

Analysis of Front-End Design in New Energy Vehicles Based on Theory of Visual Perception Dynamics

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Abstract. This study aims to explore how the distribution of visual forces in the front-end design of new energy vehicles influences the overall image of the vehicle and market preferences, providing theoretical references for designers. The study is grounded in the theory of visual perception dynamics, combined with the semantic differential method, and involves a detailed analysis of the front-end designs of four popular new energy SUVs. It begins by selecting new energy vehicle samples based on user surveys, then establishes a semantic vocabulary, and gathers public impressions of the front-end designs of the four models. These designs are then subjected to an in-depth analysis using the theory of visual perception dynamics to examine the distribution of visual forces. The results indicate that different distributions of visual forces and design strategies can effectively convey various visual impressions of the vehicle, thereby meeting the aesthetic needs of different consumer groups. Dynamic visual effects can be created by combining opposing and ascending forces; power and dominance are conveyed through repeated opposition and the convergence of visual elements; elegance and dignity emerge from a balanced distribution of forces; and stability is reinforced by emphasizing horizontal divergence and shifting the visual center downward. This study provides new perspectives and methods for front-end design in new energy vehicles, with the hope of positively influencing future design practices.

Keywords: Theory of Visual Perception Dynamics, Semantic Differential Method, New Energy Vehicles, Front-End Design.

1. Introduction

The potential for consumer demand in the new energy vehicle (NEV) market continues to grow. According to data from the Ministry of Commerce, China's automobile sales in 2023 maintained a strong growth trend, with a total of 30.094 million vehicles sold, marking a 12% year-on-year increase and securing the top global position for the 15th consecutive year. Among these, NEV sales reached 9.495 million units, representing a 37.9% increase from the previous year and accounting for 31.6% of total automobile sales [1]. Marty Dropkin, Head of Equities, Asia Pacific at Fidelity International, pointed out that mainland China holds a leading position in the NEV market, largely due to innovations in the automotive industry that have accelerated the transition to electrification and intelligent technologies. This shift has not only driven advancements in vehicle design and development technologies but also improved cost-effectiveness and production efficiency.

Changes in consumer demographics and the homogenization of technologies have made the exterior design of vehicles a critical factor in determining automotive sales [2]. According to Maslow's hierarchy of needs, once basic needs are met, consumer expectations for vehicles extend beyond performance enhancements to include aesthetic innovation that satisfies emotional and aesthetic desires [3]. The front-end design of vehicles is a crucial component of automotive exterior design, serving as a key cognitive factor that influences the vehicle's overall visual impression [4]. The front-end is vital for conveying brand characteristics and design concepts, and it is also a significant aspect of brand differentiation [5]. Therefore, the importance of front-end design in the automotive industry cannot be overstated.

Currently, both domestic and international scholars have employed various methods and perspectives to study front-end vehicle design. For example, Fu et al. introduced facial aesthetics research into the study of automotive aesthetics, using facial models as a reference to establish a

quantitative model for vehicle front-end design evaluation and aesthetic analysis [6]. Guo Ruoyu and others applied the theory of visual perception dynamics to analyze the visual forces expressed in vehicle front-end design, exploring innovative methods for front-end design [7]. Li et al. based on the theory of visual perception dynamics, analyzed and summarized the visual dynamics methods and principles reflected in automotive forms from both rational and emotional visual force perspectives, contributing to research in vehicle design [8]. Zhou conducted an analysis of the front-end design of Geely brand sedans using Gestalt psychology theory as the framework [5]. Wang et al. studied the visual imagery of front-end designs in micro new energy vehicles (NEVs) in relation to Gestalt principles, proposing innovative design methods for the front-end of micro NEVs [9].

As can be seen, most scholars in the field of automotive design research have focused on visual perception or employed its fundamental principles, showcasing the advantages of this approach in the field. However, relatively few scholars have applied this method to the analysis of NEV front-end design, resulting in a lack of comprehensive theoretical frameworks specific to NEV front-end design. NEVs differ significantly from traditional fuel vehicles in both structure and design. Based on this, the present study aims to analyze NEV front-end design from the perspective of visual perception dynamics, combined with the semantic differential method, to provide theoretical references for future design endeavors.

2. Introduction to the Theory of Visual Perception Dynamics

Gestalt psychology primarily focuses on the fields of vision and sensation and serves as the foundation for the theory of visual perception dynamics. Gestalt psychologist Rudolf Arnheim, building on the Gestalt psychology theory of "isomorphism," developed the theory of visual perception dynamics in the 19th century [7]. His seminal work, *Art and Visual Perception*, was highly praised by Sir Herbert Read, an eminent British art historian, art critic, and president of the British Society of Aesthetics. Read described it as "a highly significant work that systematically applies Gestalt psychology to the visual arts. It provides a scientific basis for various topics in the psychology of art, which is bound to have a profound impact" [10].

Arnheim posited that every visual pattern is a pattern of forces, much like a living organism cannot be described merely by the methods used to describe a dead anatomical specimen. Similarly, the essence of visual experience cannot be fully described by static measures such as distance, size, angle, dimension, or the wavelength of colors. These static measures can only define the external "stimuli"—that is, the information transmitted from the physical world to the eyes. However, the life of the perceptual object—its emotional expression and meaning—is determined by "visual forces" [11].

This process of subjectively, holistically, and essentially perceiving an object is what is referred to as "Gestalt." The most fundamental Gestalt principles include wholeness, selectivity, simplicity, and the proximity-similarity principle. The formation of "visual forces" is a manifestation of the tendencies that emerge during the Gestalt process [8].

In the context of automotive design, Guo et al. applied the theory of visual perception dynamics to analyze how visual forces are generated in the front-end design of vehicles. For instance, minimal deformation in design patterns generates a horizontal, gentle divergent force, while compact local design elements create an antagonistic force. The combination of vertical and horizontal lines produces vertical and horizontal forces, respectively, and similar deformations in the upper and lower grilles create vertical, congruent forces [7]. Li Zhuo et al. divided the visual forces in automotive design into rational visual forces, which are formed by physical patterns, and emotional visual forces, which are formed by visual imagery. They identified three common dynamic patterns in automotive forms: the tension created by the overall proportion of the body, the dynamics generated by the inclination and deformation characteristics of the form, and the interaction forces among various elements of the vehicle [8].

Based on the research conducted by these scholars, this study categorizes the formation of visual forces in vehicle front-end design into four aspects, which are:

2.1. Tension Created by Front-End Proportions

The degree of visual tension in the front-end design of a vehicle is influenced by the proportion of the front-end area occupied by the grille (or areas left blank). According to Gestalt psychology, individuals tend to perceive complete shapes and patterns. A large grille or a blank area might visually disrupt the integrity of the front-end, prompting the observer's brain to subconsciously "fill in" this perceived "incompleteness," thereby generating tension. Additionally, the contrast in area proportions further enhances visual tension.

2.2. Inclined Patterns

Inclined patterns in design contribute to the generation of visual forces. An inclined pattern occurs when a standard form deviates from its horizontal or vertical orientation, causing a shift in the observer's visual center. The psychological tendency to restore this deviation to a more stable position results in a dynamic force, creating visual tension. For example, an inclined tapering line in the front-end of a vehicle can generate a clear visual trajectory, imparting a sense of force.

2.3. Deformed Patterns

Deformations in shape also produce visual forces. A deformed pattern refers to the alteration of a standard shape due to the application of an external force, leading to a deviation from its "stable" state. The characteristic of visual perception to seek a return to a "stable" state generates visual forces. In the realm of forms, perfect circles, squares, and regular polygons are considered standard shapes with uniform distribution around a central point, representing a stable state. For instance, a flattened rectangle generates horizontal stretching forces, a parallelogram induces stretching forces along its major diagonal, and an ellipse produces stretching forces along its major axis or compressive forces along its minor axis. In the design of a vehicle's front-end, elements such as grilles, headlight assemblies, and fog lamp units typically arise from the deformation or combination of basic shapes, leading to complex visual force effects.

2.4. Interaction Forces Between Shapes

In physical terms, a larger mass exerts an attractive force on a smaller mass. Similarly, in visual terms, larger shapes exert an attractive force on smaller shapes, establishing a dominant-subordinate attraction. Additionally, according to the Gestalt principles of wholeness and proximity-similarity, complementary or reciprocal relationships between shapes can also create attractive forces. Conversely, incompatibility between shapes or opposing directions of visual forces can lead to repulsive forces. Shapes that are similar and have visual forces oriented in the same direction can generate congruent forces. Attraction and congruent forces contribute to a unified and harmonious overall design, while repulsive forces enhance the sense of internal motion.

3. Analysis of Front-End Design in New Energy Vehicles

The analysis begins with the selection of new energy vehicle (NEV) samples based on user surveys. Subsequently, the semantic differential method is employed to study these samples, yielding corresponding emotional visual imagery for each sample. Finally, an in-depth analysis of the samples is conducted using the theory of visual perception dynamics, providing insights and references for the design of front-end aesthetics in new energy vehicles.

3.1. Selection of New Energy Vehicle Samples

SUV models, known for their spacious interiors, superior off-road capabilities, and versatility, have demonstrated a consistent trend of strong market demand and sales growth globally, particularly in the Chinese market. With the rapid advancement of electric vehicle technology, an increasing number of SUV models have introduced electric versions, significantly expanding the range of new energy SUVs available in the market. Therefore, selecting SUV models as the subject of this study

on the front-end design of new energy vehicles (NEVs) allows for a more accurate reflection of market design trends and a deeper exploration of consumer aesthetic preferences within the NEV sector.

High-sales models hold significant representativeness in market research, accurately reflecting current consumer trends and preferences regarding functionality, configuration, and exterior design. Such models are typically well-received by the market, enjoying high levels of acceptance, and their front-end designs are often widely appreciated. The sales data of these models provide reliable and insightful market feedback, offering empirical support for subsequent design improvements. Consequently, this study selects the top eight models from the 2023 sales rankings of new energy SUVs in China for analysis. These eight models are, in order: Model Y, Song PLUS, Yuan PLUS, AION Y, Song Pro, Li Auto L7, Tang, and Li Auto L8 [12].

While sales figures are a crucial indicator of a vehicle's popularity in the market, they do not directly demonstrate consumer preferences for specific front-end designs. Therefore, the author conducted a survey to gauge public preferences for the front-end designs of the aforementioned eight models. To ensure comprehensive and reliable data, a detailed questionnaire was designed using a Likert Scale for scoring, as shown in Table 1 [13]. The specific scoring criteria are as follows: 5 points for "strongly like," 4 points for "like," 3 points for "neutral," 2 points for "dislike," and 1 point for "strongly dislike." The questionnaire design included collecting respondents' basic demographic information, scoring the front-end design of each model, and incorporating open-ended questions to gather qualitative data. The questionnaire was distributed both online (via social media, email, and survey platforms) and offline (at car exhibitions and shopping malls) to ensure a broad survey population.

For data analysis, the quantitative scores were analyzed by calculating the mean scores and conducting reliability analysis. Feedback from the open-ended questions was also compiled to identify common opinions and suggestions. This comprehensive approach enabled the author to gain a deeper understanding of public preferences regarding the front-end designs of these eight SUV NEVs, thereby scientifically selecting the NEV samples for this study.



Figure 1. Experimental samples of new energy vehicles.

Table 1. Selected Survey Questions on the Front-End Design of New Energy SUVs.

vehicles	strongly like	like	neutral	dislike	strongly dislike
No.1 	5	4	3	2	1
No.2 	5	4	3	2	1
...	...	...	...	...	...
No.8 	5	4	3	2	1

A total of 1,982 valid questionnaires were collected for this survey, with a nearly equal gender distribution: 1,013 male respondents and 969 female respondents, meeting the requirements for statistical validity. The age range of respondents was broad, ensuring representation across different age groups: 25% were aged 18-25, 40% were aged 26-35, 20% were aged 36-45, and 15% were aged over 45. Regarding occupational distribution, respondents included corporate professionals (30%), students (25%), teachers (15%), government employees and public institution staff (10%), technical personnel (10%), and other professions (10%). This diversity in occupational backgrounds ensures a wide-ranging and varied survey sample. Additionally, 70% of the respondents had driving experience, while 30% did not, allowing for a comprehensive reflection of the preferences for SUV NEV front-end designs across different driving experience groups.

To measure the reliability of the survey results, Cronbach's alpha coefficient was calculated. The formula for Cronbach's alpha is as follows:

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum S_i^2}{S_x^2} \right) \quad (1)$$

Where K is the number of items in the survey, S_i^2 represents the variance of scores on each individual item, and S_x^2 denotes the variance of the total scores across all respondents. Generally, an alpha value of $\alpha \geq 0.9$ indicates excellent reliability; $0.7 \leq \alpha < 0.9$ indicates good reliability; $0.6 \leq \alpha < 0.7$ is considered acceptable; $0.5 \leq \alpha < 0.6$ indicates weak reliability; And $\alpha < 0.5$ is deemed unacceptable.

Applying this formula for reliability testing, the reliability coefficient for the scale was found to be $\alpha = 0.936 > 0.9$, indicating that the survey data has high reliability. This ensures the subsequent analysis of the survey results is accurate and effective.

The average scores for each vehicle model are shown in Figure 2:

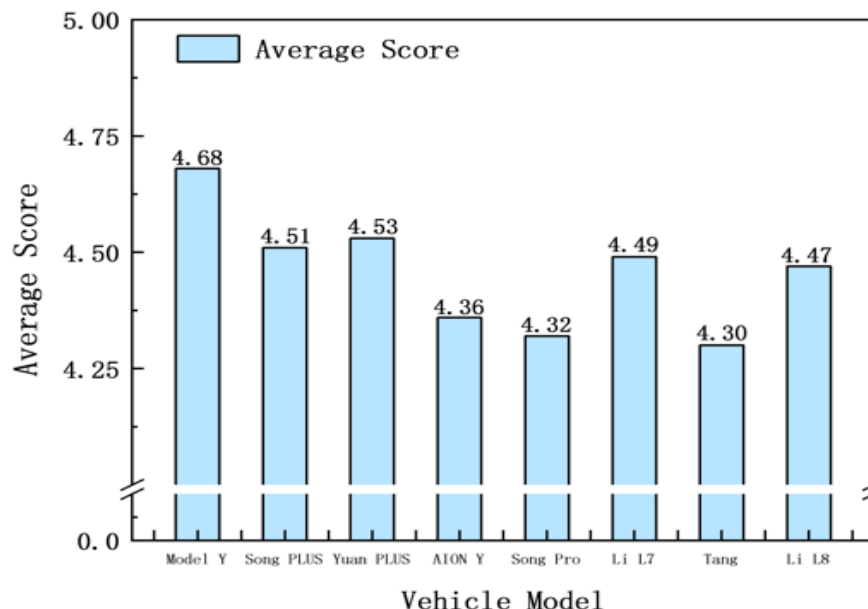


Figure 2. Average Scores for Each Vehicle Model.

The results indicate that the average scores ranked as follows: Model Y, Yuan PLUS, Song PLUS, and Li Auto L7 took the top four positions, respectively. The rankings for positions 5-8 were Li Auto L8, AION Y, Song Pro, and Tang. Consequently, this study selected the top four scoring vehicles for further analysis.

Based on a cross-analysis of the survey results, the study found that these four vehicles exhibited distinct characteristics within specific consumer groups:

Model Y consistently scored highly across all age groups and occupational categories, with particularly strong appeal among the 18-25 year-old demographic. Therefore, Model Y was selected as the primary focus for analyzing young consumer preferences.

Yuan PLUS achieved the highest average score among respondents who are corporate professionals, suggesting that its front-end design may possess elements that particularly attract this occupational group.

Song PLUS performed exceptionally well among female respondents, which may be attributed to its more refined design style and a precise understanding of female consumer needs. As a result, Song PLUS was chosen as a representative case for studying female consumer preferences.

Li Auto L7 was particularly favored by the 26-35 and 36-45 year-old middle-aged demographic. Hence, Li Auto L7 was included for an in-depth analysis of the preferences of middle-aged consumers.

3.2. Establishment of the Semantic Vocabulary

The Semantic Differential Method (SD) is a psychological research technique used to project users' mental attitudes through a semantic differential scale, which reflects consumer psychology [14]. In this study, a semantic differential scale was incorporated into the questionnaire to investigate the public's emotional impressions of the front-end designs of the four selected vehicles. This approach aimed to identify the different perceptions generated by various visual forces in the front-end designs.

The process began by reviewing relevant literature and conducting expert interviews to collect 60 affective adjectives related to automotive design. These adjectives were then grouped and cross-compared, ultimately resulting in the selection of 6 pairs of antonymous affective adjectives: dynamic–stable, powerful–gentle, novel–traditional, elegant–rugged, modern–retro, and bold–reserved [15]. These word pairs formed the semantic vocabulary, serving as the material for testing emotional impressions.

The top four vehicles from the questionnaire survey were used as test subjects. A group of 100 participants, representing various occupations and age groups, were invited to evaluate the emotional imagery of the front-end designs using a 5-point semantic differential scale. The scale was scored from -2 to 2, as shown in Table.2 [16]. A total of 100 valid scales were collected, providing the average scores for the six pairs of semantic adjectives across the four vehicle front-end designs, as shown in Table.3.

Table 2. Sample Questionnaire Responses.

	Model Y					
	2	1	0	-1	-2	
dynamic	√					stable
powerful		√				gentle
novel		√				traditional
elegant				√		rugged
modern		√				retro
bold			√			reserved

Table 3. Average Scores of Front-End Imagery for the Four Vehicles.

Semantic Adjective	dynamic stable	powerful gentle	novel traditional	elegant rugged	modern retro	bold reserved
Model Y Average Score	1.92	0.76	0.89	-0.32	0.72	0.46
Yuan PLUS Average Score	0.97	1.88	-0.45	-0.59	0.12	0.89
Song PLUS Average Score	-0.73	-0.95	-0.67	1.79	0.24	-0.14
Li Auto L7 Average Score	-1.94	0.52	-0.78	-0.12	0.34	-0.26

The data indicate that the front-end design of the Model Y is strongly associated with the semantic adjective "dynamic." The front-end design of Yuan PLUS is strongly correlated with the adjective "powerful," while the front-end design of Song PLUS is closely linked with the adjective "elegant." Finally, the front-end design of Li Auto L7 is strongly associated with the adjective "stable." This study will further analyze the front-end designs of new energy vehicles based on these identified semantic associations.

3.3. Analysis of Front-End Design in New Energy Vehicles

In the front-end design of new energy vehicles (NEVs), the distribution of visual forces plays a crucial role in shaping the vehicle's overall image and market appeal. Particularly when targeting different consumer groups, the details and stylistic choices in the front-end design can significantly influence consumers' emotional identification and purchasing decisions. This section will provide a detailed analysis of the front-end designs of four popular new energy SUVs from the perspective of visual forces, using the visual impressions obtained from the Semantic Differential Method. The aim is to uncover how these designs convey their unique styles and market positioning through the strategic allocation of visual forces and the setting of visual focal points.

3.3.1. Analysis of the Front-End Design of Model Y

The analysis of the visual forces in the front-end design of Model Y is illustrated in Figure 3. The front-end design of the Model Y, with its sharp lines and bold angular transitions, effectively caters to the aesthetic preferences of young consumers who favor modern vehicles. The upper portion of the front-end features pronounced deformations and angular shifts, creating a strong sense of visual antagonism, which imparts a dynamic feel to the overall front profile. This design not only conveys a sharp and aggressive visual impression but also aligns with the psychological needs of younger individuals who seek individuality and a sporty character in their vehicles.

In the middle section of the front-end, where the grille traditionally resides in conventional fuel-powered vehicles, the Model Y opts for a subtle deformation design. The shape mirrors that of the lower grille, creating a vertical congruent force directed upward. This design choice provides a visual lift, making the front-end appear more agile, lightweight, and vibrant, thereby enhancing the vehicle's dynamic expression. This approach resonates with the younger consumer's expectations for vehicle agility and sporty characteristics.

The lower section of the front-end employs horizontal divergent visual forces to convey a broad and open visual impression, further emphasized by the deformation of the fog lamps, which reinforces the expression of horizontal forces. This design contrasts with the sharp lines of the upper section, ensuring that the overall shape retains the necessary sense of security typical of an SUV, while also preserving a sporty and dynamic character. The distribution of visual forces in this design not only gives the vehicle a visually striking presence but also meets the expectations of young consumers for a vehicle that is dynamic, agile, and modern.

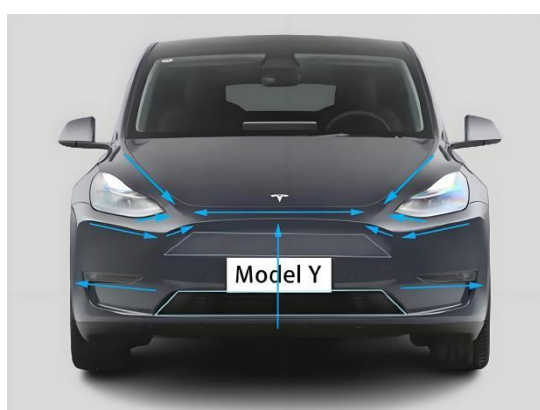


Figure 3. Analysis of Visual Forces in the Front-End Design of Model Y.

3.3.2. Analysis of the Front-End Design of Yuan PLUS

The analysis of the visual forces in the front-end design of Yuan PLUS is illustrated in Figure 4. The front-end design of the Yuan PLUS conveys a strong sense of "power," which effectively appeals to corporate professionals. This alignment with the psychological needs and professional image of white-collar workers is a key factor in the vehicle's design success. The lower and middle sections of the front-end exhibit powerful antagonistic visual forces, delivering a strong visual impact to the observer. The repeated use of inclined elements generates clear visual momentum with a

distinct sense of direction, creating a bold and forceful visual impression. This is further enhanced by the directionally aligned headlights, which intensify the convergence of visual forces toward the center, giving the front-end an almost "angry" expression that underscores a sense of dominance and strength.

The design around the vehicle's emblem is similar in form to the central design, and both share the same downward-directed visual force, creating vertical congruent forces. In contrast, the visual forces of the lower grille are directed vertically upward. This opposing force design further amplifies the vehicle's sense of power and assertiveness. It is worth noting that this design approach not only influences the vehicle's exterior appearance but also resonates on a psychological level with the specific professional needs of corporate professionals: in the workplace, they often need to project an image of stability, confidence, and undeniable presence.

Corporate professionals typically operate in highly competitive environments, where their professional identity demands a certain level of authority and strength in both appearance and demeanor. The strong visual impact of the Yuan PLUS front-end design, whether in its overall presence or in the attention to detail, aligns closely with these professional demands. The combination of the vertical force from the headlights and emblem with the antagonistic force of the lower grille conveys an undeniable aura of power, the very aura that corporate professionals seek to embody in their careers. Therefore, this design style effectively attracts those who wish to express their professional identity and power through the appearance of their vehicle, meeting their intrinsic need for confidence and strength.



Figure 4. Analysis of Visual Forces in the Front-End Design of Yuan PLUS.

3.3.3. Analysis of the Front-End Design of Song PLUS

The analysis of the visual forces in the front-end design of Song PLUS is illustrated in Figure 5. The front-end design of Song PLUS exhibits a significant appeal to female consumers, which can be attributed to its meticulous balance and distribution of visual forces, creating an impression of elegance and sophistication. The hood of the vehicle is shaped by vertical lines that generate downward visual forces, naturally guiding the observer's gaze downward, dissipating at the rounded transition beneath the emblem. This design choice harmoniously integrates with the horizontal forces present in the middle and lower sections of the front-end, allowing visual forces to develop in both vertical and horizontal directions. This balanced distribution not only enhances the overall visual breadth but also meets the aesthetic expectations of female consumers who prefer delicate and graceful vehicle designs.

In the lower section of the front-end, the grille's design mirrors that of the emblem area, but the vertical visual forces in these regions oppose each other, creating a subtle antagonistic effect. However, this antagonism is skillfully mitigated by the horizontally dispersed forces in the central part of the front-end, effectively reducing any visual tension and ensuring the harmony and unity of the overall design. This approach to visual force management preserves the softness of the design while avoiding excessive visual tension, aligning perfectly with female consumers' preference for gentle and balanced designs.

Moreover, the fog lights' inward-directed visual forces contrast with the outward forces of the black side bumpers, forming a set of opposing forces. This design technique subtly introduces a sense of visual elongation, further reinforcing the overall impression of dignity and elegance in the front-end. Through these carefully considered details, the front-end design of Song PLUS resonates with female consumers' high regard for elegance and harmonious aesthetics.



Figure 5. Analysis of Visual Forces in the Front-End Design of Song PLUS.

3.3.4. Analysis of the Front-End Design of Li Auto L7

The analysis of the visual forces in the front-end design of Li Auto L7 is illustrated in Figure 6. The front-end design of the Li Auto L7 conveys a strong impression of "stability," which resonates particularly well with middle-aged consumers. This demographic often prioritizes stability and safety when purchasing a vehicle, while also seeking a certain level of modernity to reflect both their sense of family responsibility and personal taste.

The upper section of the front-end, featuring strip-like headlights, a central design, and the lower grille, all exhibit horizontal, gently divergent visual forces that extend towards the sides. This distribution creates a broad, stable, and reliable visual impression, aligning with the expectations of middle-aged family users who value spaciousness and stability in a vehicle. These users typically desire a car that visually communicates safety and reliability, essential for protecting their families.

The combination of vertically rectangular fog lights and the horizontally rectangular lower grille forms right-angle transitions, where the intersecting horizontal and vertical forces generate a strong visual impact. This design choice not only enhances the three-dimensionality of the front-end but also caters to the middle-aged demographic's preference for vehicles that are both stylish and robust.

Additionally, the inclined tapering lines in the middle section of the front-end create two visual forces that extend downward to the left and right, respectively. These forces converge with the vertical and horizontal forces at the tires, effectively lowering the visual center of gravity of the front-end. This further reinforces the overall impression of solidity and stability in the vehicle. This design not only makes the car appear more grounded visually but also enhances the psychological perception of driving safety. This is particularly appealing to middle-aged users who have established families, as they tend to prioritize safety and stability when selecting a vehicle. The design of the Li Auto L7 successfully addresses these needs.



Figure 6. Analysis of Visual Forces in the Front-End Design of Li Auto L7.

In conclusion, the in-depth analysis of the front-end designs of four popular new energy SUVs highlights the crucial role that visual forces play in conveying the overall image and market positioning of a vehicle. Designers who aim to create a dynamic and individualized visual effect should consider using sharp lines and bold angular transitions to generate strong visual antagonism. This approach can endow the vehicle with an aggressive and powerful appearance, enhancing its sense of sportiness and vitality. Additionally, by incorporating upward vertical congruent forces in the middle and lower sections of the front-end, designers can further enhance the vehicle's dynamic expression, making it visually more lively and lightweight.

If the design goal is to convey a sense of power and dominance, designers can employ inclined design techniques and directionally focused lighting to create a clear visual momentum that concentrates visual forces toward the center. Moreover, by using similar shapes with opposing visual force directions in different areas of the front-end, designers can introduce a sense of antagonism, thereby enhancing the perception of the vehicle's power.

For those aiming to convey elegance and dignity, the key lies in the careful distribution and balance of visual forces. For example, combining vertical and horizontal forces organically allows the vertical forces from the hood to dissipate at the rounded transition below the emblem, merging with the horizontal forces from the middle and lower sections to create a sense of grace and softness. Additionally, introducing opposing visual forces, such as the vertical antagonism between the grille and the emblem, and strategically isolating this antagonism with horizontal forces in the middle section, can effectively reduce visual conflict, maintaining harmony and unity in the overall design. This method not only conveys an impression of elegance and dignity but also avoids excessive visual tension, making it suitable for designs that aim to express sophistication and balance.

For designs that aim to evoke a sense of stability and modernity, designers can consider using horizontal, gently divergent forces to create a broad, atmospheric, and stable visual impression. This distribution of visual forces can be achieved through the design of strip-like headlights, the central structure, and the lower grille, extending the overall visual forces towards the sides to convey an image of safety and reliability. To enhance the three-dimensionality and modern appeal of the design, a combination of vertical and horizontal visual forces, such as the right-angle transitions between vertically rectangular fog lights and the horizontally rectangular lower grille, can be introduced. Additionally, the appropriate use of inclined designs can lower the visual center of gravity, thereby enhancing the overall sense of stability and steadiness. Such a design not only heightens the vehicle's sense of safety but also ensures a solid and modern visual appearance, making it particularly suitable for vehicles that need to convey stability and security.

In summary, designers should carefully allocate visual forces and meticulously handle design details according to the desired visual effect, ensuring that the vehicle possesses strong market appeal and a distinctive style.

4. Conclusion

This study provides an in-depth analysis of the front-end designs of four popular new energy SUVs, revealing the critical role that visual forces play in conveying the overall image and market positioning of a vehicle. The findings demonstrate that different distributions of visual forces and design strategies can effectively communicate a range of visual impressions, such as dynamism, power, elegance, and stability, thereby meeting the aesthetic preferences of diverse consumer groups. For designers, understanding and skillfully applying these elements of visual forces not only aids in creating exterior designs with strong market appeal but also in developing products that stand out with differentiation and brand identity in the highly competitive new energy vehicle market.

Although this study captured consumers' emotional impressions of various front-end designs through the Semantic Differential Method, it is important to recognize that consumers' emotional connections and purchasing decisions are often influenced by a variety of factors, such as cultural background, social status, and usage scenarios. These complex psychological and behavioral factors

were not fully explored in this research. Future studies could integrate more consumer psychology and behavioral methods to analyze in greater depth the decision-making processes consumers undergo when purchasing vehicles, thereby offering more comprehensive design guidance.

Moreover, the research has certain limitations, such as the limited scope of sample selection, the need for a more multidimensional analysis of visual forces, the integration of technology and materials, long-term tracking of market dynamics, and cross-cultural studies. Future research should further explore these areas to enhance the scientific rigor and practical applicability of design strategies, providing more systematic and comprehensive support for the development of the new energy vehicle market. Overall, this study offers new perspectives and methods for the design of new energy vehicle front-ends, with the hope of positively influencing future design practices in the industry.

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