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EYE-TRACKER ANALYSIS OF CAR POSTER LAYOUT'S IMPACT ON THE ACQUISITION OF CAR PARAMETERS

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Abstract: Using eye-tracking technology, we conducted an in-depth exploration of how the differences in vehicle placement and layout structure in three Mercedes-Benz C-Class advertisement posters influence participants' attention to the performance specification text. By employing perception device data collection methods to capture participants' visual attention areas and combining eye-tracking technology to obtain data, we conducted an analytical study. The research found that different placement positions and layout structures led to significant differences in viewers' attention to the performance specification text in the advertisements, further affecting the effectiveness of information transmission in the ads. By studying visual attention, the aim is to provide useful references and guidance for future automobile advertisement design.
Keywords: Automobile advertisements; Eye-tracker analysis; Vehicle placement; Layout structure; Performance specification text

1 INTRODUCTION

In recent years, with the rapid development of the Internet, the ways of information dissemination and presentation have also been changing in countless ways. Obviously, with its large - scale creative space, strong visual impact, high degree of artistic expression, low production cost, and convenient application and other competitive advantages, posters play an irreplaceable role in the market. For example, in product - sales - related poster design, health - related public - welfare poster design, drama poster design, and movie poster design, etc. Through analysis, it is found that although the expressions of posters are emerging in an endless stream, the elements of posters are traceable. Symbols, texts, compositions, colors, and themes are all key elements for evaluating posters [1].
In poster design, composition is particularly important. It is the first step in the whole process and is of great significance for the combination and application of elements, the conveyance of information, and the creation of artistic sentiment [2].
In most automotive cultural environments, each vehicle adheres to its own different automotive design languages. Over time, these design languages have gradually evolved into intangible contemporary commercial values, forming a bottom - up DNA culture of automobile enterprises and carrying the value and price positioning of automotive products [3]. The emergence of eye - trackers has provided novel and effective tools for psychologists to use eye - movement technology to explore human visual information processing mechanisms under various conditions and to study their direct or indirect, wonderful and interesting relationships with psychological activities [4].
Automobile advertisements serve as a crucial means for brand promotion and product marketing, and their design plays a vital role in attracting viewers' attention and conveying product performance characteristics. However, the question of how vehicle placement and layout structure in advertisements affect viewers' attention to performance specification text has not been adequately explored. Therefore, this paper employs eye-tracking technology to conduct an in-depth analysis of three Mercedes-Benz C-Class advertisement posters, aiming to uncover the impact mechanism of vehicle placement and layout structure on the attention to performance specification text.

1.1 Experimental Objectives

The primary objective of this study is to thoroughly analyze and understand how differences in vehicle placement and layout structure within automobile advertisement posters impact participants' attention towards car performance specification text. The research aims to explore the influence of vehicle placement (such as centering versus off-centering and horizontal versus inclined positions) on participants' focus on performance specification text. Furthermore, it analyzes how varying layout structures (such as symmetrical balance, dynamism, and tension) affect participants' attention towards the performance specification text. By utilizing eye-tracking analysis technology, this study provides empirical data support to offer scientific justification for optimizing vehicle placement and layout structure in future automobile advertisement designs.

2 LITERATURE REVIEW

2.1 Research Background

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Development of Advertising Psychology: Advertising psychology applies fundamental principles of psychology to advertisement design, aiming to design advertisements that most effectively stimulate consumers' purchasing desires through in-depth exploration of their psychological processes and characteristics. With the continuous development of advertising psychology, an increasing number of research tools have been applied to evaluate advertisement effectiveness, among which the eye tracker is one. As an advanced psychological measurement instrument, the eye tracker can accurately record and analyze data such as viewers' gaze trajectories, fixation durations, fixation counts, and pupil diameter changes when viewing advertisements. These data provide an objective and scientific basis for evaluating advertisement effectiveness.

2.2 Experimental Significance

Complexity of Automobile Poster Design: Automobile poster design involves multiple elements such as brand, imagery, and copywriting, and the matching relationships, layout size, color schemes, and spatial positions among these elements all impact advertisement effectiveness. Therefore, how to design automobile posters that are both eye-catching and effectively convey information has become the focus of attention for advertisement designers and advertisers.And eye - tracker tracking technology will still be the most effective and scientific research method for a long time [5].

At present, there are a lot of studies on automotive print advertisements. Wedel and Pieters studied print advertisements by using the advertisement inserts in magazines. The results showed that the subjects looked at the pictures the most times, followed by the copy, and the brand received the fewest times of being looked at. However, because the average area occupied by pictures is the largest, followed by the copy and brand elements [6].

Enhancing Advertisement Effectiveness: By studying automobile poster design using an eye tracker, we can first understand viewers' visual behavior characteristics when viewing advertisements, such as gaze order and fixation durations. These data help advertisement designers optimize advertisement layout, adjust color schemes, and highlight important information, thereby enhancing advertisement attractiveness and dissemination effectiveness through design.

Guiding Advertisement Strategy Formulation: Eye tracker research can also reveal viewers' psychological activities when viewing advertisements, such as interest points and cognitive processes. This information helps advertisers understand consumer needs and preferences, thereby formulating more precise advertisement strategies and improving the targeting and effectiveness of advertisement placement.

Promoting Interdisciplinary Research: Studying automobile poster design using an eye tracker involves not only fields such as advertising and psychology but also design, engineering, and other disciplines. This interdisciplinary research helps drive the development and innovation of related disciplines, providing richer perspectives and ideas for the theory and practice of advertisement design.

Providing Objective Evaluation Basis: Traditional evaluation of advertisement design effectiveness often relies on subjective judgments and empirical summaries, lacking objectivity and scientificity. Eye tracker research provides an objective and quantitative evaluation method, offering a more reliable and accurate basis for evaluating advertisement design effectiveness

2.3 Domestic and Foreign Literature

2.3.1 Domestic literature

Research in "The Application of Eye Tracker Technology in Evaluating the Effectiveness of Automobile Print Advertisements" uses eye tracker technology to record viewers' gaze trajectories when viewing automobile posters, analyzing the impact of different design elements (such as color, layout, and text) on viewers' attention. These studies aid designers in more scientifically optimizing poster design and improving advertisement effectiveness.

Research in "A Study on Color Design of Vehicle Human-Machine Interface Based on Eye Movement Experiments" not only focuses on poster design but also extends to color design within vehicle interiors. Through eye movement experiments, researchers can understand drivers' visual attention patterns under different color schemes, providing a scientific basis for vehicle interior design [7].

In other aspects of eye tracker applications in the automobile industry, although literature directly addressing automobile poster design may be limited, eye tracker applications in other areas of the automobile industry (such as automotive styling feature line design and driving fatigue complexity judgment) also provide indirect references and inspiration for poster design.

2.3.2 Foreign literature

Research in "Evaluating Advertisement Effectiveness" by foreign scholars uses eye tracker technology to assess the attractiveness and effectiveness of automobile posters, revealing which elements in advertisements most attract viewers' attention by analyzing parameters such as fixation durations, fixation counts, and pupil changes.

Research in "Multimodal Data Fusion" indicates that with technological advancements, foreign studies have begun combining eye movement data with other biometric technologies (such as facial expression recognition and voice analysis) to obtain more comprehensive consumer response data. This multimodal data fusion method provides richer analytical dimensions for automobile poster design.

Using an eye tracker to study automobile poster design has important backgrounds and significance. It not only helps enhance advertisement effectiveness, guide advertisement strategy formulation, and promote interdisciplinary research

but also provides an objective and scientific basis for evaluating advertisement design effectiveness. However, domestic and foreign literature supporting the use of eye trackers to study automobile poster design is not abundant. These studies primarily focus on the visual design elements of posters themselves, lacking exploration of viewers' psychological mechanisms and cognitive processes during viewing, as well as the first point of retrieval for poster information. We hope that through continuous research by our group, the use of eye trackers in the field of automobile poster design will provide deeper insights into viewers' psychological activities and the first point of retrieval for poster information.

2.3.3 Domestic and foreign research status

Domestic researchers primarily use eye tracker technology to record and analyze key indicators such as viewers' eye movement trajectories, fixation durations, and fixation counts when viewing automobile posters. These data provide a scientific basis for evaluating poster design effectiveness.

The application of eye tracker technology in automobile poster design primarily focuses on advertisement effectiveness evaluation, consumer behavior analysis, and design optimization. Through eye movement data, researchers can reveal which design elements attract viewers' attention more and how these elements impact viewers' cognitive and emotional responses.

Domestic scholars have achieved some research results, such as discovering the influence patterns of specific color schemes, image layouts, or text content on viewers' attention through the analysis of eye movement data. These results provide valuable references for improving automobile poster design.

However, despite some progress in domestic research on automobile poster design using eye trackers, there are still challenges and deficiencies. For example, research objects may be relatively homogeneous, and there is a lack of exploration of viewers' psychological mechanisms and cognitive processes during viewing, as well as the first point of retrieval for poster information, which is the direction of our research. Domestic research methods may lack integration with other advanced technologies (such as electroencephalography), resulting in the comprehensiveness and accuracy of research results needing improvement.At the same time, in the aspect of automobile print advertising, the research recorded by eye tracker shows that the number of times that pictures are paid attention to is the most, followed by copywriting [8].

Foreign research on automobile poster design using eye trackers is relatively deeper and broader in scope. Researchers not only focus on the visual design elements of posters but also deeply explore viewers' psychological mechanisms and cognitive processes during viewing. Foreign research often involves cross-disciplinary collaboration among fields such as psychology, cognitive science, design, and marketing. This interdisciplinary collaboration provides a broader perspective and richer theoretical basis for the application of eye tracker technology in automobile poster design.

Foreign applications of eye tracker technology are more innovative and diverse. For example, eye movement data is combined with other biometric technologies such as facial expression recognition and voice analysis to obtain more comprehensive consumer response data; virtual reality (VR) and augmented reality (AR) technologies are used to simulate viewing experiences in real scenarios.

Foreign research results have not only had a wide impact in academia but have also received widespread attention and application from automobile companies and advertisers. Many automobile brands use eye tracker technology to optimize their poster designs, enhancing advertisement effectiveness and market competitiveness.

3 EXPERIMENTAL METHODS

This experiment aims to explore the impact of vehicle placement and layout structure in automobile advertising posters on participants' attention allocation towards performance indication text. The design is divided into three groups of experimental pictures, including center type and inclined composition for comparison [9].

3.1 First Group: Text Layout Variations

With the vehicle position held constant, the layout positions of the performance indication text within the posters (e.g., top, middle, right, etc.) are altered. This group analyzes changes in participants' attention to the text under different text layouts.

3.2 Second Group: Vehicle Orientation Changesv

Keeping the text layout fixed, the placement position and angle of the vehicle (e.g., front-facing, side-facing, etc.) are adjusted. This group observes how vehicle orientation affects participants' level of attention towards the performance text.

3.3 Third Group: Combined Factors

Combining the variables from the first two groups, both the vehicle placement and text layout are simultaneously altered. This group assesses the impact of these two factors combined on participants' attention.

An equal number of samples are selected for each experimental group to ensure the fairness of the experiment and the reliability of the results. Eye-tracking technology is employed to collect and analyze participants' attention duration and

focus on the performance indication text, quantifying attention allocation under different conditions and thus providing an in-depth analysis of the influence of vehicle placement and layout structure on participants' attention allocation.

4 EXPERIMENTAL PROCEDURE

4.1 Participant Preparation

Participants are informed of the experiment's purpose and procedure, then equipped with an eye tracker and calibrated to ensure accurate recording of eye movement data.

4.2 Experimental Tasks

Participants view three groups of images on a screen, each presented for 10 seconds, while their eye movement data is recorded. Experimental tasks include observing static images and conducting visual searches.

4.3 Data Recording

The eye tracker records participants' eye movement data during the experiment, including gaze scanpaths and fixation durations. These data will be used for subsequent data analysis and result interpretation.

5 EXPERIMENTAL RESULTS

The experimental results indicate that the placement of text and vehicles in automobile advertising posters significantly influences participants' attention. Specifically, when the text layout is near the top of the poster, participants' attention significantly increases, suggesting that shifting the visual center of gravity upwards can effectively attract viewers' attention. Experimental data shows that, across all observations, participants spent more time attending to performance indications on posters with text positioned at the top compared to those with text in the middle or bottom.

Furthermore, even when text position remains consistent, the orientation of the vehicle also has a notable impact on participants' attention. When vehicles are placed at dynamic, oblique angles, participants' focus on performance indication text significantly improves compared to front-facing or horizontal placements. The dynamic feel of the vehicle not only enhances the poster's visual impact but also indirectly guides viewers' gaze towards the text information, enhancing the reception of the message.

In the third group experiment, which considers both text layout and vehicle placement, we found that when vehicles are placed in a dynamic, oblique position and text is located at the top of the poster, participants' attention duration towards performance indications reaches a peak, significantly higher than the average attention duration under other combinations of conditions. This suggests that the synergistic effect of text layout and vehicle orientation can greatly enhance the communication effectiveness of advertising information.

These results reveal that in automobile advertising design, carefully arranging the layout of text and vehicle placement can effectively enhance the attractiveness of target information, providing important practical guidance for advertising design.

6 EXPERIMENTAL ANALYSIS

6.1 Data Visualization Analysis

6.1.1 Analysis of pupil diameter variations

The experimental results indicate that there are significant fluctuations in pupil diameter among subjects when viewing images. Specifically, pupil diameter expands correspondingly when the image content evokes high interest or increases cognitive load in the subjects; conversely, it contracts. This suggests that changes in pupil diameter can indeed reflect the subjects' visual attention state and cognitive processing.

It is noteworthy that there are differences in pupil diameter variations among different subjects under the same visual stimulation, which may be related to factors such as individual cognitive styles, interest preferences, and prior experiences (Figure 1).

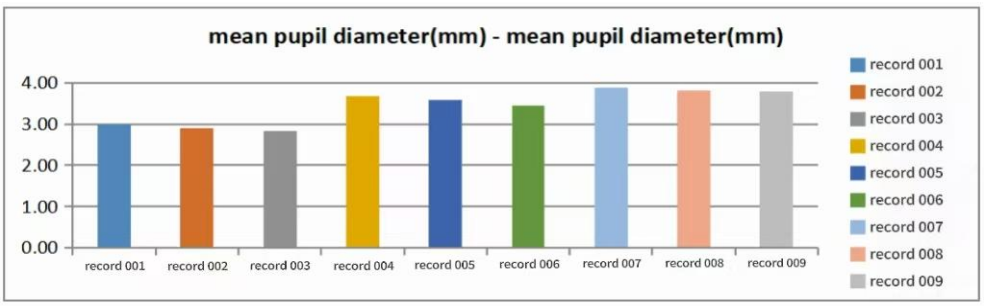

Figure 1 Mean Pupil Diameter

6.1.2 Analysis of saccadic eye movements and blinking behavior

The frequency and duration of saccadic eye movements reflect the efficiency of information acquisition in subjects' visual search processes. Experimental data show that both the number of saccades and the duration of saccadic movements increase when subjects view complex or information-dense images. This indicates that they need to employ more saccades to quickly locate and acquire information. The frequency of blinking may be associated with factors such as subjects' fatigue levels, interest levels, and cognitive loads. The experiment found that blinking rates increase when subjects are highly concentrated or feeling fatigued (Figure 2-3).

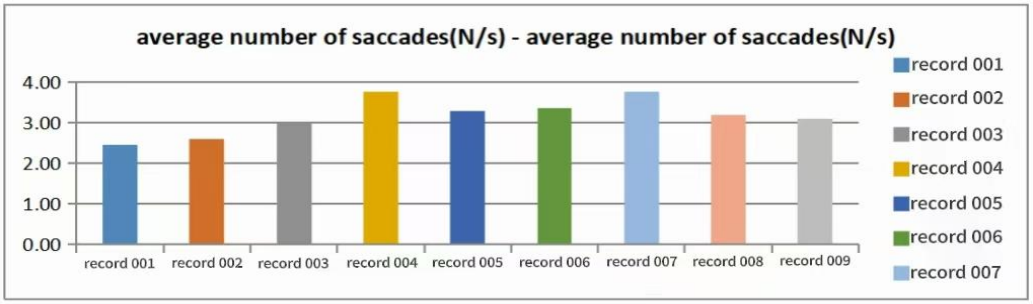

Figure 2 Average Number of Saccades

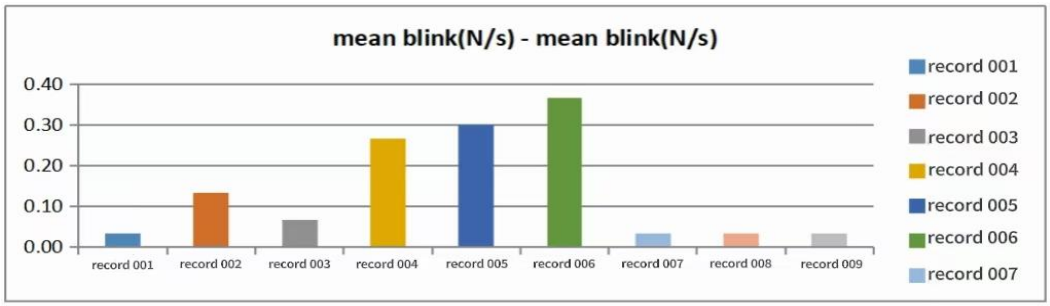

Figure 3 Mean Blink

6.1.3 Analysis of gaze point trajectories

The gaze point trajectory maps reveal the visual search paths and attention allocation patterns of subjects when viewing images. Emphasize the process of gazing [10], as well as the gazing time. The longer the gazing time is, the higher the degree of attention of the subjects to this area is [11]. We observed that subjects tend to first focus on salient areas in the image (such as objects, text, brightly colored sections, etc.), and gradually expand their gaze to other regions based on these initial focal points. Additionally, there are certain individual differences in gaze point trajectories among subjects, with some exhibiting more systematic search strategies while others appear more random and leapfrogging.

Analysis of Visual Preferences and Attention Allocation:

By analyzing data such as average horizontal distance, average vertical distance, and average absolute distance, we found that subjects exhibit specific visual preferences and attention allocation patterns when viewing images. Specifically, subjects are more inclined to focus on the central and salient feature areas of the image and spend more time gazing at these regions. Furthermore, there are also differences in visual preferences among subjects, with some possibly preferring to focus on detailed sections of the image while others prioritize the overall layout and aesthetic composition.

6.2 Comparative Analysis

6.2.1 Analysis of the impact of vehicle placement

Experimental results indicate that the placement of vehicles has a significant impact on subjects' attention to performance indication text. When the vehicle is positioned at the center of the poster, subjects' gaze primarily focuses on the vehicle's exterior design, with relatively lower attention paid to the performance indication text. This suggests that a centrally placed vehicle is more likely to capture the audience's attention but may result in the performance information being relatively overlooked.

In contrast, when the vehicle is positioned towards one side of the poster, subjects' gaze, while still attending to the vehicle's exterior, also notices the performance indication text more frequently. This placement breaks the symmetrical balance and guides the audience's gaze to move within the poster, thereby increasing attention to the performance information (Figure 4-5).

Figure 4 Car Poster a Comparison of the Placement of Vehicles in the Order of Attention

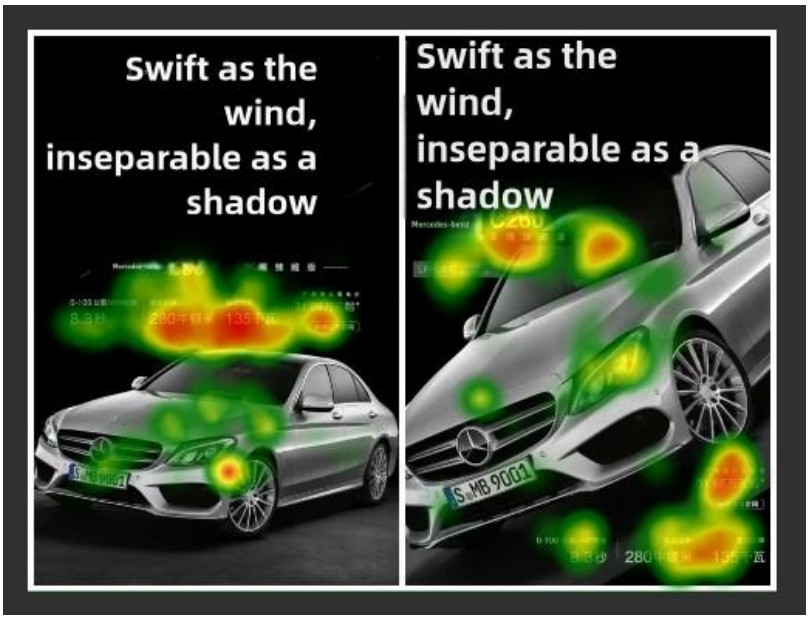

Figure 5 Car Poster Car Placement Position Comparison of Gaze Frequency Chart

6.2.2 Analysis of the impact of layout structure

Further analysis reveals that the impact of layout structure on subjects' attention to performance indication text is even more significant. A symmetrical and balanced layout draws viewers' attention more towards the overall image and aesthetic appeal of the vehicle, while neglecting the communication of performance information. In such layouts, performance indication text is often placed in a secondary position, resulting in lower attention from viewers.

Conversely, layouts with a sense of dynamism and tension can guide viewers' gaze to move within the poster, increasing attention to performance information. These layouts enhance visual impact, allowing viewers to appreciate the vehicle's exterior while also paying closer attention to its performance characteristics. Especially when performance indication text is integrated with dynamic elements of the vehicle, viewers' attention to it increases significantly (Figure 6-7).

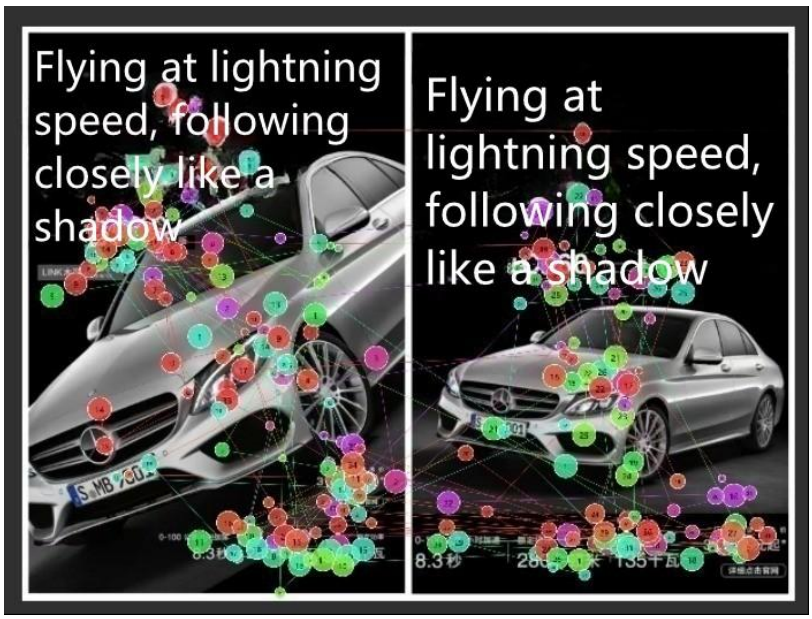

Figure 6 The Sequence Diagram of the Comparison of the Layout Structure of Car Posters The Sequence Diagram of the Comparison of the Layout Structure of Car Posters

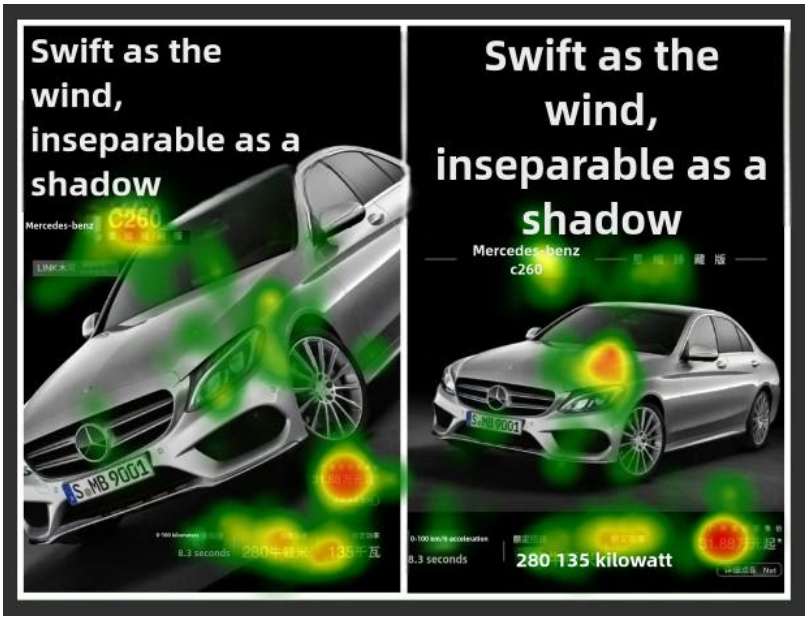

Figure 7 The Fixation Frequency Chart of the Comparison of Car Poster Layout Structure

6.2.3 Analysis of the impact of visual symmetry and balance

When a vehicle is positioned at the center of a poster, it acts like the protagonist on a stage, instantly capturing all attention. Subjects' focus primarily concentrates on the vehicle's exterior design, as they are deeply drawn by its elegant lines and unique styling. However, this central placement tends to make the performance indications easy to overlook, resulting in significantly lower attention. On the other hand, when the vehicle is positioned towards one side of the poster, it breaks the balance of the stage and creates a new visual flow. Subjects' gaze, while enjoying the vehicle's exterior, naturally shifts towards the performance indication text. This placement not only makes the vehicle's exterior more eye-catching but also allows the performance information to be discovered like a treasure, significantly increasing its attention.

In summary, visual symmetry and balance play a crucial role in determining how viewers perceive and engage with the content of a poster. A centrally placed vehicle may dominate the scene but may overshadow important performance information. Conversely, a more dynamic and off-center placement encourages viewers to explore the poster more thoroughly, increasing their engagement with both the vehicle's aesthetics and its performance details (Figure 8-9).

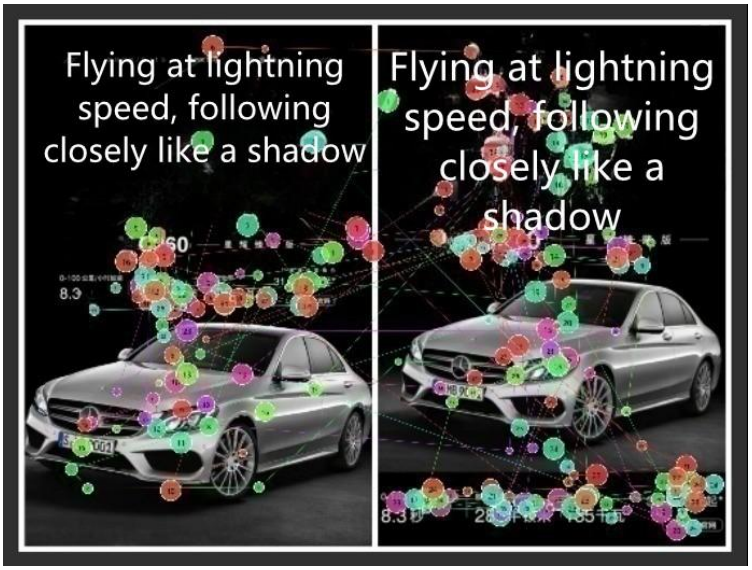

Figure 8 The Car Poster Layout Structure is Balanced or not to Look at the Sequence Diagram

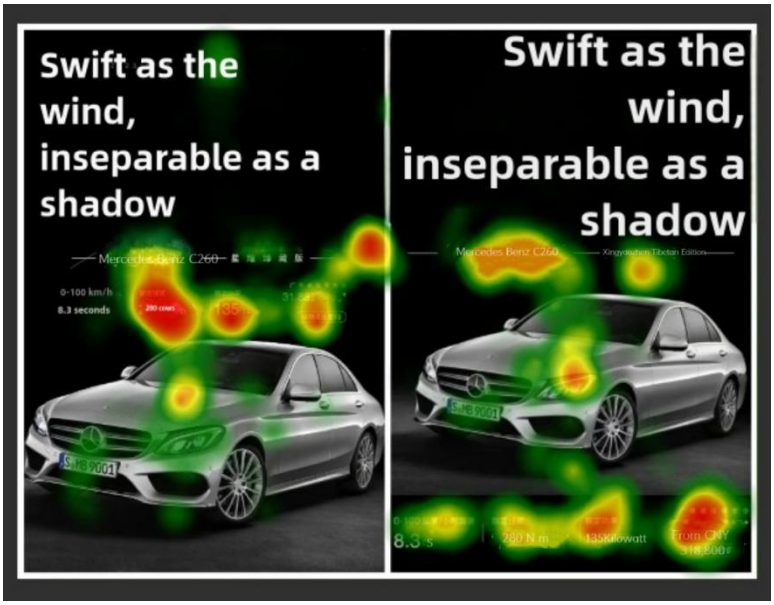

Figure 9 Car Poster Layout Structure Balance or not Fixation Frequency Chart

7 DISCUSSION

The study employed sophisticated eye-tracking technology to conduct an in-depth and systematic analysis of the complex impacts of vehicle placement and layout structure on viewers' attention to automobile parameters in automotive poster design. The research results indicate that both vehicle placement and text layout are core factors influencing viewers' visual attention. These findings provide invaluable practical guidance for the field of automotive advertising design. The conclusions of this study align with numerous previous research findings in the areas of advertising psychology and visual attention, while further refining the specific roles of vehicle placement and layout structure in the communication of advertising information. The research reveals that when vehicles are laid out in a non-central position,biased to one side,and text is designed at the top of the poster, it can effectively guide viewers' gaze flow and significantly increase their attention to performance indication text.

Despite these findings, the study still faces some limitations. For example, the representativeness of the experimental samples could be improved, and the individual differences in eye-tracking data may also affect the research results. To overcome these limitations, future research should strive to further expand the sample size to include more brands, models, and advertising styles, thereby validating the universality and reliability of the findings of this study. Additionally, by combining other advanced biometric technologies and electroencephalogram (EEG) technology, researchers can delve deeper into the psychological mechanisms and cognitive processes of viewers when they view automotive posters, providing more comprehensive and scientific guidance for the field of automotive advertising design.

8 CONCLUSION AND FUTURE DIRECTIONS

This study demonstrates that variations in vehicle placement and layout structure have a significant impact on the attention paid to performance indication text in automotive advertisements. To optimize the effectiveness of advertising design, designers are advised to consider placing vehicles off-center to direct viewers' attention to performance indication text. Additionally, adopting dynamic and tension-filled layout structures can further enhance viewers' attention to performance information.Designers can also pay attention to the influence of top - down or bottom - up factors on consumers to carry out poster design [12].

For future research, it would be beneficial to further explore the impact of vehicle placement and layout structure on the attention paid to performance indication text in automotive advertisements for different brands and models. Furthermore, there is potential to investigate the application of new technologies in automotive advertising design. By doing so, the field can continue to evolve and adapt, leveraging the latest advancements to create more engaging and effective advertisements. In addition, the experimental objects in this study are applied - type poster designs. Different from the research in other fields of psychology, the classification of its design languages is somewhat fuzzy in itself. Therefore, this experiment is only applicable to the discussion of the application effects of the two pun techniques of figure - ground conformal and figure - ground collinear in poster design [13].

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COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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