Facial Expressions in Car Design
A method to compare relative importance of design attributes

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Abstract: People often associate human facial features with automotive front-end designs. This study reveals which combination of facial feature attributes best communicates the personality of human and car brands and which of these combinations evoke the strongest and favorable emotional attachments. The study also identified differences in emotional reactions between different cultural groups (in this case, Japanese and American consumers) to given facial images. The author developed a method of decomposing facial features into individual attributes and created variables associated with each. The author applied Conjoint Analysis to identify the relative importance of each facial attributes from which consumers perceived personalities. The study was intended to support preliminary design directions for a car manufacturer who aims to communicate and differentiate personality association of their different car brands.

Key words: Car design, facial expressions, emotional attachment, brand identity, cultural acceptance, conjoint analysis

Background: Front-end design features of cars are often compared with human or animal faces. For this reason, car designers attempt to leverage facial feature comparisons in order to create emotional attachment to their automobiles. Headlamps are commonly called "eyes" and an air intake or a radiator grill called "mouth" by analogy. [1] People also associate front-end design with facial characters such as, "gentle face" or "catty face". Children, being more sensitive than adults point out "that car is smiling" or "this car is angry". It is important to consider, however, that the perception of such facial expressions may vary from culture to culture. For instance, Japanese car styling have often been perceived as "too modest" or "having no character" in Western countries, whereas Japanese consumers see some American cars being "too exaggerated."

Meanwhile, the design division of Toyota Motor Corporation, for which the author worked as a designer, strove to distinguish their brand identities not only from other car manufacturers, but also from other brands within the company. Unlike some European and American car manufacturers, none of their brands, Lexus, Toyota, Scion, have been acquired from other enterprises, in other words, they are all native-born in Toyota. Therefore, they needed to carefully plan distinct design directions for each brand, otherwise be prone to become too similar and blend into one another. It is essential for them to appropriately communicate a distinct personality of each brand to their target customers. Prior to this study, the design group had developed sets of adjectives that define the personalities they intended to communicate through the brands, and empirically established the brands' front-end design features. Designers needed to further learn how even subtle difference in attributes of a front-end design feature could affect emotional reaction from customers. Furthermore, another question was if people from different cultures would associate the same type of personalities from given facial expressions. While many cars

are becoming closer with respect to quality and functionality, it became critical to create a method for measuring what factors are emotionally relevant to their customers.

Approaches

The design team and the author set the following questions to be answered. 1) What combination of facial feature attributes best communicates the intended personalities of the human and the car? 2) Which of the attribute and what kind of design execution for each attribute (levels) has greater contribution to prompt emotions?   3) How consistent are perceptions of human faces and car faces from observer to observer? Are there any differences in perceptions between different cultural groups, for example, between Japanese and American with respect to the importance of attributes in facial features and the specific level of execution in an important attribute?

Methods

In order to determine what combination of attributes best communicates an intended personality to customers, the author developed a method of leveraging conjoint analysis. This method uncovers the importance of each individual attribute, part worth of the each level of attribute and total utility of a given facial feature.   In order to isolate factors, facial features were decomposed into individual attributes and four attributes of design features for each brand: Lexus, Toyota and Scion, were selected and three levels of design executions were created (Figure 1).   For data collection, surveys were conducted with respondents from both the United States and Japan to compare differences in perceptions.

Figure 1. Three levels of design executions for each attributes in human and car face features for Lexus

The survey displayed a description of personality attributes, such as, "Resolute, intelligent and admirable".   Respondents were asked, "Please rank the following facial expressions on how they portray the following personality characteristics. Please put a "1" next to the facial expression that best portrays the personality characteristics and a "9" next to the facial expression that least portrays the personality characteristics, and use all numbers in between to rank the remaining facial expressions".   Three personality descriptions were tested (Table 1).   Although the factorial of possible combinations of facial images is 81 (3^4), fractional factorial design method was used to narrow combinations of facial images to be tested to nine (Table 2). Nine randomized images in three rows, with three images in each row, were presented (Figure 2).

Table 1. Sets of adjectives defining personalities of car brands

Lexus	Resolute, intelligent and admirable
Toyota	Vital, engaging, honest and fresh-faced
Scion	Individual, challenging and aspirational

Table 2. Fractional factorial design matrix

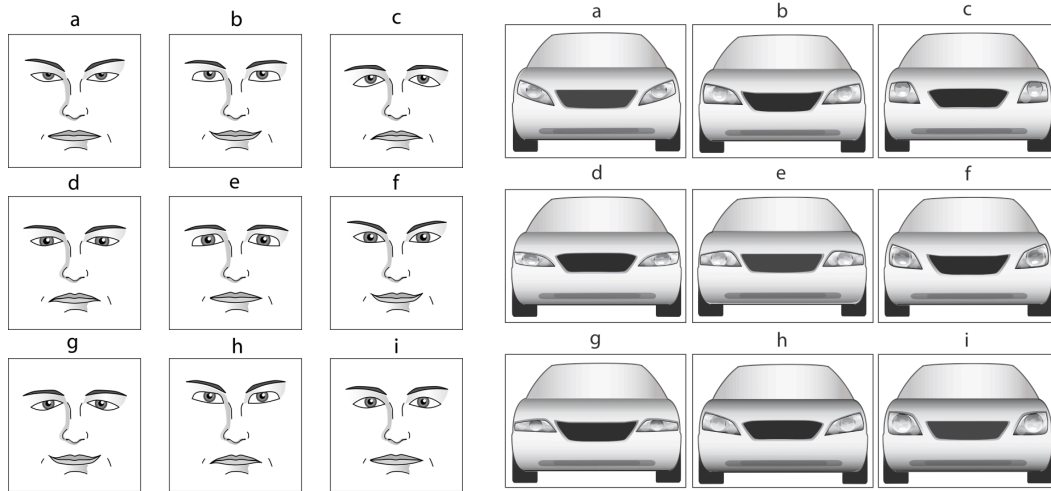|	a	b	c	d	e	f	g	h	i
A	1	1	1	2	2	2	3	3	3
B	1	2	3	1	2	3	1	2	3
C	1	2	3	2	3	1	3	1	2
D	1	2	3	3	1	2	2	3	1

Figure 2. Nine combinations of human and car faces for Lexus presented to respondents

For the American respondent, the survey was conducted via the Internet using the Harris Poll On Line panel. The total sample size of n=510 was weighted to the adult US general population and screened to exclude respondents who work in a sensitive industry. For the Japanese respondents, the survey was conducted in paper form with the company's design evaluation panel. The total sample size of n=132 were not weighted to the Japan's general population. All the instructions, questions and personality descriptions were translated to Japanese. For data analysis, the multivariate statistical analysis software called TPOS-PC, developed internally at Toyota, was used. Before starting conjoint analysis, clustering analysis was performed in order to filter groups that were significantly heterogeneous in the pattern of response. By providing the raw ranking data from the respondents, as well as the number of attributes, levels, and fractional factorial design matrix, the software returned the result including the comprehensive ranking of all design profiles with total utility score, partial utility (part worth) scores for each level in each attribute and importance, which is the contribution ratio of each attribute in percentage.

Results and discussions: Figure 3 presents combinations of attributes of the facial feature that best communicate intended personalities of humans and cars. In general, it is consistent in both human and car faces that eye features play a relatively significant role in creating the overall impression of personality, whereas the mouth feature, that is, the radiator grill or air intake in car front-end design, alters the perceptions the least (Figure 4-9). This observation suggests that people tend to pay more attentions to eyes when they try to read the personality or emotional state of a person and a car. As commonly known, to detect a fake smile, look at the eyes[2]. The implication for a design practice is that, when a designer intends to "face lift" in order to attach a new impression to a car, it is more effective to change the head lamp features rather then changing radiator grills or air intake to

inspire customers' emotions. The same seems true for the human face. Although reliable statistical information is lacking, it can be observed that eyelid surgery is the most popular facial cosmetic surgery today.

While some of the attributes selected for human faces are not exactly comparable to those for car front-end design, a few consistencies are observed in facial features between humans and cars. One of the few consistencies is comparable iris position and lamp position for the Lexus personality perceived by American respondents. For them, both human irises being near to top and car head lump being near to top creates positive partial utilities for conveying Lexus personality. In effect, this attribute has a ninety percent value of importance over other attributes for Lexus car front-end design. Although there is agreement between American and Japanese respondents about the front-end design image that best portrays the Lexus personality, what Japanese respondents assess most sensitive is not the lamp position, but the lens angle of the headlight (Figure 4-5). They also give considerable importance of 41.4% in eye angle in human facial features for the Lexus personality (Figure 4). Another consistency found between human and car facial features is the eye angle, which refers to the lens angle in front-end design, for the Scion personality among Japanese audience. The analysis indicates that Japanese respondents recognize slant eyes as a strong positive factor for the Scion personality shown by the substantial importance rate of 81.1% (Figure 8). The same reaction appears on car front design, too, where they value slant lens as a strong positive factor for the personality with significant importance of 71.1% (Figure 9).

Americans and Japanese differ considerably in human face perception of the intended Lexus personality. The representation of resolute, intelligent and admirable, selected by American respondent looks sharper than the one selected by Japanese respondent. The actual difference between these two faces are eye features, where the face selected by American respondent has so called "sanpaku" eyes, which refers to the iris being small and near to top of the eye so that it can only cover about two-thirds or less of the vertical of the eye[3]. Japanese respondents showed a contrasting reaction to "sanpaku" eyes as the analysis indicates strong negative partial utility for the intended personality. Another difference is the face selected by American respondents has narrow and slant eyes as opposed to the one selected by Japanese has curved and neutral angled eyes. Similar perception differences repeatedly appeared also for Toyota and Scion personalities. The best representation images for Americans tended to have more slant eyes or slant lenses, as opposed to the Japanese respondents whose preferences tended to have less slant, non-"sanpaku" or larger irises that make the overall facial impression softer. When comparing only car front-end design attributes, American respondents consistently pay more attentions to either lamp position or lamp size. In contrast, Japanese respondents tend to be sensitive about lens angles.

Although the study was experimental and was not intended to serve directly to any specific new vehicle design, the analysis was shared within the company's design center, as well as top executives. Several other studies that attempt to define more specific design languages and executions regarding facial expressions in car front-end designs, followed this study, and were applied to the design guidelines. As a luxury car brand, Lexus face continues to maintain a resolute, intelligent and admirable persona, expressed by appropriately slanted lenses and carefully located lamps and a subtle smile. As Toyota personality evolves, slanted, low-profile lenses and a

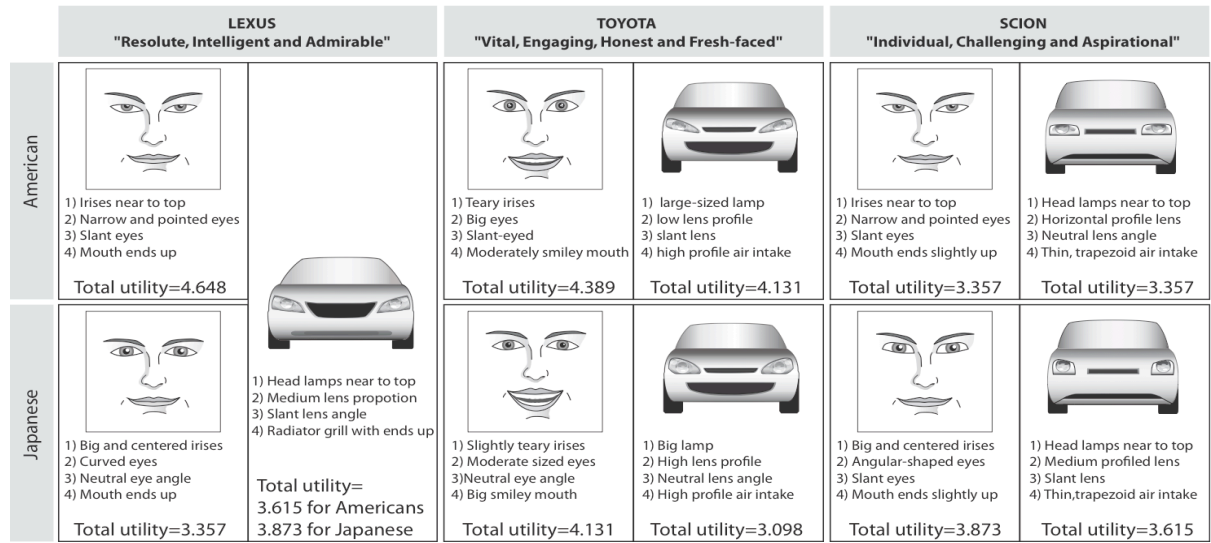|	LEXUS "Resolute, Intelligent and Admirable"		TOYOTA "Vital, Engaging, Honest and Fresh-faced"		SCION "Individual, Challenging and Aspirational"	
American	1) Irises near to top 2) Narrow and pointed eyes 3) Slant eyes 4) Mouth ends up Total utility=4.648		1) Teary irises 2) Big eyes 3) Slant-eyed 4) Moderately smiley mouth Total utility=4.389	1) large-sized lamp 2) low lens profile 3) slant lens 4) high profile air intake Total utility=4.131	1) Irises near to top 2) Narrow and pointed eyes 3) Slant eyes 4) Mouth ends slightly up Total utility=3.357	1) Head lamps near to top 2) Horizontal profile lens 3) Neutral lens angle 4) Thin, trapezoid air intake Total utility=3.357
Japanese	1) Big and centered irises 2) Curved eyes 3) Neutral eye angle 4) Mouth ends up Total utility=3.357	1) Head lamps near to top 2) Medium lens propotion 3) Slant lens angle 4) Radiator grill with ends up Total utility= 3.615 for Americans 3.873 for Japanese	1) Slightly teary irises 2) Moderate sized eyes 3)Neutral eye angle 4) Big smiley mouth Total utility=4.131	1) Big lamp 2) High lens profile 3) Neutral lens angle 4) High profile air intake Total utility=3.098	1) Big and centered irises 2) Angular-shaped eyes 3) Slant eyes 4) Mouth ends slightly up Total utility=3.873	1) Head lamps near to top 2) Medium profiled lens 3) Slant lens 4) Thin,trapezoid air intake Total utility=3.615

Figure 3. Best human and car facial representations that communicate the intended personalities for each brand
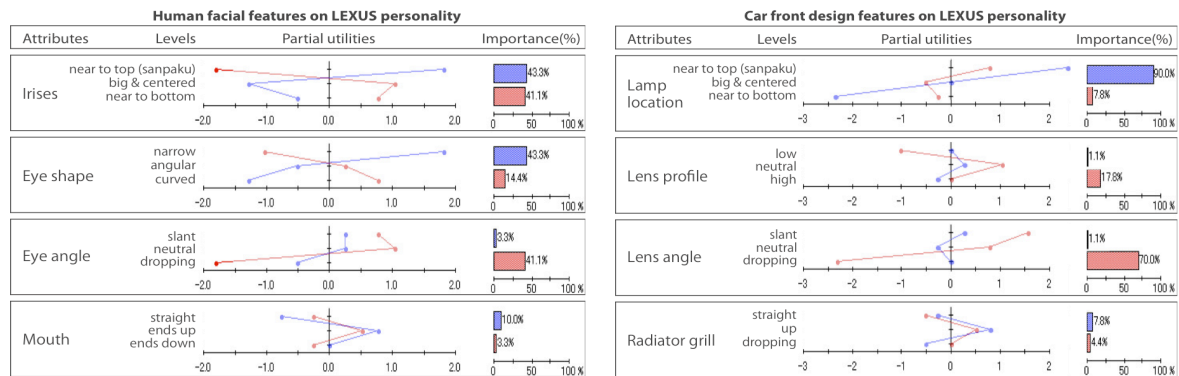

Figure 4.5. Partial utilities and importance in individual attributes for human face and car front design for Lexus trait
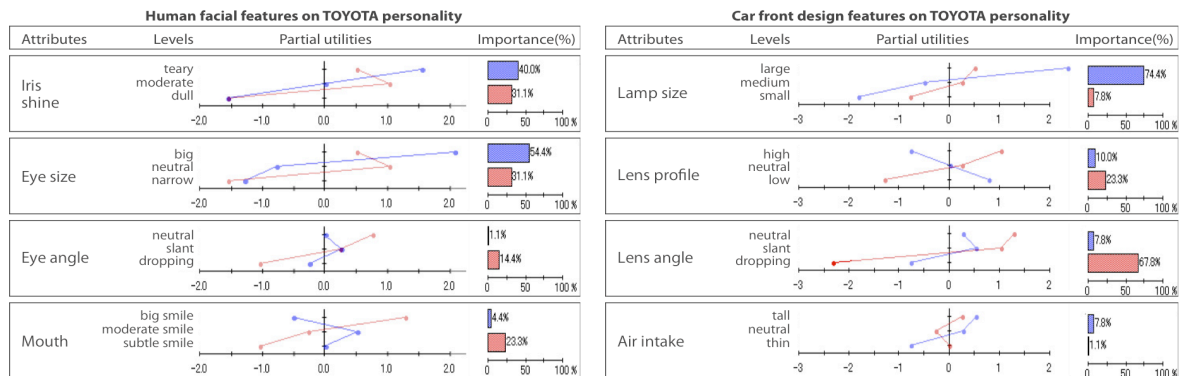

Figure 6.7. Partial utilities and importance in individual attributes for human face and car front design for Toyota trait
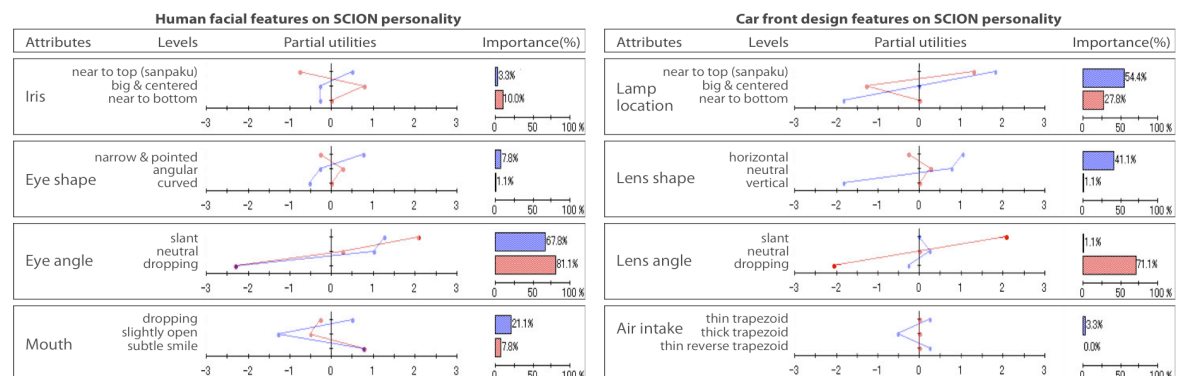

Figure 8.9. Partial utilities and importance in individual attributes for human face and car front design for Scion trait

Figure 10. Typical Lexus, Toyota, Scion faces today

smiley mouth portray a sharper or more serious look while upholding an relaxed personality. Scion has horizontal and static design attributes that support the strong attitude of the brand (Figure 10).

Facial expression is highly emotional and even small changes could radically alter the impression of the car. Like human relations, perception is highly context sensitive. A confident look could be mistaken as arrogance, or a friendly smile considered to be a frivolous face. Other limitations of this study include: 1) The number of attributes is limited so that some other attributes that were not tested may have greater contribution to create certain facial expressions. 2) Limited sample size and sensitive population in Japanese respondents. 3) There may be nuances in English-Japanese translation for the adjectives that describe the characteristics of aimed brand personality. 4) Respondents may feel forced to evaluate attributes they would otherwise not much thought about.

Conclusion: The study attempts to isolate the design attributes of car front-end design and identify the most effective expressions that collectively form overall facial features of the car by introducing conjoint analysis, which have traditionally been used for marketing initiatives. The analysis unveiled certain attributes that are significantly more sensitive than others to create either negative or positive emotional reactions from customers. There seems to be perception differences caused by cultural factors and design directions may need to vary geographically. Since facial perception is highly emotional and context-sensitive, further study should explore such variables. As automotive technologies rapidly change, the concept of functional elements of cars, such as headlights, radiator grills and air intake are likely to change significantly. Further facial expression study needs to respond to those changes as well.

References:

[1] Harada Toshinobu, Mori Norihiko, *Analysis of Recognition of Car's Front View Design*, Bulletin of Japanese Society for Science of Design, 45(2) pp.11-16 19980731, Japanese Society for the Science of Design

[2] Daniel H. Pink, *A Whole New Mind: Why Right-Brainers Will Rule the Future*, pp.166, Penguin Group 2006

[3] Wikipedia, http://en.wikipedia.org/wiki/Sanpaku, March 15, 2010