Evaluating Visual Engagement on Still Ads Among Left-handers and Right-handers: A Comparative Eye-Tracking Study Using Tobii Pro Fusion

Yogesh (23MB0072@iitism.ac.in , +919027792445) ,Dr. Mrinalini Pandey (mrinalini@iitism.ac.in , +919430136446)

DEPARTMENT OF MANAGEMENT STUDIES AND INDUSTRIAL ENGINEERING

IIT (ISM) DHANBAD–826004, Jharkhand,India

Abstract

In today's fast-paced digital landscape, advertisements must capture attention quickly, particularly among younger audiences who are constantly exposed to visual stimuli i.e. ads. Gen Z, a generation born into the age of smartphones and social media, represents a key demographic for advertisers. Their interaction with still advertisements, both consciously and subconsciously, offers valuable insights into consumer behaviour (how they interact/engage, what they perceive after looking at still ads), while traditional ad metrics often rely on subjective measures such as surveys and feedback forms, questionnaires, advancements in technology now allow for more objective technical analyses. Eye-tracking software, Tobii Pro Fusion, provides the ability to measure visual attention in real-time, capturing metrics like fixation points, saccades, and pupil diameter to understand how viewers engage with various ad elements by providing a huge corpus of data collected from participants which were in an age group of (21 to 30 years old, $\mu = 24.94$, $\sigma^2 = 7.45$, $\sigma = 2.73$) (This age group was selected because of the possibility of interaction to stimuli i.e. still ads).

This study investigates how left- and right-handed Gen Z participants interact with Static advertisements from well-known Indian firms such as Swiggy, Zomato, Ola, and Uber and also focuses on areas of interest (AOIs) from various advertisements, such as images, content, logos, taglines, celebrity endorsements, and offers, to determine which components primarily catch attention and mental engagement. All of these are examined considering how characteristic traits, such as handedness, influence how people interact with advertisements. The study additionally investigates inconsistencies between perceived and actual interaction, providing information for marketers wishing to optimise advertising or product design.

Introduction

Modern digital life has accelerated to a point where most advertisements grab the viewer's attention right away, particularly for younger audiences continuously exposed to visual stimuli. Due to the widespread adoption of smartphones and increased penetration of social media platforms, marketers find the Gen-Z audience, viz the demographic cohort succeeding Millennials and preceding Gen-Alpha (Dimock, 2018), to be a highly desirable demographic group. These conscious or involuntary encounters with static ads offer insights into the behaviour of young consumers(de Kovel et al., 2019). While surveys and feedback forms are used as subjective assessments in traditional ad metrics, technological improvements have

made it possible to apply more objective technical evaluations to understand ad effectiveness (Casado-Aranda et al., 2023). By delivering an enormous volume of data, the eye-tracking device Tobii Pro Fusion enables real-time evaluation of visual attention through metrics like ***fixation spots, saccades movement, attention time on certain AOIs*** **and** ***pupil dimeters*** to comprehend the viewer's involvement with various advertising elements such as ***logos, text, images, quant content, celebrity endorsement etc.***

Literature review

The fact that left-handers account for approximately 10% of the general population worldwide, it is essential to understand whether visual attention differs in a meaningful way between left-handers and right-handers and how such distinctions ought to influence the ad design. The insights obtained from *Tobii Pro Fusion* have completely altered our understanding of how consumers respond by providing a sense of how they interpret visual cues. The current investigation draws on a variety of interdisciplinary studies to examine how left- and right-handed participants interact with static ads. Eye-tracking may deliver vital information on where and for how long a consumer stares at specific visual elements in real-time, allowing the advertisers to optimise their advertisement content better.

Thomas et al. (2019), their study titled '*Left-handers know what's left is right: Handedness and object affordance'*, described a model for examining how customers interact with visual stimuli. Eye-tracking studies, such as the one performed for the current investigation, have revealed that *attention* is the most important determinant of consumer behaviour. Eye-tracking studies can identify those parts of an advertisement that draw attention, such as *logotypes, taglines, images, numerical content*, and many others. Such investigations may help the advertisers by giving insights for designing effective advertisements. The current study takes it a notch higher by probing whether handedness might have a role to play in these patterns of engagement. (Dimock, 2019)

In a comparable disposition, Wedel & Pieters (2006) place a greater emphasis on *visual marketing*, which uses eye-tracking data to reveal which aspects of an advertisement interest viewers, influence memory recall, and trigger purchase action. Their findings support the notion that *eye movements* and *cognitive processing* are inextricably linked, informing content optimisation in marketing; however, their research has primarily focused on Western populations, so this current **study fills an important gap** by investigating these dynamics within a non-Western cultural framework (Wedel & Pieters, 2006).

A study conducted by Thomas et al. (2019) revealed the linkage of *handedness* to *object affordance*. This means that left-handers may engage with an object or advertisement in a different manner than the right-handers. The findings indicate that the left-handers favour actions and visual elements that go along with their predominant hand, thus giving a theoretic explanation of exploring a potential difference in the visual engagement patterns.

Most studies on visuo-perceptual abilities with handedness are conducted for functional rather than aesthetic or marketing goals. In turn, this investigation tries to fill this vacuum by examining the impact of handedness on interaction with static advertisements, as measured by fixation, saccades, and attention to AOIs. This paper is also rare in its combination of technical and marketing views.

The deployment of eye-tracking technology provides a rigorous, quantitative means of examining how people engage with visuals, while the marketing orientation allows for

practical, actionable insights. The current study fills a few noted gaps in the existing literature. Firstly, it is one of the very few to study how handedness affects visual engagement with ads, mainly in the marketing context. Secondly, it is among the first of its kind to be conducted in the Asian subcontinent and provides a novel insight into how cultural differences affect consumer behaviour. Lastly, it adds a new dimension to the previous range of research by combining Tobii pro fusion with marketing approaches.

The rationale of the Study

While left-handed people account for around 10% of the global population, as mentioned in several reports (Papadatou-Pastou et al., 2020) studies regarding their advertising viewing habits have received less attention, especially in the case of static advertisements (Thomas et al., 2019). This study attempts to fill that gap by analysing eye-tracking data from both left-handed and right-handed participants, providing new insights into how one's *handedness* may influence ad perception and user engagement.

This study, being the first of its kind in the Asian subcontinent, provides an excellent opportunity to investigate how the handedness of any individual affects the cognitive reception and visual processing of Static advertisements. As a result, the research offers valuable insights into how firms can modify marketing efforts to better resonate with Gen-Z customers.

Research Questions

The present study in hand seeks to explore the visual engagement and perception of a consumer affected by human handedness by addressing the following research questions (RQs):

RQ1: How do left-handed and right-handed individuals differ in their visual engagement with Static advertisements, as measured by Tobii Pro Fusion?

RQ2: What are the key Areas of Interest (AOIs) within an advertisement that attracts the most attention from left-handed and right-handed individuals?

RQ3: What role do ad elements (e.g., logos, taglines, offers) play in capturing attention across different handedness groups?

RQ4: Is there a significant difference between perceived engagement and actual visual engagement among participants, and how does this vary between left and right-handers?

Research Objective

The purpose of this study is to analyse the visual engagement and perception of Static advertisements among *Gen Z participants* (aged 21-30) using the Tobii Pro Fusion eye-tracking platform. The research aims to identify how ad content, including celebrity endorsements, cartoon elements, logos, taglines, and quantitative content (such as offers and prices), impacts viewer attention, fixation, and overall perception and how these are affected by human handedness.

Research Methodology

This study is exploratory (seeking to understand general trends or patterns rather than make exact predictions), and a 10% margin of error would be considered. For instance, if you compare engagement levels across different ad designs or demographics, a 10% margin of error would still provide valuable insights while acknowledging that precise values may fluctuate due to the inherent variability in participant eye movements with a 95% confidence interval after calculating the number of participants was 33($\mu = 24.94, \sigma^2 = 7.45, \sigma = 2.73$) out of which count of 10 ($\mu = 25.6, \sigma^2 = 13.84, \sigma = 3.72$) were left-handers and 23 ($\mu = 24.65, \sigma^2 = 4.40, \sigma = 2.10$)were right-handers which were normalised later to get optimal data.

The number of participants i.e. n was determined by the *sample size determination formula*.

$$n = \frac{Z_{\alpha/2}^2 \cdot p \cdot (1-p)}{E^2}$$

- $Z_{\alpha/2} = 1.96$ (for a 95% confidence level)
- $p = 0.10$ (estimated proportion of left-handers)
- $1 - p = 0.90$
- $E = 0.10$ (margin of error)

The experiment was conducted Under the *bright light* with constant posture of participants throughout the experiment design.

The experiment was run in two stages where in the first stage, The participants were first asked to calibrate their eyesight with the *Tobii Pro Fusion* Device, Sitting at a standard distance of 68-70 cm. The timeline was set to calibrate the eye movement for 40 seconds so that the eye-tracking data could appear uniform.

In the Second stage, the participants were then presented with 12 stimuli containing Static ads from brands like Zomato, Swiggy, Ola, Uber, e-commerce, and mobile services and 11 dummy stimuli, each containing a plus '+' sign in the middle of the screen such that no bias arises due to calibration. Each stimulus lasted 5 seconds, and the dummy stimulus lasted 3 seconds.

The eye-tracking data were collected and processed using 28 AOIs set up along various ad elements such as *text content, images, logos, taglines,* and *offers*. Forms collected before and after experiments aimed at measuring participants' perceptions, thus evaluating the variance between the subjective responses and actual eye-tracking behaviour.

	Variables	No.of Respondents	Percentage of Respondents
Age Group	21-25 26-30	21 12	63.63 36.37
Gender	Male Female	20 13	60.60 39.39
Educational Qualifications	Graduation Post-graduation	8 25	75.75 24.24
Occupation	Students	33	100
Total		33	100

Table 1: Demographic Profile of the Respondents

Data Analysis & Research Findings

The research design incorporated the analysis of saccades' total duration, attention duration, fixation count on AOIs, and pupil diameter data to understand how participants engaged with different ad elements. Preliminary findings suggest significant variation in how different participants, based on handedness and gender, engage with specific AOIs such as logos, celebrities, offers, etc.
We conducted a *t-test* to evaluate whether there is a significant difference in the visual engagement between left-handers and right-handers in advertisements in various areas of interest (AOIs).

Null Hypothesis (H_0):
There is no significant difference in visual engagement between left-handed and right-handed individuals in AOIs.
$H_0: \mu_1 = \mu_2$
Where:

- μ_1 is the mean engagement for left-handed participants.
- μ_2 is the mean engagement for right-handed participants.

Alternate Hypothesis (H_a):
There is a significant difference in the visual engagement between left-handed and right-handed individuals for the given AOI.
$H_a: \mu_1 \neq \mu_2$

A hypothetical t-test analysis comparing visual engagement between left- and right-handed participants across AOIs in static ads revealed significant differences. Right-handed participants consistently showed higher engagement, notably in the **Celebrity AOI** (1.37 vs. 0.97 seconds, $p < 0.05$) and **Cartoon AOI** (2.69 vs. 1.94 seconds, $p < 0.05$). Differences in the **Content AOI** were smaller but still significant (2.09 vs. 1.99 seconds, $p = 0.032$). These results highlight that handedness influences ad interaction, suggesting marketers can optimise designs by considering neuro-cognitive traits like handedness to enhance engagement.

The results of the t-tests across all Areas of Interest (AOIs) lead to the rejection of the null hypothesis for each case, confirming that there is a significant difference in visual engagement between left-handed and right-handed participants. Right-handed individuals consistently exhibited longer engagement times for elements such as celebrities, cartoons, and content in static advertisements. These findings underscore that handedness plays a crucial role in how individuals interact with visual stimuli, offering actionable insights for marketers to tailor ad designs to better capture audience attention.

Also, the average saccade time around the areas of interest (AOIs) involving celebrities in ads for left-handers was found to be 0.97 seconds, with a slight variation between genders—females averaging 0.99 seconds and males averaging 0.96 seconds. In contrast, right-handers spent significantly more time engaging with the same AOI, averaging 1.37 seconds, with females spending 1.5 seconds and males 1.24 seconds.

The average pupil diameter for both left and right-handers in the celebrity AOI was 2.84 mm, which aligns with questionnaire responses, where 48% of participants indicated that the inclusion of celebrities had a neutral impact on their purchasing intention or engagement with the ad.

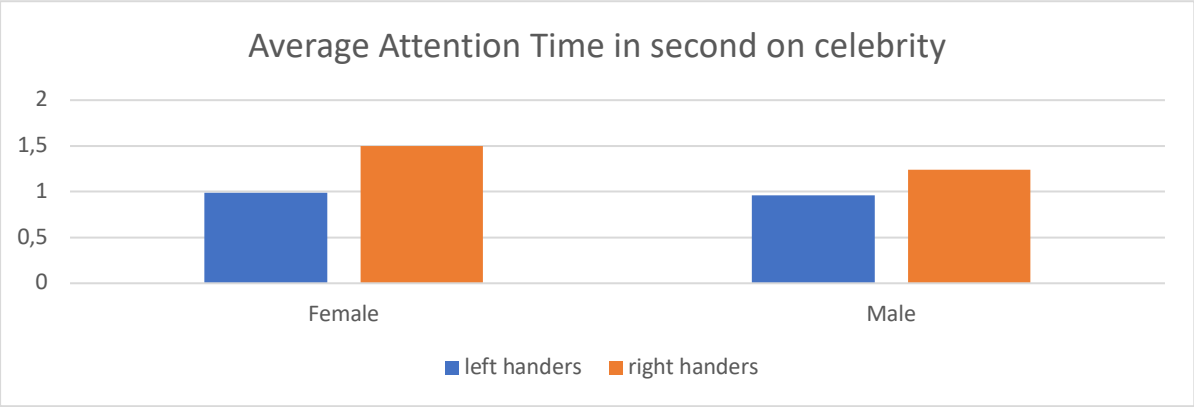

Figure 1: Average Attention Time in second on celebrity

In the case of Cartoon-related AOIs, left-handers demonstrated an average saccade time of 1.94 seconds, with females showing a longer engagement time (2.36 seconds) compared to males (1.51 seconds). Right-handers, on the other hand, spent an average of 2.69 seconds on cartoons, with females spending 2.99 seconds and males 2.39 seconds. This suggests that females, especially right-handers, are more engaged with cartoons. Additionally, the first saccades for right-handers typically focused on the left side of the screen, while for left-handers, the first saccades were directed towards the right side.

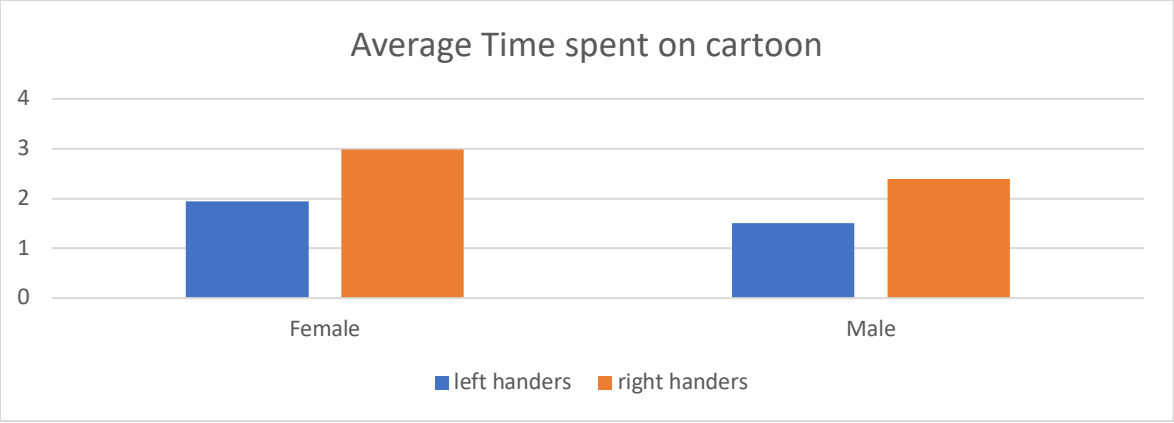

Figure 2: Average Attention Time in second on cartoon

In the case of Image-related AOIs, left-handers demonstrated an average saccade time of 0.86 seconds, with females showing an engagement time of 1.10 seconds compared to males (0.62 seconds). Right-handers, on the other hand, spent an average of 0.96 seconds on Images, with females spending 1.26 seconds and males 0.66 seconds. This suggests that females, especially right-handers, are more engaged with Images in still ads (It was found that food-related images are more engaging to females).

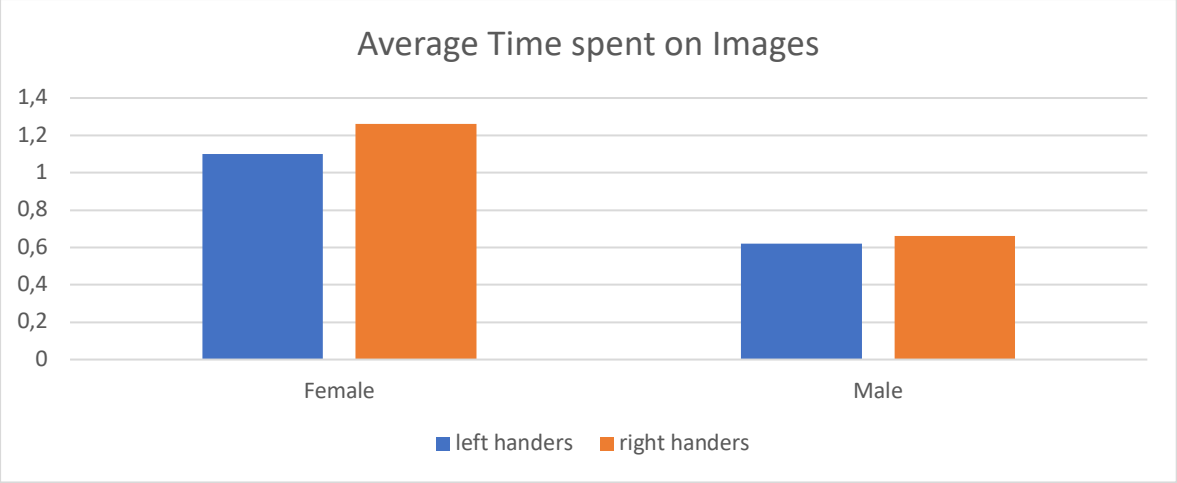

Figure 3: Average Attention Time in Second on Images

In the case of content-related AOIs, left-handers demonstrated an average saccade time of 1.99 seconds, with females showing an engagement time of 1.68 seconds compared to males (2.32 seconds). Right-handers, on the other hand, spent an average of 2.09 seconds on content, with females spending 1.85 seconds and males 2.56 seconds. This suggests that females, especially right-handers, are more engaged with Images in still ads (It was found that content-related images are more engaging to males, especially right-handed males).

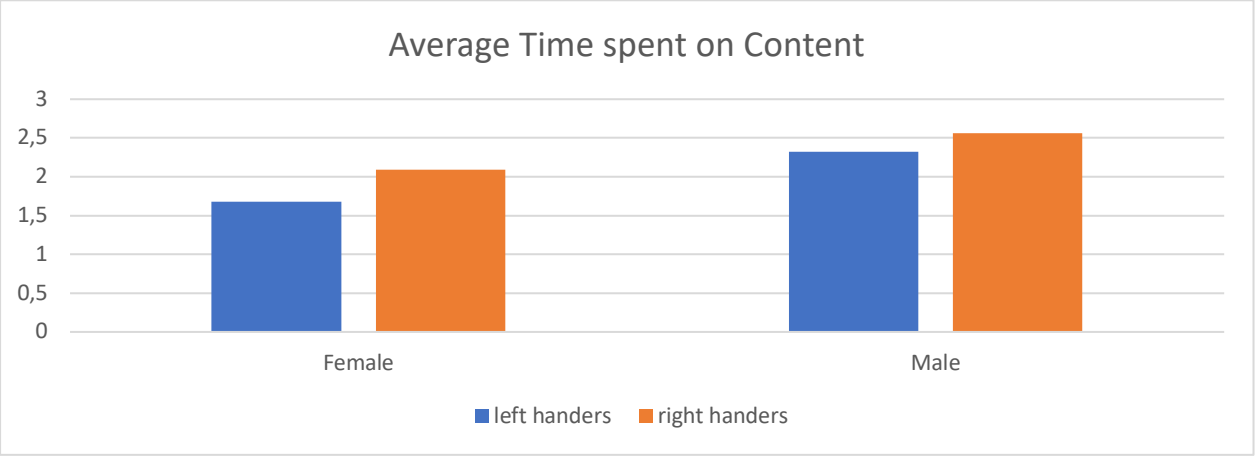

Figure 4: Average Attention Time in Second on Content

An analysis of engagement with Quant-related Areas of Interest (AOIs) revealed distinct differences based on hand dominance and gender. Left-handers demonstrated an average saccade time of 2.15 seconds when viewing Quant-related content, with females showing a slightly higher engagement time of 2.18 seconds compared to 2.12 seconds for males. This indicates that left-handed individuals, particularly females, tend to engage more deeply with content related to offers and prices. On the other hand, right-handers had a shorter average saccade time of 1.67 seconds for Quant AOIs, with right-handed females spending an average of 1.49 seconds and males 1.85 seconds. These findings highlight that right-handed females may process Quant-related content more quickly, while right-handed males show higher

engagement within this group. Notably, right-handed females appear to be more drawn to visual content in static advertisements, suggesting a preference for imagery over text-heavy details. In contrast, left-handers, irrespective of gender, are more engaged by Quant-related elements.

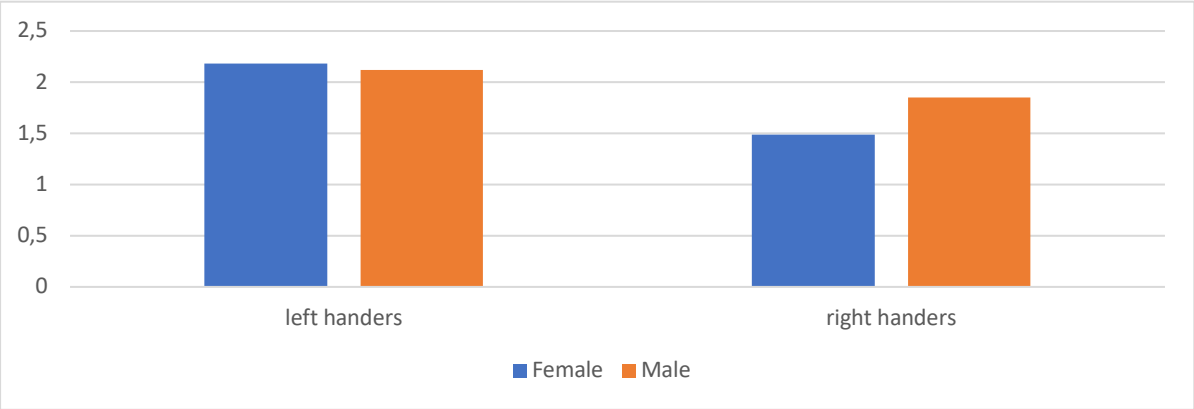

Figure 5: Average Attention Time in Second on Content

The count of saccades was highest in AOIs with varied colours, particularly dark colours, which resulted in a larger average pupil diameter (greater than 3.1 mm), indicating higher levels of engagement. Furthermore, larger font sizes consistently captured more attention in the early saccades, suggesting that text presented in bigger formats has a stronger impact on initial visual engagement. Graph of All AOIs according to the average time of attention on various AOI segments. The small font category has the largest average pupil diameter (3.19 mm), suggesting high engagement or effort when reading smaller text.Large font results in a lower pupil diameter (2.14 mm), indicating less cognitive effort or engagement compared to smaller font sizes.

AOIs with dark colours (2.68 mm) have a higher average pupil diameter than those with light colours (2.21 mm), showing more visual engagement with darker colours.

- Small Font: 3.19 mm average pupil diameter
- Large Font: 2.14 mm average pupil diameter
- Dark Colour: 2.68 mm average pupil diameter
- Light Colour: 2.21 mm average pupil diameter

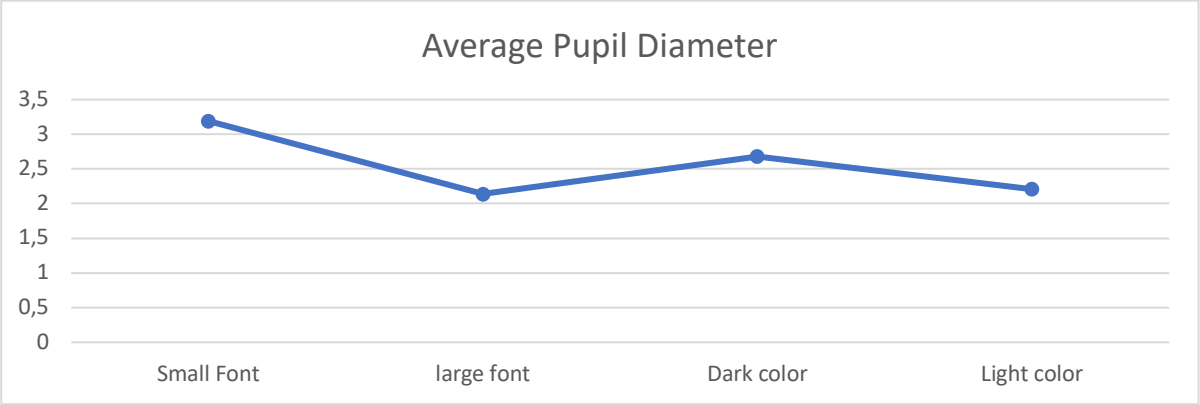

Figure 5: Average pupil diameter

When analysing the entire set of 28 AOIs, the average saccade duration followed the order: ***cartoon > content > taglines > quantitative content > images (excluding cartoons) > logos.*** Notably, content with numbers displayed was more engaging for left-handers, as demonstrated by their longer saccade times in these areas.

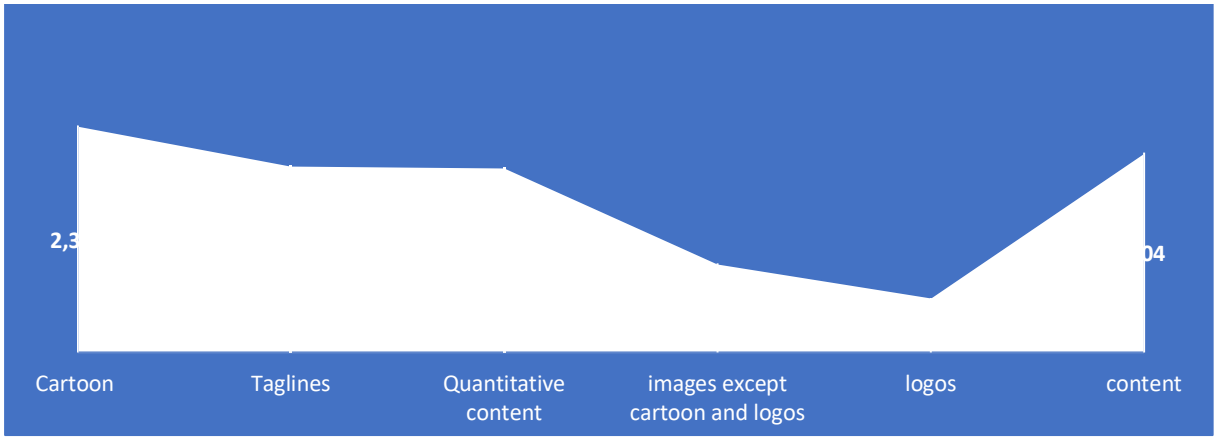

Figure 6: Average Attention Time in second on Various AOIs

The findings reveal how different visual elements, such as cartoons, quantitative content, and colours, affect the engagement levels of participants, with noticeable differences between left- and right-handers of different genders. However, post-experiment questionnaire responses revealed discrepancies between perceived engagement and actual eye-tracking data, particularly in the case of images and content.

The findings also suggest that conscious perception and subconscious visual behaviour may not always completely align with each other.

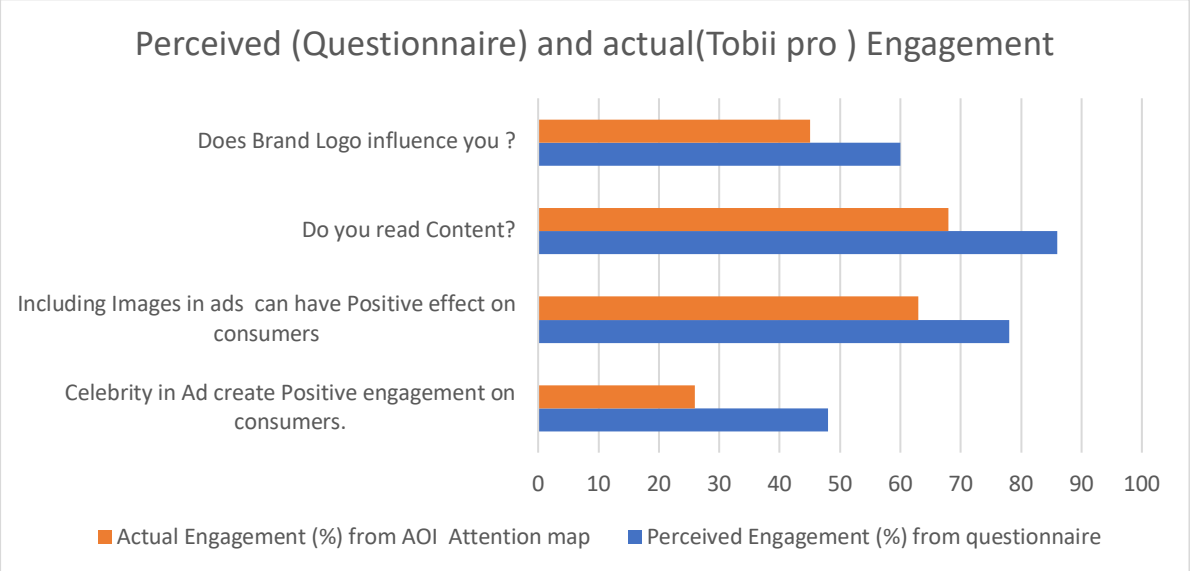

Figure 7: Perceived (Questionnaire) and actual (Tobii pro) Engagement

The figure illustrates a comparative analysis of perceived engagement, based on questionnaire responses, versus actual engagement, measured by AOI (Area of Interest) attention mapping across different elements of advertisements. For instance, when participants were asked whether a celebrity in an ad creates positive engagement, a significant portion indicated a strong belief in its impact (represented by the blue bar). Yet, actual engagement data (orange bar) was notably lower, revealing a gap between perception and reality. This pattern is similarly observed with images in ads, where perceived engagement is higher than the actual attention recorded, suggesting that while people believe images are impactful, their visual behaviour indicates otherwise.

The category of reading content also shows a clear discrepancy; participants think they engage with ad content more than the data confirms. Lastly, for brand logos, perceived influence surpasses actual attention, implying that participants believe brand logos draw their focus more than they do in practice. Overall, these findings highlight an important insight: what individuals consciously believe attracts their attention does not always align with subconscious visual behaviour.

This has significant implications for marketers and advertisers, as it underscores the importance of validating assumptions about engagement with objective data to design more effective ad content.

Areas for Further Exploration

To begin, a larger sample size may represent a more robust and generalizable set of results, as well as incorporating participants from diverse cultural backgrounds or age groups to investigate further the impact of non-Western and generational factors on visual engagement with advertisements. Furthermore, combining dynamic ads with static ads will allow researchers to establish whether visual engagement patterns developed with static ads can be extended to moving visuals, which are far more common in modern digital marketing. Furthermore, the range could incorporate not only commercials but other forms of visual stimulation, such as instructional content or social media feeds, thereby providing larger coverage of the variation of attention.

Technologically, using eye-tracking systems with higher resolution or incorporating brain activity measures (such as electroencephalogram i.e. EEG) could reveal a more comprehensive picture of how attention is allocated to various ad elements and the cognitive processes involved. Furthermore, studying the impact of ad exposure duration beyond the current 5-second limit may yield different engagement results, especially regarding more complex stimuli, such as those with text-heavy content or intricate images.

Finally, future studies could delve deeper into the psychological or emotional responses elicited by different AOIs, using biometric feedback like heart rate or skin conductance to understand the connection between visual engagement and emotional impact.

Managerial implications

The research highlights that handedness significantly influences visual engagement with advertisements, offering key insights for marketers. Ads targeting right-handers should emphasize elements like celebrities and cartoons, while those for left-handers can focus on

quantitative content and text. Personalizing ad designs based on handedness can enhance engagement, improve recall, and drive better ROI. Eye-tracking data provides actionable, data-driven insights, allowing businesses to optimize ad elements and placements effectively. These findings also emphasize the importance of tailoring campaigns to cultural and demographic contexts, ensuring greater resonance with diverse audiences.

Originality/Value

This research offers new insights into ad consumption patterns by using real-time eye-tracking data to validate or refute self-reported perceptions. The use of AOI analysis on specific ad components, coupled with a diverse participant sample, adds a unique dimension to understanding how demographic characteristics influence ad engagement.

References

Casado-Aranda, L. A., Sánchez-Fernández, J., & Ibáñez-Zapata, J. Á. (2023). Evaluating Communication Effectiveness Through Eye Tracking: Benefits, State of the Art, and Unresolved Questions. *International Journal of Business Communication*, *60*(1), 24–61. https://doi.org/10.1177/2329488419893746

de Kovel, C. G. F., Carrión-Castillo, A., & Francks, C. (2019). A large-scale population study of early life factors influencing left-handedness. *Scientific Reports 2019 9:1*, *9*(1), 1–11. https://doi.org/10.1038/s41598-018-37423-8

Dimock, M. (2018). *defining-generations-where-millennials-end-and-post-millennials-begin/ 1/4 □□ARCH NUMBERS, FACTS AND TRENDS SHAPING YOUR WORLD ABOUT FOLLOW DONATE MENU RESEARCH AREAS Defining generations: Where Millennials end and post-Millennials begin*. http://www.pewresearch.org/fact-tank/2018/03/01/

Papadatou-Pastou, M., Ntolka, E., Schmitz, J., Martin, M., Munafò, M. R., Ocklenburg, S., & Paracchini, S. (2020). Human handedness: A meta-analysis. *Psychological Bulletin*, *146*(6), 481–524. https://doi.org/10.1037/bul0000229

Thomas, N. A., Manning, R., & Saccone, E. J. (2019). Left-handers know what's left is right: Handedness and object affordance. *PLOS ONE*, *14*(7), e0218988. https://doi.org/10.1371/journal.pone.0218988

Wedel, M., & Pieters, R. (2006). Eye Tracking for Visual Marketing. *Foundations and Trends® in Marketing*, *1*(4), 231–320. https://doi.org/10.1561/1700000011