19) = 0.46, p = .017$

To put it more simply, r is the correlation coefficient. It defines the strength and direction of the linear relationship between the two variables. The value of r = 0.46 indicates a moderate positive correlation, meaning the likelihood of buying the product increases with an increase in the level of emotional arousal. But the increase in the level of emotional arousal will not cause a perfect increase in the purchase of the product. The number (19) in the parentheses indicates the degree of freedom in which in Pearson correlation is computed as n – 2. n in this case is 21 which is the number of participants in the analysis, thus 21 – 2 = 19. It is important to note that the value impacts the statistical significance, as smaller samples are expected to have stronger relationships in order to reach significance.

The p-value is recorded as p = .017. This is the value of the correlation and determines whether the correlation is due to mere chance, how probability is defined in correlation. With a p-value of 0.017, there is only a 1.7% chance that the relationship that has been observed is due to chance. Since this value is below the 0.05 mark, it is acknowledged that the result is statistically significant, meaning the correlation is significant and not a mere coincidence.

	r	**p**
average_skin_conductance_level and purchase_intent_1_7	0.46	.017

Table 18. Pearson Correlation Results - GSR Study

Interpretation

According to the correlation result, people with higher emotional arousal, as determined through increases in skin conductance, are more likely to indicate a greater intent to buy the product. It reinforces the notion that emotional involvement, even when not consciously articulated, still counts in the formulation of a decision to buy something. This result has even been corroborated by different brain-based marketing studies. These studies show that the purchase decisions made by individuals are not just logical but also influenced by emotions. Hence, emotional reactions in the brain stimulate the purchase decision for individuals (Russo et al., 2023).

The correlation of r = 0.46 is a positive correlation that is observable and meaningful but not 100% definitive. The arousal of emotions is not indicative of intent to purchase, but is likely to be a highly significant component. The p-value of 0.017 only serves to illustrate how authentic the result is for the sample set. It serves to reinforce the general theory that advertisements with emotional triggers, such as rush offers or discounts do not only capture attention but also intent to act as well.

4.3.23 Spearman Correlation Analysis

In case of non-parametric data, where the relationship between the variables is monotonic, Spearman's correlation coefficient is used. A Spearman correlation analysis was performed to analyse the relationship between average_skin_conductance_level and purchase_intent_1_7.

The Spearman correlation result was:
r(19) = 0.28, p = .105

These results can be interpreted in the following manner. r = 0.28 is the Spearman rank correlation coefficient. This coefficient measures the strength and direction of a relationship between two sets of scores, that is, whether a change in the value of one variable corresponds with a change in the value of the other variable, irrespective of the relationship being a perfect line. A 0.28 coefficient means there is a weak correlation, therefore, a modest relationship between the amount of emotional arousal and the amount of purchase intent. The

(19) indicates the number of population parameters that can vary (the degrees of freedom) n - 2. In this case, n represents 21 participants. So, 21 - 2 = 19 degrees of freedom.

The p-value = .105 shows the probability that this correlation is actually weak due to random chance. In simpler words, “the smaller the value of the p, the more statistically significant the result is”. Since p = .105 is more than 0.05, we can say the correlation is not statistically significant, and therefore the relationship is random and not observed in this particular relationship.

	r	p
average_skin_conductance_level and purchase_intent_1_7	0.28	.105

Table 19. Spearman Correlation Results - GSR Study

Interpretation

This result appears to reveal a weak yet affirmative trend, wherein participants displaying slightly higher levels of emotional arousal during the ad tended to report purchase intent slightly more than the other participants. That said, the relationship was still not strong enough to achieve statistical significance.

While Pearson’s correlation plots a line and assumes there is some form of a line between the two variables, Spearman’s test is more appropriate for cases of consistent ranking systems for which the relationship is not a straight line. This is generally more useful for social sciences because real-life behavior data is almost always irregular.

In any case, r = 0.28 and p = 0.105 suggest that there is a disparity between behavioral and physiological activity. We cannot claim that the sample’s trend is applicable to a wider population. People’s emotional and decision-making behaviors are very complex, as this sample suggests. Arousal does not always result in a declaration of intent, especially in unclear emotional situations.

4.3.24 Conclusion

The goal of this study was to investigate the relationship between emotional arousal (measured through skin conductance) and the intent to purchase in response to the digital

advertisement of a scarcity principle. The Grove GSR sensor was used in a laboratory-controlled setting and was able to capture physiological indicators in the first 4 seconds after ad exposure, an interval that other studies suggest reflects emotional response to the stimulus. Participants were then surveyed to estimate their purchase intent on a 7-point Likert scale.

The results present interesting findings. The results of Pearson's method suggested a statistically significant, moderate positive correlation, which indicates that higher emotional arousal during the advertisement was more likely to be associated with purchase intent. The Spearman correlation, although also positive, was non-significant and suggests a possible linear (as opposed to monotonic) trend.

In the context of this study, the findings strengthen the notion that emotional arousal is not simply irrelevant background noise, but rather offers an important insight into consumers' interactions with time-sensitive marketing offers. Although physiological signals cannot autonomously determine one's behavior, they may indicate a level of engagement that one may not even be consciously aware of and thus overlook with self-report measures. This potentially allows marketers to create campaigns that go beyond surface-level persuasion and resonate on a deeper emotional level.

These findings provide a starting point for future research that seeks to analyze advertising within contextualized ecosystems, incorporating more diverse product offerings, and examining longitudinal behavior change. Even within these parameters, this study provides evidence that emotion, fast, subconscious, and physiological, has a measurable role in shaping consumer intent.

Future studies can expand on this by considering the specific emotional valence, like joy, anxiety, stress, or excitement, on purchase intent and move beyond the general physiological arousal variables to understand the type of emotional responses due to different advertising cues (Liang and Lin, 2023). Apart from this, future studies can even use a number of different neurophysiological attributes like frontal theta or P300-based EEG activity, which will help to better understand emotion-driven behavior in response to advertisement stimuli (Bagdziunaite, 2018).

CHAPTER 5

DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

5.1 Introduction

This chapter focuses on interpreting the findings derived from the three cue-focused studies. It discusses what the findings indicate on the role of digital cues in influencing consumer decision making. Each of the studies focused on a different process: the fMRI study studied how luxury imagery activates the value related brain areas, the eye tracking study analyzed how the visible customer reviews guide the allocation of eye gaze, and the GSR study investigated to what extent urgency of price framing impacts the emotional arousal of a consumer.

In this study, findings from neural, visual, and physiological insights are aligned with the understanding of the intent to purchase. It advocates for a broader inter-disciplinary combination of psychology, marketing, and neuroscience to capture the complexities of consumer and brand relations in the digital era (Calderon-Fajardo et al., 2024). In simple words, this study performs a comparative analysis of the effect of each cue on its respective measure, draws parallels to existing neuromarketing studies, and outlines digital design and strategic implications.

It summarises the main take away and provides rationale for future studies that could build from the work and the insights it provides. In the future, studies could explore the influence of contextual variables, like product attributes or company altruism, on price processing among different consumer types (Medina et al., 2020).

5.2 Summary of the Study and Findings Conclusions

5.2.1 Findings by Cue: What Changed and What it Means

Luxury Imagery (fMRI study)

The fMRI study of advertisements of luxury products showed activation of the ventromedial prefrontal cortex (vmPFC) of the subjects being studied, the area of the brain involved in evaluation and reward processing. This is because human decision making is driven by the

subjective value assigned to the different alternatives and the reward signals (Murawski et al., 2012).

As a result, the participants which had higher z-scores in the reward/value region of the vmPFC area also reported higher purchase intent. This implies there is potential value-related processing attributed to luxury advertisements even without explicit behavior responses, and therefore, value neural processing ascribed to preferences is likely present.

Interpretation

Even in the absence of a decision, luxury advertisements appear to trigger value processing automatically. This gives evidence that high-end ads appeal to a subconscious motivational level. Therefore, high-end, clean, minimalist advertising images of a prestigious luxury product are likely to provoke the consciousness 'value response.'

Moreover, these soft-sell ads unconsciously encourage the consumers to purchase the products (Beazer et al., 2013). In simple words, digital marketers should focus on marketing premium products in a clean way so that people feel the 'value' of the product before they can even think about it.

Product Reviews (Eye-Tracking Study)

The eye tracking results confirmed that having reviews in an advertisement influenced where participants looked and the duration of their gaze. In particular, customer reviews in ads increased overall participant engagement, as demonstrated by longer Dwell Time and more participants viewed the Review section.

More recent combined EEG and eye-tracking studies report that review cues are processed quickly, and sometimes even before direct fixation, while the AOI metrics indicate that there is categorical fixation on the review element (Pšurný et al., 2024).

Recent EEG + eye-tracking research shows that review cues are processed rapidly, often before direct fixation, while AOI metrics confirm measurable viewing time on the review element (Pšurný et al., 2024). In addition to this, studies conducted in retail webshops show that longer and more frequent gaze duration is predictive of choice, thereby linking attention to choice made (van Loon et al., 2022). Following this idea, our findings correlate with the expected attention and decision pathway. According to meta–analytic studies, online reviews,

particularly their valence, have a positive impact on the intent to purchase (Qiu and Zhang, 2024). Hence, the most influential factor is the review sentiment.

Consistent with this attentional pathway, meta-analytic evidence shows that online reviews, particularly their valence, exert a significant positive effect on purchase intention across diverse contexts (Qiu and Zhang, 2024).

A validated multi-dimensional scale shows that online reviews impact consumers' intent to purchase by affecting the factors of credibility, volume, and relevance (Fernandes et al., 2022). The results of controlled experiments that align with our dwell–intent framework indicate that the effect of reviews on the influence of purchase decisions pivots on perceived uncertainty. When uncertainty is lowered, intent to purchase rises, illustrating that review information shapes purchase intent (Wang et al., 2021). Furthermore, structural modelling research demonstrated that review cues increase purchase intention indirectly via perceived diagnosticity and it identified diagnosticity as an important mechanism (Ahn and Lee, 2024).

Interpretation

Thus, confidence anchors are created when potential buyers read user reviews because reviews serve as 'social proof' (Mallik, 2025). This helps buyers feel more confident about their buying choices. Ratings and comments are visually available and serve as anchors buyers use to make quicker and more confident decisions. However, for product reviews, visibility and ease are crucial (Alzate et al., 2021). Reviews that can be easily accessed and scanned are early attention catchers and increase confidence. If the review column is positioned below the fold, and formatted with "too much" information, users might ignore it.

For designers, the solution to this problem is to ensure that reviews are placed in a way that they can easily be seen, they are kept readable, and they provide the necessary reassurance buyers will need. This is an important finding because it provides evidence to researchers that visible social proof actually does decrease uncertainty (Kanani & Glavee-Geo, 2021) and increase the buyers' intention to purchase.

5.2.2 Urgency Cues (GSR): How Arousal Drives Action

In the study regarding GSR and pricing communication, the use of immediacy and time urgency was included in the pricing communication (i.e., time-limited offer and discount). These stimuli corresponded with increases in physiological arousal as measured with skin

conductance. It was noted that participants displaying greater arousal during the advertisement showed greater intent to purchase.

This finding is similar to much recent research which has shown that limited availability creates a sense of scarcity in the users and hence, results in a higher perceived competition which in turn, activates the purchase intention of the users (Broeder and Wentink, 2022). Within the context of digital shopping, these stimuli may activate short-term emotional engagement that promotes rapid decision-making.

Other works of research has also shown that time bound promotions tend to raise purchase intentions because of two reasons. Firstly, arousal due to the scarcity functions as the mechanism and the added time pressure compels the consumers to make an impulsive choice (Li et al., 2023; Marjerison et al., 2022).

Interpretation

The experience of urgency can be beneficial due to its impact on short-term states of readiness. When an offer is believable and the label is unambiguous, the chances of this state of readiness turning into an intent to act increase. However, when urgency is employed too frequently, the trustworthiness of the offer is diminished, and its impact is lost. Put simply, urgency is most effective when it is perceived as real and infrequent, because scarcity pressure causes choices to be made quicker and more effect- driven (Sun et al., 2023).

Genuine scarcity cues create a sense of urgency, enhance the perceived value of a given product or service and positively influence consumers' purchase intention (Song et al., 2021).

5.2.3 Putting It All Together

The same pattern of results was present in each study: stronger the neural response, the focused attention, or the psychophysiological arousal, the greater the intention to purchase.

- Luxury brand imagery stimulated neural circuits associated with the processing of value and desire.
- Product reviews focused consumers' attention and increased confidence.
- Urgency messages heightened emotional arousal and behavioral readiness, suggesting intention-to-act.

The implications for marketers and designers are evident. Evoking feelings of worth and value can be accomplished through the use of high-quality graphics because high-quality graphics persuades consumers of professionalism and superior quality (Alfakrah et al., 2024); confidence can be reinforced through the presentation of visible testimonials (Rajender et al., 2024; Mallik, 2025); and limited time offers evoke urgency for the user (Luo et al., 2021). When used in unison and moderation, these small cues provide an opportunity to shift the user perception and influence user decision-making.

5.3 Implications and Applications

The three pathway approach taken in this case study aligns with social consumer neuroscience. Attentional, emotion/arousal, and memory-related engagement indices are all associated with advertising efficacy and consumer behavior. Thus, when these pathways are authentically triggered, they can be practically employed (Pozharliev et al., 2017).

5.3.1 Cue-Level Implications for Decision-Making

In this study, each cue examined has an impact on a separate stage in the consumer decision process. The findings shed light on when and how the cues work optimally, and how they can be applied in the most responsible way to enable better digital design and communication.

Luxury Imagery (fMRI)

This finding shows that luxury imagery evokes a sense of worth due to professionalism and superior quality (Alfakrah et al., 2024), but this is only the case when two criteria hold: the product itself is truly premium and the audience appreciates that level of quality.

In this scenario, both the stimuli and the audience resonate within the luxury domain which enables the ad to instigate profound value-related cognitions. The activations within the ventromedial prefrontal cortex are responsible for assessing the individual's willingness to pay for a product, and assigning a potential value to a given payment behavior, which is the subjective value (Alsharif and Isa, 2024).

This, for marketers, means that the advertisement is likely to connect better when it is both authentic and clear compared to when it is cluttered. Visual enhancements are not needed for truly premium products. The product image requires meticulous and honest appreciation.

High quality presentation requires the advertisement to be clean with uncluttered lighting, appropriate balanced composition, and minimal compositional clutter by integrating principles of visual hierarchy, so as to allow the audience to focus on the aspects of the product that make it aspirational. When excessive amounts of decorative elements are introduced, the visually represented quality of the advertisement is likely to be diminished alongside the emotional pull the advertisement exerts.

This finding supports the notion that value processing is not always conscious action. A person does not need to dissect a luxury product to analyze it in order to 'feel' that it is valuable. Brains assess that value in the blink of an eye. This quick brain reaction demonstrates how powerful even the most minute visual aspects of a product can be in forming consumer perception of premiumness and that companies can optimize for these visual aspects to increase value perception (Pombo and Velasco, 2021).

In other words, the most effective way to advertise luxury products is to show real quality to an admiring audience. The relationship between product authenticity, audience values, and visual simplicity makes desirability effortless and difficult to replicate.

Product Reviews (Eye-Tracking)

The customer review section that is positive and visible tends to elevate intent to purchase (Qiu and Zhang, 2024). This substantiates the power of social proof as a trust indicator (Mallik, 2025). Consumer behaviors are designed to seek out signals that reduce their uncertainty (Kanani & Glavee-Geo, 2021) and reviews are reassurance that other users had affirming experiences.

The inference here for digital marketers and designers is that they can make use of reviews by placing them at a key area near the product image of price and use simple layouts to highlight the ratings rather than cluttering the text with longer phrases. The main aim of using clear visibility is to enable quick scanning and immediate confidence boost for the viewers. In simple words, reviews create a 'trust button' to fasten the decision making process of the people.

Urgency Cues (GSR)

Urgency messages were shown to enhance arousal, which suggests that the emotional state of readiness to respond is heightened under conditions of time pressure and scarcity.

When an offer is limited but possible, it creates enthusiasm and moves the consumer closer to the purchase (Broeder and Wentink, 2022; Li et al., 2023; Marjerison et al., 2022). Still, the impact hinges on reliability and occurrence because when urgency is encountered too many times or without context, the urgency's emotional impact is lost.

From a brand perspective, this suggests that urgency should be used in a targeted rather than a repetitive manner. Short statements like "Offer ends tonight" or countdown timers work best in context with real offers that end. Moreover, complementing these cues with supportive design and a clear call to action provides a structure that helps balance emotional arousal with clear logical thinking. The intention is to capture attention, not to create panic.

5.4 Design Implications

5.4.1 Luxury Imagery

Luxury visuals must convey authenticity over excessive ornamentation. The fMRI results indicated that clear displays of authentic premium products trigger reward areas of the brain. This means the design should allow the product to speak for itself. Accordingly, minimalist design and high-quality photography are crucial, as communicating luxury to consumers must occur on a neural level (Shi et al., 2021).

These details should be focal elements, as they enhance the aspirational nature of the product, ensuring that it is the premium product that speaks for itself rather than the glitzy decorations. So, the best principle the brand campaigns can follow for a luxury design is the 'less is more' principle. Minimalistic design approaches with clean aesthetics can communicate the product value effectively to engage the reward system of the brain (Shi et al., 2021).

5.4.2 Product Reviews

The eye-tracking outcomes also support the notion that certain types of visibility control how and whether users interact with their reviews. People seek reassurance before making a decision, however, in order to receive that reassurance, it must be present in a very straightforward manner.

To optimize usability, reviews should be located close to the product image and should be readily visible without scrolling. The star rating should be complemented with the number of reviews using high contrast typography. Typography is an important part of this process because it provides visual consistency across designs thus reinforcing brand identity (Lelis et al., 2022; Šola et al., 2025).

5.4.3 Urgency Cues

Urgency-driven design should aim for constructing a feeling of time relevance, not a sense of panic. The GSR study showed that while urgency cues amplified emotional arousal, it's important for the offer to be felt believable by the audience. Deceptive timers are perceived as manipulative, immoral, and unethical (Tiemessen et al., 2023)

For example, 'FLAT 20% OFF' along with a 'Limited-time offer' callout sounds believable. But, 'Buy 1, Get 1 FREE' along with a 'Offer ends in 15 minutes' callout doesn't sound believable. The inference from this is to use urgency cues only for genuine cases because time pressure causes choices to be made quicker and more affect-driven (Sun et al., 2023).

Design features (e.g., banners, countdown timers, or 'Ends Tonight', '2 Left in Stock' phrases) should be used. But the use of repeating pop ups or continuous flashing should be avoided, which moves arousal to the negative pole of stress rather than help in engagement.

Effective urgency design allows users to have clear information and a sense of comfort when taking action, thus, giving them an honest nudge rather than manipulation.

5.5 Measurement and Strategy

Other than design, the studies illustrate how neuromarketing tools can assist in testing and strategy formulation. Each tool captures a distinct dimension of the user's reaction, and collectively, they offer a practical set of instruments for quantifying consumer behaviors and sentiments beyond self-reported data.

5.5.1 Using fMRI

The fMRI study demonstrated that the activations of the brain in the vmPFC and other value areas reflects the strength of feeling, or the perceived worth of the product or brand (Chib et al., 2009). As a point for strategic testing, this means fMRI technologies can assist in the

validation of expensive, high-value creative assets, particularly during the inception of a new product, the launching of a brand, or luxury campaigns.

FMRI, though expensive and labor intensive (Turner et al., 2018; Liu et al., 2021), does determine if an advertisement simply garners attention or triggers an emotional connection that is intimate. During their R&D, brands can use neuroimaging techniques to fine-tune their visual branding assets (Alsharif and Isa, 2024) before broader applications of the design.

5.5.2 Using Eye Tracking

Eye tracking is the easiest and immediate way to collect feedback for the design teams. Webcam-based eye tracking can determine whether users scan important content, such as reviews, buttons, or price tags, and the amount of time spent on them. Such eyeball movement patterns are good early predictors of the efficiency of a message.

To practically make use of eye tracking, attention data can be used while conducting A/B testing (Baier and Rese, 2020). Members of the team can analyze attention spans on various versions of specific emails, web pages, and ads, then note which designs maintain focus on the important areas for extended periods of time. Attention data, when merged with relevant behavioral metrics such as purchase intent, conversions, or click-through ratios, allows us to understand the correlation between the visual focus of users and their actions.

5.5.3 Using GSR

GSR can detect emotional intensity in an affordable and simple way. It allows team members to identify the portions of the message or the designs that trigger the most excitement. During controlled lab experiments, the moments when excitement, music, or visuals elicit a sudden positive emotional lift, can be marked by a spike in skin conductance.

However, GSR should only be used as a supportive signal of emotional depth, and not as a solitary measure. This is because, while GSR measures the intensity level of an experience, it does not find the nature of that experience. Therefore, it has to be combined with other measures, such as surveys or observational data to accurately interpret it (Hansen et al., 2017).

5.6 Future Trends and Innovations

In consideration of the evolution of technology, the field of neuromarketing has been expanding at a rapid pace. The future will witness the more advanced integration of neuroscience tools with artificial intelligence and immersive media. This will provide marketers and researchers a more advanced and realistic understanding of the mental and emotional processes and behaviors of consumers. Also, work using the neuromarketing tools is bound to yield knowledge which is otherwise inaccessible through conscious introspection or self-reports (Calderón-Fajardo et al., 2024).

While understanding real emotions and intentions will be simplified by these advancements, human insight is still crucial and will not be completely overshadowed.

5.6.1 Advanced Biometric Integration

Biometric parameters such as GSR, heart rate variability, and facial coding are now being combined with EEG and fMRI technologies. With the continued advancement and popularization of technology and wearable devices, there is a greater potential for growth for neuromarketing (Shivappa and Ramanjaneyalu, 2021).

The developments in neuroimaging, portable devices, and real time analytics that allow marketers to perceive the difference between what people say, what they click, and how their body and brain respond are the major contributors to the anticipated growth. Future studies are expected to use GSR (arousal), eye trackers (attention), and fMRI (value processing) in the same experimental sessions. Taken together, they will provide a more holistic picture of consumer interactions, which in turn will enhance accuracy and interpretation.

In simple terms, these integrations can pinpoint the specific moments in an advertising, or the experience with the product that trigger real emotional responses, making it possible for the design to be more user impactful and meaningful.

5.6.2 Artificial Intelligence and Predictive Analytics

Artificial Intelligence (AI) and Machine Learning (ML) are important in neuromarketing as they change the methods used to assess biometric and neural data. Algorithmic approaches in predictive marketing help marketers get insights by recognizing large volumes of datasets to know what consumers would like or dislike in the future. AI has three important purposes:

automating marketing processes, making the systems more accurate, and decreasing the amount of human work.

AI is capable of predicting new campaign outcomes by analyzing behavioral and physiological data such as gaze patterns, peaks of arousal, and brain activation. Therefore, marketers would be able to conduct virtual tests of their hypotheses, greatly decreasing expenditure and time.

Predictive models in the future might even be able to personalise experiences for consumers in real time, like adjusting visuals, sounds, or even offers based on the user's emotional and attentional condition. This mix of AI and neuroscience in digital marketing can provide new advanced features (Badrulhisham et al., 2024), which will allow emotion-aware personalization (Bhadange, 2025). This will make the marketing technique more relevant and less intrusive.

5.6.3 Immersive Technologies (VR and AR)

When it comes to neuromarketing, Virtual Reality (VR) and Augmented Reality (AR) technologies are rapidly transforming how marketers analyze consumer behavior (Russo et al., 2022). They allow researchers to develop realistic experiences (Pozharliev et al., 2021) and then observe how shoppers act in virtual stores and how they engage with digital products. What these technologies reveal about shopper behavior can greatly enhance digital marketing approaches to address consumer demands and behaviors in reality.

The best benefit of VR and AR environments is that they can simulate real-world environments while keeping the experiment fully controlled. For example, within the VR headset, eye tracking can be used to capture how participants negotiate an aisle of a virtual store or how they react to virtual discount tags, while physiological devices can measure arousal at the same time. This will help neuromarketers to no longer be constrained by flat screens and understand how people engage, decide, and feel across the dynamic digital experiences.

5.7 Future Research Directions

Although this research sheds light on perceptions of value, attention, and digital signals, there is much more to be explored. Along with the rest of the field, neuromarketing holds the potential for much more.

5.7.1 Longer and Real-World Exposures

This study examined short and controlled exposures which are optimal for effect isolation. However, they do not accurately reflect user behavior in an ecologically valid online context. Subsequent research should examine prolonged periods of browsing, or multi-cue interactions. Wagner and Hort (2025) stress that the value of combining multiple biometric sensors during prolonged, and naturalistic sessions can give deeper information about the consumer experience in its contextual and temporal factors.

5.7.2 Combined Cue Interactions

Authentic digital interfaces usually do not contain a single, isolated cue. Subsequent research could investigate the interaction of different cues, how a sense of urgency could increase focus on a review, or how premium images modify the effect of time pressure. These interactions may clarify whether cues additively or competitively shape intent.

5.7.3 Personalization and Adaptive Design

There are individual differences in reactions. What feels exciting to some may be stressful for others. Hence, subsequent research should focus on personalized cue strategies, applying AI to personalise the level of certain visual or emotional triggers based on user attention and physiological response (Deckker and Sumanasekara, 2025). For example, an adaptive system may lower urgency cues for hesitant users or more emphasis on reviews for users who are overly cautious.

5.7.4 Integration with Emerging Technologies

As discussed earlier, tools such as wearable biometric tools, AR, and VR will enable new approaches to studying consumers in immersive and realistic settings. The different 3D virtual objects and environments which are interactive (Javornik, 2016), and when used in a real environment, can enhance the user experience (Rauschnabel et al., 2022) and provide a

number of insights to show products and deliver information to the users (Huang and Liao, 2015).

5.7.5 Expanding the Ethical Framework

With the increased access to neural biometric information comes even greater responsibility. Future research must continue to develop ethical principles that ensure that data handling is transparent and there is respect for the privacy of participants (Mouammine and Azdimousa, 2023; Gonçalves et al., 2024). The objective of using neuromarketing should be to facilitate communication and not manipulate it.

5.8 Summary

The greatest potential for future growth in neuromarketing is in its integration, the ability to combine many tools, datasets, and technologies (Hurzhyi, 2023) in a more thorough and ethical understanding of consumers. This does not just include incorporating different methodologies together but also ensuring to take care of the ethical implications revolving around neuromarketing like consumer data privacy, autonomy and potential consumer manipulation using these advanced techniques of Neuromarketing (Bell et al., 2018).

Fusing biological, behavioral, and contextual information will enable future researchers to develop a comprehensive framework that models the integration of emotion, attention, and value in each digital decision.

This will position neuromarketing as a field of understanding, rather than of persuasion, designed to help brands build experiences that resonate with people’s thoughts, emotions, and decisions.

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APPENDICES

Appendix A: Neuromarketing Study Questionnaire

Questionnaire Link- https://forms.gle/FtPk8FHwQzbddDW97

Title: *Neuromarketing Study Form*

Purpose:
This short form collects basic demographic and shopping-related details. Responses help in analyzing consumer behavior patterns. All data are kept confidential under a coded ID, and participation is voluntary.

Section 1: Participant Consent

1. **Participant consent***
    - Tick all that apply:
        - I have read the study information and consent to participate in this Neuromarketing Study.
2. **Participant code (pid):***
    - Enter the code assigned by the researcher.

Section 2: Demographic Information

3. **What is your age?***
4. **What is your gender?***
    - ☐ Male
    - ☐ Female
    - ☐ Other: _____
5. **Which city do you live in?***
6. **Which is your household income bracket?*** (Mark Only One)
    - ☐ 1 - Lowest income group

- ☐ 2 - Lower middle group
- ☐ 3 - Upper middle group
- ☐ 4 - Highest income group

Section 3: Shopping Behaviour

7. **How often do you shop?*** (Mark Only One)
    - ☐ 1 – Almost never
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ 5
    - ☐ 6
    - ☐ 7 – Very often
8. **How sensitive are you to price when you shop?*** (Mark Only One)
    - ☐ 1 – Price rarely affects my choices
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ 5
    - ☐ 6
    - ☐ 7 – Price strongly affects my choices

Appendix B: fMRI Study Data

pid	age	gender	city	income_bracket_1_4	shop_frequency_1_7	price_sensitivity_1_7	reward_gain_zscore	purchase_intent_1_7
1	26	F	Ahmedabad	4	6	2	1.45	5
2	33	M	Ahmedabad	4	5	3	2.68	7
3	28	F	Ahmedabad	3	7	2	1.82	6
4	31	M	Ahmedabad	3	6	3	1.05	3
5	35	M	Ahmedabad	4	4	4	2.94	7
6	30	F	Ahmedabad	3	5	3	2.15	6
7	27	F	Ahmedabad	4	6	2	1.38	5
8	29	M	Ahmedabad	3	5	3	2.51	7

Table 20. fMRI Study Data

Terms Used

- pid: Participant ID (1–8), unique identifier.
- age: Age in years (25–35 range for this sample).
- gender: Participant gender (M = male, F = female).
- city: City of residence
- income_bracket_1_4: Self-reported monthly income bracket (1 = lowest, 4 = highest).
- shop_freq_1_7: Online shopping frequency (1 = very rarely, 7 = very frequently).
- price_sensitivity_1_7: Sensitivity to price (1 = not price-sensitive; 7 = highly price-sensitive).
- reward_gain_zscore: Z-score from Mango Viewer's Behavior Analysis for the vmPFC (Reward/Gain) ROI during ad viewing; higher = stronger reward/gain activation.
- purchase_intent_1_7: Post-scan self-reported intention to purchase the iPhone 17 Pro Max (1 = not at all likely; 7 = extremely likely).

Appendix C: Eye Tracking Study Data

pid	age	gender	city	income_bracket_1_4	shop_freq_1_7	price_sensitivity_1_7	DwellTime_Review	FirstView_Review	PurchaseIntent_Review	DwellTime_NoReview	FirstView_NoReview	PurchaseIntent_NoReview	Excluded
1	19	Male	Bangalore	3	7	3	1.43	0.46	7	0	0	3	FALSE
2	33	Male	Mumbai	3	2	3	1.59	0.75	3	0.67	1.22	4	FALSE
3	38	Female	Mumbai	2	3	7	0	0	5	0	0	2	FALSE
4	24	Male	Hyderabad	4	6	4	3.42	0.32	5	0.04	0.89	3	TRUE
5	30	Male	Bangalore	2	5	7	1.77	0.6	5	1.24	0.74	4	FALSE
6	32	Male	Hyderabad	1	6	4	1.16	0.55	3	0.02	0.9	5	FALSE
7	20	Female	Hyderabad	3	3	5	1.22	0.46	5	0.81	0.77	5	FALSE
8	25	Female	Hyderabad	2	5	3	1.91	0.59	5	0.67	1.01	3	FALSE
9	27	Male	Mumbai	3	4	6	2.13	0.23	4	3.98	0.67	2	TRUE
10	30	Male	Hyderabad	3	4	2	1.62	0.41	5	0.03	0.65	5	FALSE
11	30	Female	Hyderabad	3	3	7	1.61	0.64	4	1.03	0.81	3	FALSE
12	18	Female	Mumbai	3	1	2	1.34	0.14	6	1.23	0.8	4	FALSE
13	35	Male	Bangalore	1	5	1	0.79	0.67	5	0.73	0.79	4	FALSE
14	22	Male	Bangalore	3	6	6	1.52	0.87	4	0	0	3	FALSE
15	32	Female	Hyderabad	2	3	5	1.39	0.65	6	3.67	0.12	5	TRUE
16	28	Female	Hyderabad	2	6	1	1.79	0.98	6	0	0	5	FALSE
17	18	Male	Hyderabad	2	3	3	1.23	0.83	6	0.83	1.09	5	FALSE
18	35	Male	Hyderabad	1	7	7	1.34	0.86	6	1.22	0.97	3	FALSE
19	37	Male	Bangalore	3	4	4	1.41	0.85	3	0	0	5	FALSE
20	21	Male	Hyderabad	2	4	6	1.9	0.57	6	0.87	0.72	3	FALSE
21	39	Female	Hyderabad	1	2	7	1.51	1	5	1.18	0.84	4	FALSE
22	21	Female	Hyderabad	2	2	6	1.14	0.99	3	0	0	3	FALSE
23	29	Female	Bangalore	3	6	6	3.23	0.98	6	0.76	0.98	5	TRUE
24	26	Male	Hyderabad	1	1	3	2.07	1.17	4	0.02	0.94	5	FALSE
25	20	Male	Bangalore	3	3	1	0	0	4	1.36	0.73	4	FALSE

26	35	Male	Mumbai	1	1	3	1.47	0.71	4	0.34	0.41	4	FALSE
27	25	Male	Hyderabad	2	5	4	1.58	0.6	4	0.88	0.64	4	FALSE
28	24	Female	Hyderabad	1	5	3	1.53	0.59	6	0.54	0.82	5	FALSE
29	32	Female	Bangalore	2	2	7	2.2	0.9	3	0	0	3	FALSE
30	33	Male	Hyderabad	4	7	7	3.09	0.56	4	1.21	1.34	6	TRUE
31	30	Male	Mumbai	3	2	1	1.75	0.55	5	0.02	0.82	5	FALSE
32	29	Female	Bangalore	1	5	1	1.87	1.13	5	0.41	0.68	4	FALSE
33	32	Female	Hyderabad	2	1	7	1.62	0.58	5	0.87	0.68	4	FALSE
34	29	Female	Hyderabad	3	1	5	1.74	0.94	4	0.44	0.58	4	FALSE
35	21	Female	Hyderabad	1	6	3	1.09	0.88	6	0	0	4	FALSE
36	21	Male	Mumbai	2	3	4	3.12	0.48	5	0.83	1.05	5	TRUE
37	26	Male	Bangalore	3	6	3	1.41	0.94	6	0.39	1.04	5	FALSE
38	39	Female	Mumbai	1	6	3	1.74	1.1	4	0	0	3	FALSE
39	35	Female	Hyderabad	2	4	2	2.47	0.99	4	0.58	1	3	FALSE
40	31	Male	Hyderabad	2	1	5	1.69	0.81	6	0	0	4	FALSE
41	23	Female	Hyderabad	4	3	5	2.46	0.73	5	3.12	1.15	5	TRUE
42	34	Female	Hyderabad	1	2	6	1.16	0.84	4	0.41	0.56	3	FALSE
43	26	Female	Hyderabad	2	7	1	1.41	1.04	5	0.83	0.76	4	FALSE
44	28	Female	Hyderabad	2	7	7	1.17	0.89	3	0.32	0.89	2	FALSE
45	28	Female	Hyderabad	3	6	4	1.71	1.09	7	0.78	1.32	4	FALSE

Table 21. Eye Tracking Study Data

Terms Used

- pid: Unique participant id (1–45).
- age: Age in years.
- gender: Participant gender listed as Male or Female.
- city: City of residence (Bangalore, Mumbai, Hyderabad).

- income_bracket_1_4: Self-reported monthly income bracket from 1 (lowest) to 4 (highest).
- shop_freq_1_7: Online shopping frequency from 1 (rarely shops online) to 7 (shops very frequently).
- price_sensitivity_1_7: Self-rated sensitivity to price from 1 (not sensitive) to 7 (highly sensitive).
- DwellTime_Review: Total fixation duration (in seconds) on the Rating Review section during the Review condition.
- FirstView_Review: Time taken to first fixate on the Rating Review section (in seconds) during the Review condition.
- PurchaseIntent_Review: Self-reported purchase intention after the Review stimulus, rated from 1 (not at all likely) to 7 (extremely likely).
- DwellTime_NoReview: Total fixation duration (in seconds) on the Description section during the No-Review condition.
- FirstView_NoReview: Time taken to first fixate on the Description section (in seconds) during the No-Review condition.
- PurchaseIntent_NoReview: Self-reported purchase intention after the No-Review stimulus, rated from 1 (not at all likely) to 7 (extremely likely).
- Excluded: Indicates whether a participant was removed from analysis (TRUE = excluded, FALSE = included). Participant IDs 4, 9, 15, 23, 30, 36, and 41) were removed based on predefined criteria.

Appendix D: GSR Study Data + Raw Data

pid	age	gender	city	income_bracket_1_4	shop_freq_1_7	price_sensitivity_1_7	average_skin_conductance_level	purchase_intent_1_7	exclusion_flag
1	20	Female	Hyderabad	3	6	6	2.95	4	Included
2	32	Male	Ahmedabad	3	6	6	2.3	4	Included
3	29	Female	Ahmedabad	4	5	7	2.09	5	Included
4	22	Male	Ahmedabad	4	5	3	2.51	6	Included
5	34	Male	Ahmedabad	1	5	6	2.24	6	Included
6	23	Female	Hyderabad	2	4	6	3.22	7	Included
7	30	Male	Hyderabad	2	5	4	2.24	4	Included

8	21	Male	Hyderabad	3	3	7	3.44	7	Included
9	24	Female	Hyderabad	4	4	7	2.57	4	Included
10	20	Male	Hyderabad	3	5	6	2.89	4	Included
11	27	Male	Hyderabad	1	6	4	2.41	4	Included
12	25	Female	Ahmedabad	2	6	3	2.3	5	Included
13	31	Female	Hyderabad	4	3	6	2.46	4	Included
14	30	Male	Hyderabad	1	5	5	2.46	6	Included
15	35	Male	Hyderabad	2	4	4	3.84	7	Included
16	24	Female	Hyderabad	3	7	4	2.46	4	Included
17	30	Male	Ahmedabad	4	5	5	3.39	7	Included
18	31	Male	Hyderabad	2	5	6	2.14	6	Included
19	23	Male	Hyderabad	4	7	3	29.01	3	Excluded
20	30	Female	Hyderabad	1	6	5	2.89	4	Included
21	23	Male	Ahmedabad	3	6	7	3.67	5	Included
22	27	Male	Ahmedabad	4	6	5	Undefined	3	Excluded
23	35	Female	Hyderabad	4	6	5	2.35	5	Included

Table 22. GSR Study Data

Resistance and Skin Conductance Level

Participant	**Avg Sensor**	**Resistance (Ω)**	**Resistance (kΩ)**	**Skin Conductance Level (µS)**
1	455	339,298.25	339.30	2.95
2	467	435,111.11	435.11	2.30
3	471	479,512.20	479.51	2.09
4	463	397,959.18	397.96	2.51

5	468	445,454.55	445.45	2.24
6	450	310,322.58	310.32	3.22
7	468	445,454.55	445.45	2.24
8	446	290,303.03	290.30	3.44
9	462	389,600.00	389.60	2.57
10	456	345,714.29	345.71	2.89
11	465	415,744.68	415.74	2.41
12	467	435,111.11	435.11	2.30
13	464	406,666.67	406.67	2.46
14	464	406,666.67	406.67	2.46
15	439	260,547.95	260.55	3.84
16	464	406,666.67	406.67	2.46
17	447	295,076.92	295.08	3.39
18	470	467,619.05	467.62	2.14
19	136	34,468.09	34.47	29.01 *(Excluded – High SCL)*
20	456	345,714.29	345.71	2.89
21	442	272,571.43	272.57	3.67
22	512	Undefined	Undefined	— *(Excluded – No measurable response)*
23	466	425,217.39	425.22	2.35

Table 23. Resistance and Skin Conductance Level

Notes:

- Participants 19 and 22 are excluded from the final analysis.
- For Participant 22, readings were nearly identical to the calibration value (average = 511.9 ≈ 512), leading to undefined resistance/conductance.
- All other participants' values represent valid physiological data.