Young Chinese Consumers' Perception of Passenger Car Form in Rear View

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Abstract. It aims to explore the perception of passenger car form in rear view of young Chinese consumers as the main force in China's passenger car market. Young Chinese consumers as subjects are invited to estimate the similarity of eighty form samples of triple-compartment passenger car form in rear view selected by engine displacement and brand. Then seven form categories are classified by cluster analysis and consumers' perceptual map is plotted by multidimensional scaling, respectively. The gradual form change related to the distribution of eighty form samples in the perceptual map is further analyzed qualitatively. It is found that (1) in their cognitive process, young Chinese consumers perceive and judge the passenger car form in rear view and its variation by both overall and local form features. The former are features including ratio of height to width, stiff or round style, and richness of details and sense of depth in trail, while the latter are ones such as taillights, the blend between side window and the side of body, and the upper surface of trunk; and (2) the degree of variance in the form in rear view of passenger cars in current Chinese market is limited since the samples in each of seven categories are distributed dispersedly in the perceptual map.

Keywords: Passenger car form in rear view · Consumer research
The perceptual map · Quantitative and qualitative analyses

1 Introduction

People make value judgments mainly by visual information [1]. Consumers' perception of passenger car form also starts from the visual appearance of car body form. In China, passenger car form has been the fourth most important factor among fourteen main factors that affect consumers' purchase decisions [2]. Passenger car form that fulfills the expectations of consumers can not only cause the consumers' attention and the emotion of pleasure, but stimulate consumers' purchase decisions and behaviors.

Numerous studies have been carried out on car form and related consumers' perception and behaviors in the following topics: (1) in the field of sensory engineering, studies focus mainly on consumer preference of passenger car form and its image, evaluation model and quantitative consumer's cognition, involving in the difference of form and image preference between male and female consumers [3–5], form preference analysis of female user groups [6], autobody form evaluation model [7, 8], imagery processing

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and aesthetic cognition [9, 10], evaluation on the attractiveness of passenger car form [11, 12], contextual collaboration in car styling [13], car styling development based on consumers' preferences [14], and semantic-oriented car styling [15]; (2) in the field of branding and product identification, studies involve in form genes of specific brands, recognition of consumer's perception, consumer's perception towards car brands [16], car recognition rate and consumer's perception based on the archetype theory [17], design strategy for enhancing brand recognition and consumers' long-term memory [18], aesthetic features' influence on consumer's perception of brands [19], styling DNA design methodologies [20], and semantic feature extraction and visualization of passenger car form genes of specific brands [21] and so on; (3) in the field of form perception, studies involve in consumer's form perception model, form perception differences between designers and consumers [22], side-view form perception [23], perceptual modeling based on fuzzy rules [24], form design reference model [25], consumer's expression mode for describing car form [26], feeling quality of car profiles [27], car form prototype fitting [28], automobile sketch design [29], formative elements of car styling [30], and design language of passenger car form [31]; and (4) in addition, some studies involve in passenger car form design trends [32], evolution in automotive styling design [33], and the relationship between car form design and culture [34, 35].

In general, these studies usually pay attention to consumer's perception of overall car form viewed from specific angles such as front quarter view [36], front view [37], side view [38, 39], while some local forms in car form such as the headlight, the rearview mirror and wheel hub [40, 41] are studied as well.

It has been proven by first author's team that, when taking a close look at and perceiving the passenger car form, Chinese consumers concern most the appearance of passenger car form in front quarter view among the most regular five viewing angles of passenger car form [42], i.e., side view, front view, rear view, and rear quarter view in addition to front quarter view. At the same time, however, it is observed that the difference between the Prominence values of four viewing angle factors, i.e., side view, front view, rear view, and rear quarter view, is small because the Prominence values of these four factors are very close [42]. This implies that it is also necessary to explore the consumers' perception of passenger car form at different viewing angles including rear view. Meanwhile, there exist numerous brands and models of passenger cars in current Chinese domestic market, and the sales volume of passenger cars with engine displacements between 1.6 L to 2.0 L has a rising tendency since 2009 [43]. Meanwhile, passenger car consumers in China tend to be younger obviously [44]. In this context, focusing on passenger car form in rear view with engine displacements between 1.5 L to 2.4 L in Chinese market in 2016, subjects aged 18 to 30 including undergraduate and graduate students, professionals from different industries are invited and investigated to explore the cognitive features of young consumers on passenger car form in rear view.

2 Method

2.1 Preparatory Phase

Eighty pictures of form samples of passenger car form in rear view are collected from websites such as online forums, involving in thirty major brands (or sub-brands) in Chinese passenger car market, including BBAC (Beijing Benz), Beijing-Hyundai, BYD, Changan Ford, Changan-Mazda, Changan, Great Wall, Dongfeng-Honda, Dongfeng-Peugeot, Dongfeng-Nissan, Dongfeng-Citroen, Dongfeng, Dongfeng-Yueda-Kia, GAC-Honda, GAC-Toyota, GAC, Qoros, BMW-Brilliance, Chery, SAIC Volkswagen, SAIC-GM (Buick and Chevrolet included), SAIC MG, SAIC Roewe, FAW Audi, FAW-VW, FAW-Toyota, FAW Hongqi, FAW-Mazda and FAW.

All pictures are selected ensuring that they were photographed visually at as same angle as possible in order to reduce experimental error in the later investigation phase. Furthermore, in order to avoid the possibility that car body color will distract the subjects from passenger car form presented in the pictures, all pictures are converted into black-and-white color mode, and passenger car form in each picture is presented centrally on the white background while the brand logo and license plate in each picture are removed (some examples of processed pictures are as shown in Fig. 1). Finally, all eighty pictures of form samples of passenger car form in rear view are marked randomly with serial numbers of V1, V2, ⋯ , V79, V80.

Fig. 1. An interface of grouping task tool

2.2 Investigation Phase

In this phase, a number of consumers as subjects are invited to take part in the investigation into the similarity between eighty form samples. Every subject is kindly asked to estimate on the similarity between any pair of form samples in eighty pictures and to classify eighty pictures according to his/her own judgment with an interactive tool developed by the first author's team [36, 38] for grouping task as shown in Fig. 1. One piece of similarity matrix data is generated by the tool after a subject completed his/her trial and evaluation. Totally, thirty-nine pieces of effective data are collected, consisting of twenty pieces of data from male subjects and nineteen from female subjects.

3 The Results of Quantitative and Qualitative Analyses

3.1 Cluster Analysis

An averaged similarity matrix is obtained by averaging original similarity matrices acquired in the investigation phase, and it is then analyzed by hierarchical cluster analysis method and a dendrogram as result is plotted.

By observing and analyzing the dendrogram, it is reasonable to classify eighty passenger car forms into seven categories according to the related cluster analysis principle [45] that in cluster analysis process, it is ideal for all samples to be classified as 'evenly' as possible into categories (although it is usually difficult). The seven categories are named G1, G2, G3, G4, G5, G6, and G7, including 11 samples, 13 samples, 9 samples, 12 samples, 12 samples, 10 samples, and 13 samples, respectively.

3.2 Multidimensional Scaling

A dissimilarity matrix can be obtained by transforming the mentioned-above average similarity matrix, and the perceptual map is plotted as shown in Fig. 2 by multidimensional scaling method using this dissimilarity matrix. By perceptual mapping, all subjects' averaged judgment on the dissimilarity, i.e., the distance measurements between samples of passenger car form in rear view, is mapped into a two-dimensional consumers' perceptual space where eighty form samples are distributed. In the perceptual map shown in Fig. 2, all passenger car form samples in each of seven categories are illustrated in a specific color and the samples in the same category are marked by the same color.

In the addition, the distribution range of the samples from each category of G1 to G7 is outlined in the perceptual map, respectively, as shown in Fig. 3. It can be observed that the samples from each of categories are dispersed in the two-dimensional perceptual space.

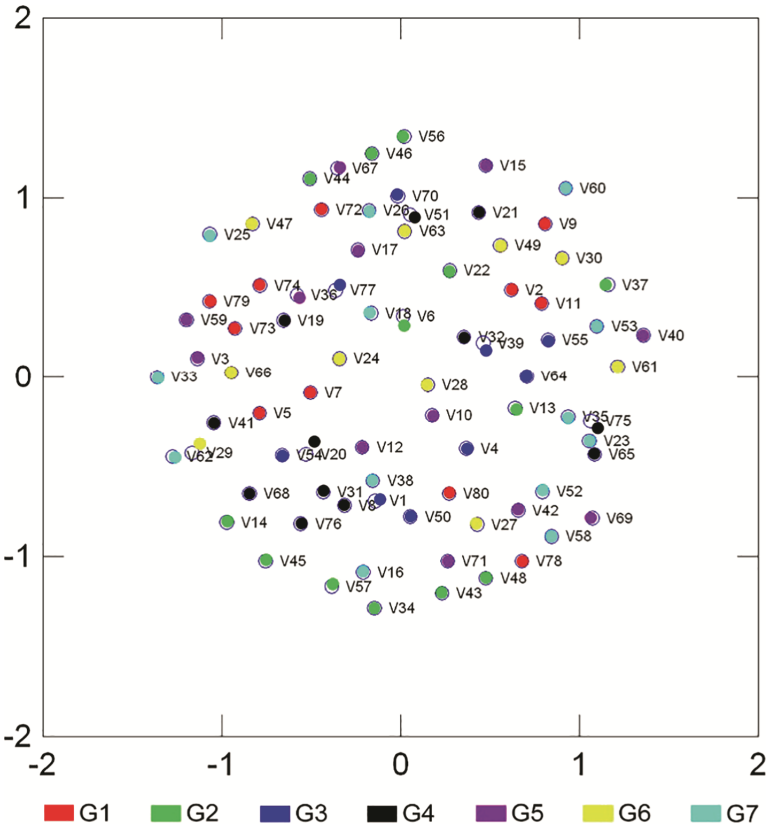

Fig. 2. The perceptual map (Color figure online)

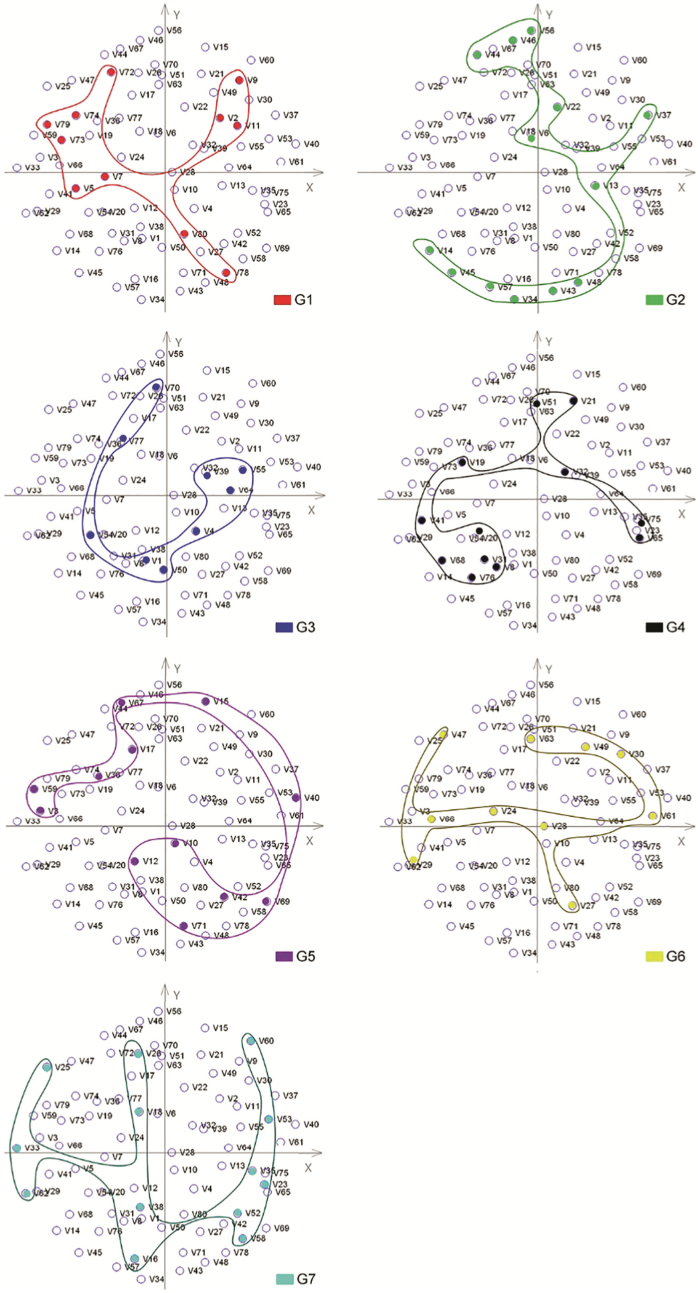

Fig. 3. The distribution of samples in each of seven categories in the perceptual map

3.3 Qualitative Analysis of Form's Distribution and Gradual Change in the Perceptual Map

To probe into the properties in the distribution and transition of passenger car form in rear view in consumers' perceptual space, all eighty form samples' pictures are printed and placed on a physical plate in the corresponding locations as presented in the perceptual map. The qualitative analysis process is completed with the help of knowledge in related car styling and design field.

It is found that in the perceptual map, along the horizontal axis (x axis), the vertical axis (y axis), and the x' axis and y' axis by rotating x axis and y axis 45° counterclockwise, respectively, the distribution and gradual change of passenger car form in rear view indicate certain regularities which are concluded and illustrated as shown in Fig. 4 (the xoy coordinate system and x'oy' coordinate system are outlined in this figure to facilitate the description below) and further discussed in details as follows.

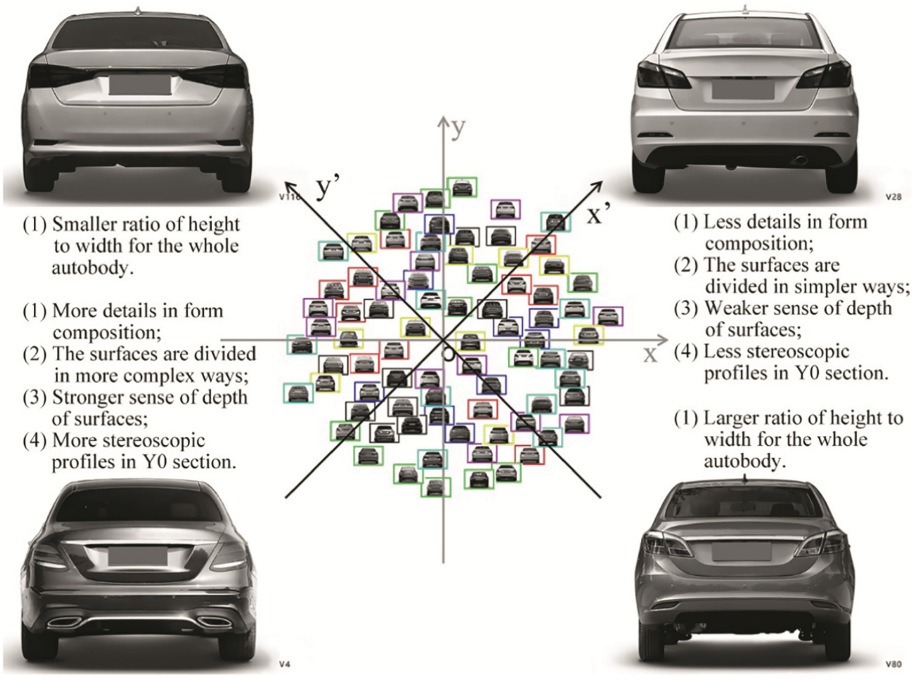

Fig. 4. Sample locations and gradual form change in the perceptual map

Form Changes Along the X Axis. Firstly, there is a certain clue to form change observed that whether or not there exist continuous transitional edges, i.e., curves and lines as edges' projection in rear view, between the upper outlines of two taillights and the upper decorative part above the license plate area, implying the form feature whether or not there is a morphological link of two taillights. This property of form change is embodied specifically as following features: for the majority of the passenger car forms

scattered and located onto the left end of x axis in the perceptual map, there is a continuous transition between taillights' outlines and decorative parts' edges as shown in the upper figure in Fig. 5, while for the majority of those on the right end, there is no continuous transition feature but an apparent discontinuity or positional transition as shown in the lower figure in Fig. 5.

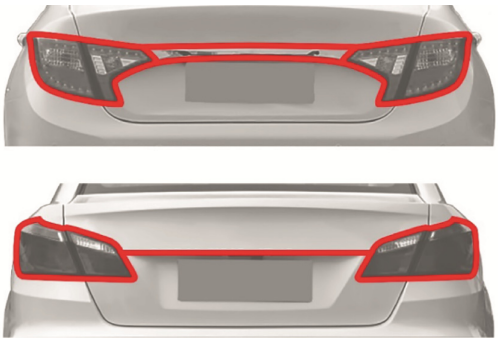

Fig. 5. Transitional features of two taillights

Secondly, there is a certain clue to form change observed that the upper and the lower outlines of upper surface of trunk are curved or straight shape in rear view. This property of form change is embodied specifically as following features: for the majority of the passenger car forms scattered and located onto the left end of x axis in the perceptual map, the two outlines of the trunk's upper surface in rear view have larger curvatures, and the trunk's upper surface slide towards the rear of autobody significantly being presented by an apparent distance between the curve A and curve B in rear view as shown in the upper figure in Fig. 6, while for the majority of those on the right end, the two outlines of the trunk's upper surface are flatter in both rear view and side view as shown in the lower figure in Fig. 6.

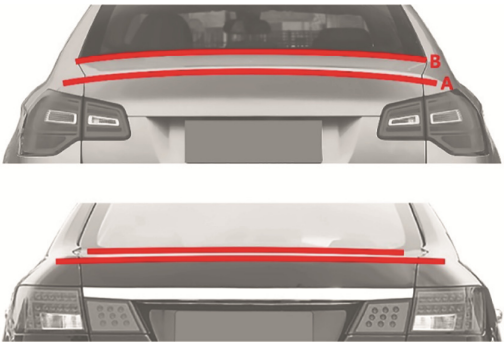

Fig. 6. Curved and flat shape features of trunk's upper surface

Thirdly, there is a certain clue to form change observed that the whole outline of the taillight is profiled as a combination of curved or flatter segments in rear view. This property of form change is embodied specifically as following features: for the majority of the passenger car forms scattered and located onto the left end of x axis in the perceptual map, the whole outline of a taillight is mainly composed of curves connecting each other smoothly at intersecting point with less acute angles as shown in the left figure in Fig. 7, while for the majority of those on the right end, the taillight's whole outline is mainly composed of stretched and flatter curves/lines connecting each other with sharp angles as shown in the right figure in Fig. 7. This finding shows that consumers consider a local feature, i.e., the outline shape of taillight form in rear view, as a basis for evaluating the similarity between passenger car forms in rear view.

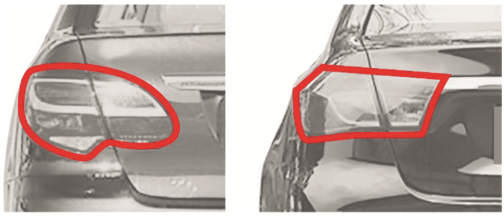

Fig. 7. Taillight's outline features

Form Changes Along the Y Axis. Firstly, there is a certain regularity in form change observed in the degree of roundness of passenger car form in rear view. This property of form change is embodied specifically as following features: for the majority of the passenger car forms scattered and located onto the upper end of y axis in the perceptual map, the adjacent surfaces intersect at stiffer and flatter edges' profile as viewed from the rear and the angles between adjacent surfaces are smaller with clear transitional edges as shown in the left figure in Fig. 8, while for the majority of those scattered and located onto the lower end of y axis in the perceptual map, the angles between surfaces are larger with smoother transition and more curved profiles as viewed from the rear as shown in the right figure in Fig. 8.

Fig. 8. Stiff and round features in the overall form

Secondly, there is a certain regularity in form change observed in autobody's shoulder area, conveying the relationship between the side window surface and side autobody surface of passenger car form in rear view. This property of form change is embodied specifically as following features: for the majority of the passenger car forms scattered and located onto the upper end of y axis in the perceptual map, the surfaces of side window and the side of autobody in rear view blend smoothly without acute angles as shown in the left figure in Fig. 9, while for the majority of those scattered and located onto the lower end of y axis in the perceptual map, those surfaces intersect with clear or acute transition as shown in the right figure in Fig. 9.

Fig. 9. Relation features of side window and the side of body in rear view

Form Changes Along the X' Axis and the Y' Axis. The certain regularities in form change along the x' axis and y' axis, respectively, in the perceptual map are discovered by qualitative analysis.

Firstly, for the majority of the passenger car forms scattered and located onto the negative end of x' axis in the perceptual map as shown in Fig. 4, they have more stereoscopic profiles in Y0 section due to the more bumped flows and ups and downs of surfaces and its transitions, and the surfaces of rear autobody form are divided in more complex manner resulting in richness of details in trail form composition and stronger sense of depth of surfaces. On the contrary, for the majority of the passenger car forms scattered and located onto the positive end of x' axis in the perceptual map as shown in Fig. 4, they have less bumped profiles in Y0 section due to the less ups and downs of surfaces and its transitions while the surfaces of rear autobody form are divided in simpler ways resulting in less details in form composition.

Secondly, by observing all eighty pictures of passenger car forms along the y' axis, it is observed that there is a significant regular variation of ratio of height to width. This property of form change is embodied specifically as following features: the passenger car forms scattered and located onto the negative end of y' axis in the perceptual map look more probably taller by maintaining a larger ratio of height to width for the whole autobody as shown in Fig. 4, while the majority of those scattered and located onto the positive end of y' axis look shorter due to a smaller ratio of height to width for the whole autobody as shown in Fig. 4.

4 Conclusion

In the fiercely competitive Chinese market of passenger cars with mainstream 1.5 L to 2.4 L engine displacements, it is a make-or-break necessity for automakers and its design

studios to understand the perceptual characteristics of passenger car form of young Chinese consumers as the main force in China's passenger car market and form's dissimilarity and variance exposed in their morphological cognition. In this study, their perception of passenger car form in rear view is investigated by quantitatively analyzing data with cluster analysis and by qualitatively examining the clues to morphological shifts in the perceptual map derived from multidimensional scaling.

It is found that there exist observable regularities, i.e., the differential form features and gradual changes, in young consumers' perceptual mapping of passenger car form in rear view when evaluating the similarity between the form samples. On the one hand, it reflects obviously young consumers' cognitive ability of identifying the dissimilarity of passenger car form in rear view. On the other hand, it shows that as viewed from the rear, there is certain difference between the production models in current triple-compartment passenger car market segment in China.

The perceived differential form features and gradual changes are determined by both overall and local form features as shown in Fig. 4 in details, which have influence on young consumers' perception of passenger car form in rear view. In general, however, the dispersed distributions of form samples for all categories in the perceptual map implies probably that this kind of difference is limited among the production models in current Chinese passenger car market segment.

These findings imply that intentional design differentiation for targeted young consumers by means of both the local and overall form features in rear view while considering form coordination, is helpful for an automaker to distinguish its own passenger car form in rear view and product identity from competitors.

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