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INVESTIGATING NOT ONLY SENSATIONS BUT ALSO EMOTIONS TO INCREASE VISUAL COMFORT OF CAR SEATS

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ABSTRACT

Sensory testing focuses on explaining customers' preferences through the sensory properties of the products. Actually, knowing how much of each "ingredient" to put into the "recipe" is essential for New Product Development (NPD). However, in highly competitive markets like automotive industry, recent technological breakthroughs have leveled off the perceived differences between products. Consequently, advertisements have increasingly focused on the emotional benefits of products. Besides, it is now acknowledged that emotions influence satisfaction and may be a decisive factor in purchase decisions. Thus, understanding which characteristics of the products would elicit emotions is of a great importance for NPD. The purpose of this study is to test and evaluate a method to investigate customers' emotional perception related to cars.

Actually, Renault has done a lot of work to understand and optimize its car seats' safety as well as static and dynamic comfort. Nevertheless, designers still miss data on visual perception of car seats, and more specifically on the visual perception of comfort. What characteristics of the car seat will make it look comfortable to customers?

Our study was designed to investigate the visual perception of car seats, and to understand which specific visual characteristics would elicit emotions, enhance the visual comfort and eventually make the seat appealing to customers. A test was conducted on fifteen car seats and a hundred French customers. A description of the approach used to develop the methodology and the main results of the study are presented.

Keywords: Car seats, Emotions, NPD, Visual Perception, Comfort

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1. INTRODUCTION

Sensory testing focuses on explaining customer's preferences through the sensory properties of the products. The sensory profile methodology allowed obtaining precise sensory description of the products [1]. Customer's preferences are explained with the sensory description of the product using the preference mapping technique [2]. Thanks to product experts' knowledge, elementary sensations can be translated into physical or technical properties of the products. The product designer will know exactly how much of each "ingredient" to put into the "recipe". These data are essential for New Product Development.

However, in highly competitive markets like automotive industry, technological breakthroughs have leveled off the perceived differences between products. Actually, any car company is able to propose cars with the same level of quality to the same price. We can differentiate introducing innovations that match customers' needs. We can also differentiate by touching the customer in the deepest of his being. Maslow's hierarchy of needs is predetermined in order of importance and is often depicted as a pyramid consisting of five levels [3]. The lowest levels refer to physiological and safety needs. They can be achieved with well-working cars, functional and safe. In fact, customers should be able to move with their car when they want, how they want and in safety conditions. The upper levels refer to more complex needs such as social interactions, esteem and self-actualization. They involve emotionally-based relationships in general. The customers need products that stimulate their senses, that may be incorporated into their lifestyle and that allow them to live an experience. They try to be rewarded by the psychological, symbolic and emotional benefits rather than by the functional overstatement of products or services [4].

As emotions are fundamental to the human experience, it is not surprising that advertisements have increasingly focused on the emotional benefits of products. An important role of emotional stimuli is to capture viewer's attention. Once advertisers have that attention, advertising will try to create a strong link between the product itself and a specific emotion. The emotions evoked by products increase the pleasure of buying, possessing and using them [5]. Thus, understanding which characteristics of the product would elicit emotions is of a great importance for NPD. The Hyundai Motor Company developed his Mazda MX-5 applying aesthetic engineering [6]. Engineers investigated correlations between three aesthetic characteristics of cars (dynamic, elegant and stylish) and purchase decision in order to find out specific relations between design factors and customers' preferences. Appeal is a kind of emotion, but it could be interesting to investigate others such as pride, attraction or surprise. A lot of information is available on methods for measuring emotion but little is published on how to relate emotions to the properties of the products. Companies may keep this material secret in order to maintain a competitive advantage. Besides, methods appropriate for fundamental laboratory research might not be appropriate to the context of car industry.

When one chooses to measure product emotions, the first issue that arises is the definition of an emotion. It seems to be that there is no point in insisting on that question. Everyone knows what an emotion is… until the moment one asks for a definition. Indeed, the term emotion is not a scientific term but a word of the everyday language. In the literature, the definitions are very different. In 1997, Stemme [7] counts more than 32 definitions. In 1994, Frijda [8] proposes a classification that allows distinguishing emotions, mood and feelings.

- The emotion implies a relation between a person and a particular object at the cause of the emotion. Emotions are short lasting, from a few seconds to a few minutes. The behavioral and physiological modifications resulting from an emotion have an effect on the central nervous system, influencing the progress of the physical and cognitive activities.
- The feeling also implies a relation between a person and a particular object, but it is long lasting. Indeed, a feeling could last all life: for example, I'm afraid of dogs. The feeling remains essentially intellectual and presents few physiological demonstrations. Nevertheless, the accumulation of feelings can be the cause of emotional states. In everyday life, emotions and feelings are often mistaken.
- The mood is long lasting and has indistinct, often combined causes (e.g., "I am happy" or "I feel in a bad mood").

In the context of product appearance, our study will be focused on feelings that are of a smaller intensity than emotions. The purpose of our study is dual. The first objective is to develop and to test a methodology to evaluate the customer emotional perception of car. The second one is to evaluate the visual perception of car seats comfort. In fact, Renault has done a lot of work to understand and optimize its car seats' safety as well as static and dynamic comfort. Nevertheless, designers still miss data on visual perception of car seats, and more specifically on the visual perception of comfort. What characteristics of the car seat will make it look comfortable to customers? This project was of a great interest to explore customers' emotional perception.

2. METHODOLOGY

2.1. Method for investigating customers' emotional perception

Emotions are complex and can be treated as a multifaceted phenomenon consisting of behavioral reactions, expressive reactions, physiological reactions and subjective feelings [9]. Different methodologies were developed to measure emotions, and in fact, each one only measures one of these components. Therefore, the number of approaches and tools available to measure emotions is impressive. Our purpose is not to make an exhaustive list of all the methods provided by the scientists but to make an outline to introduce our research orientations. In the literature, the first distinction is made between non-declarative methods and declarative methods:

- The non-declarative methods are so called because the emotional state is directly measured on the subject (the subject him(her)self is not even conscious of his(her) own state). One can distinguish the physiological measures (heart rhythm, blood pressure, electrodermal response, hormonal dosages or even brain waves) and the ethological measures (facial expressions or vocal expressions). The first advantage of these non-declarative methods is that they are objective: they do not rely on the subject's own assessment, which includes his/her abilities of speech and his/her, willingness to talk about his feelings. The second one is that, as they are non-verbal, they can be used in different countries. However, this kind of measures has several limitations. The main limit of these methods is that they require a complex and expensive equipment, which need to be handled by experienced persons. The responses themselves (signals or customer's behavior that were recorded)

require experience to be analyzed with precision. Besides, some methods are obtrusive (for example, sensors are placed on the skin), and the recorded signals are really dependant on the test conditions. If the test conditions are not strictly under control, signals will be disrupted. This is a major constraint for tests during driving. Finally, these methods are claimed to reliably assess basic emotions such as fear, surprise and anger but find difficulty with mixed emotions. They show what happens in the body of the subjects, but not in their mind. For example, I can feel some pleasure to be afraid. Given these limitations, it was decided not to use this approach to measure customer's emotional responses to car seats.

- The declarative methods are self-reported. The main limit of these methods is that the test results are dependent on the goodwill of the subject and on its understanding of the instrument. However, the above-mentioned limitations of non-declarative methods become an advantage because one has access to the subjective component of emotions. Declarative methods can also assess complex or mixed emotions. There are two types of declarative methods. The first category consists of rating scales in which the intensity of the emotions is scored. Examples are the PAD system [10], the Differential Emotion Scale [11], the Emotion Profile Index [12] and more recently, the Consumption Emotion Set [13] and the food questionnaire [14]. The main limitation of these questionnaires is that they are language-dependent, and consequently not cross-cultural. To overcome this problem, rating scales with pictograms representing different emotions have been developed. This is the second type of declarative methods. One can quote the SAM [15] and the PrEMO [16]. The main disadvantage of the SAM that was pointed out is that only generalized emotional states, such as pleasantness and arousal, are measured. Considering the PrEmo, Norman [17] said that, although the cartoons are short, simple and playful, the time and the effort needed to fill in the whole questionnaire is disheartening. Besides, the tool requires not only a computer but also an internet connection.

Considering this inventory and our test constraints, we concluded that the most appropriate method is a declarative one. Therefore, in a first step, we listed all the positive and negative emotions we could find in the literature. Then, in preliminary studies, we asked customers to report their emotional visual perception of different parts of the car. We were then able to select the feelings the most appropriate to the automotive context. For example, *loving* and *furious* were eliminated. The list of the most selected feelings was composed of 28 positive and negative emotions.

2.2. Method for investigating customers' global perception

At the beginning of the session, the customers discovered all the fifteen seats. Then, they were asked to fill out the questionnaire in a chronological order:

- The preference task: each seat was given a preference score from 0 "I really dislike this seat" to 10 "I really like this seat". We allowed customers to add comments on the questionnaire to explain each score: which characteristic(s) of the seat they did especially like or dislike.
- The emotion task: customers were asked to imagine that each seat was the seat of their own vehicle. Then, they had to describe their emotional perception by checking all the appropriate feelings they want from the 28 proposed (see § 2.1.).

- The comfort task: customers were focalized on the perception of the comfort. Imagine you had to test each seat, do you think you would feel well or not? Thus, each seat was given a comfort score from 0 “this seat looks uncomfortable” to 10 “this seat looks comfortable”. We allowed customers to add comments on the questionnaire to explain each score: which characteristic(s) of the seat looks comfortable or not.

2.3. Method for investigating the sensory properties of the products

The appearance of the seat was described using the sensory profile methodology [1,18]. Eight people were selected to constitute a trained panel attending 3h sessions a week throughout 3 months. Some panelists were novices and representative of the customers’ perception. The others were experts of the seat (researchers, product and graphic designers). As sensory profiles on car seat perception have ever been conducted, we already dispose a list of attributes. Specific training was conducted as follows:

- One session to check attributes that we already dispose.
- One session to define eight different parts of the car seats.
- Three sessions to add visual terms to the initial list of attributes (group discussion with consensus on the word itself, its definition and its test procedure).
- Three sessions to practice test procedures and scaling through rating on 15cm linear scales.

Four additional sessions were required to build the final list of attributes. This list was composed of 35 visual attributes : 6 about the cushion, 4 about the cushion bolsters, 1 about the seating outer housing, 6 about the backrest, 4 about the backrest bolsters, 7 about the headrest, 5 about the coating and 2 about the global perception of the seat. Each panelist finally scored each seat on each attribute during one last session.

3. MATERIALS

3.1. Sample selection

The work group that started the project selected more than a hundred pictures of car seats. Some pictures were real seats and the others were concept seats. The pictures were classified in ten families taking into account their appearance (dimensions and shapes). Then we tried to select one representative of each family. We also wanted the seats to come from different car platforms and to be made of different materials and colors. Our final selection was composed of 15 seats: 6 from Renault and 9 from competitors.

To avoid the influence of the numerous elements of the cockpit on the customer visual perception of the seats, the seats were pulled out of the cars. In order to standardize their heights, the seats were placed on individual trolleys. To remain anonymous, they were coded with three digit numbers (Figure 1).

Figure 1: Car seat trolley

3.2. Selection of the customers

A hundred French customers participated in the test. They were selected according to their gender, age, vehicle (brand and platform) and material of their seat (leather vs. other materials).

3.3. Test procedure

The seats were presented in a circle for the customers to compare them easily. The sun lounge let us get natural light. The customers evolved in the circle made by the seats. They were not allowed to look at the seats by the back, to sit in them or even to touch them. 2 hours were necessary to fill out the questionnaire. The different steps of the test were presented in §2.2.

4. RESULTS

In the following text, the seats will be coded from A to O.

4.1. Sensory description of the seats

Agreement between the eight panelists was checked by calculating standard deviations and using Factorial Discriminant Analysis (FDA) and General Procrustes Analysis (GPA). The way each sensory term would discriminate between the 15 seats was checked using one-way Analysis of Variance (ANOVA). Results showed that the panelists agreed on the visual description of the seats and that all the 35 sensory terms were discriminating. Therefore, we kept the 35 terms to build the sensory profile of the seats. Figure 2 shows the variables and the observations maps obtained by Principal Component Analysis (PCA). Only the first two axes are represented. In order to enhance readability of the figure, sensory terms badly correlated to the first two axes were removed. Car seats that are closed to each other are surrounded (groups were constituted performing cluster analysis on the coordinates of the seats on the fourteen axes of the PCA).

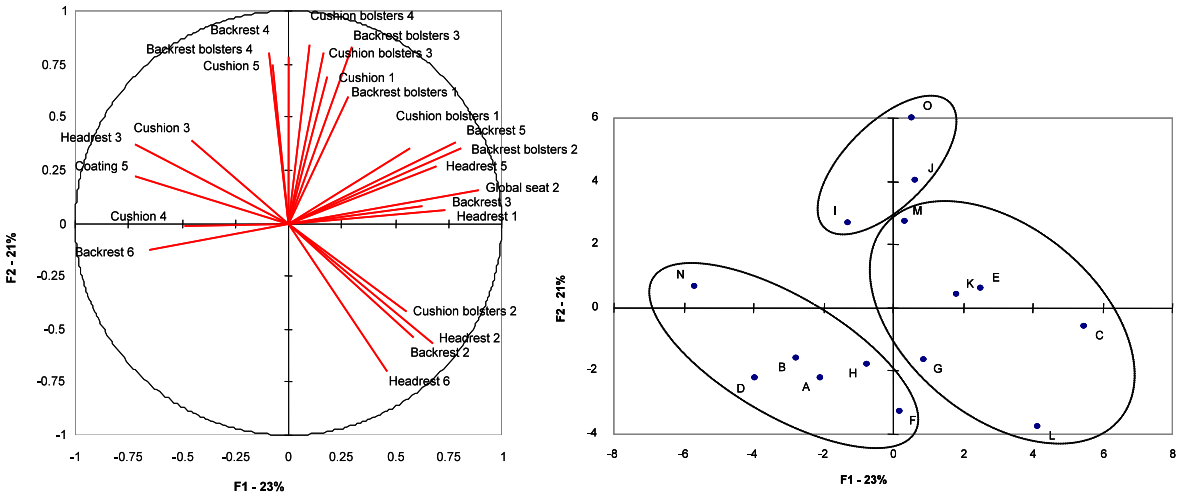

Figure 2: PCA performed on the mean scores of the experts' description

We can see that the seats are well discriminated on the sensory map. Overall, we can describe the three groups of seats as follows:

- O, J and I are sport seats with special shapes and prominent bolsters.
- N, D, B, A, H and F are seats from smaller cars: they are small, thin and relatively flat.

- M, K, E, G, C and L are seats from the highest platforms levels: they are bigger and thick, with a leather coating.

4.2. Preference and comfort results

Satisfaction and comfort scores allowed us to rank the 15 seats from the less appreciated (or less comfortable) seat to the most appreciated (or the most comfortable) seat. One way ANOVA were performed to check if the mean scores of the seats were significantly different. Then, Pearson correlations between satisfaction and comfort scores showed us that satisfaction and comfort are correlated for 44 customers: the more I appreciate the appearance of the seat, the more the seat seems comfortable to me. There is no linear relationship between satisfaction and comfort scores for 42 customers: some seats that I appreciate will look comfortable and some other seats will not. Finally, there is no link between satisfaction and comfort scores for 14 customers.

4.3. The emotional profile of the seats

First, we calculated how many times each emotion was selected by the customers (Figure 3). We noticed that the customers selected all emotions. An emotion can be chosen (15*100) times, so their use rate varies from 3% for *Indignant* to 27% for *Confident*. The positive emotions are more selected than the negative emotions. Car seats perception can be globally linked to positive emotions. We can also explain this result by the fact that negative emotions are not appropriated to the description of car seat perception: they may be too intense. As it happens in other studies, we can also imagine that customers are happy to be involved in a test, they are in a good mood and more inclined to select positive emotions.

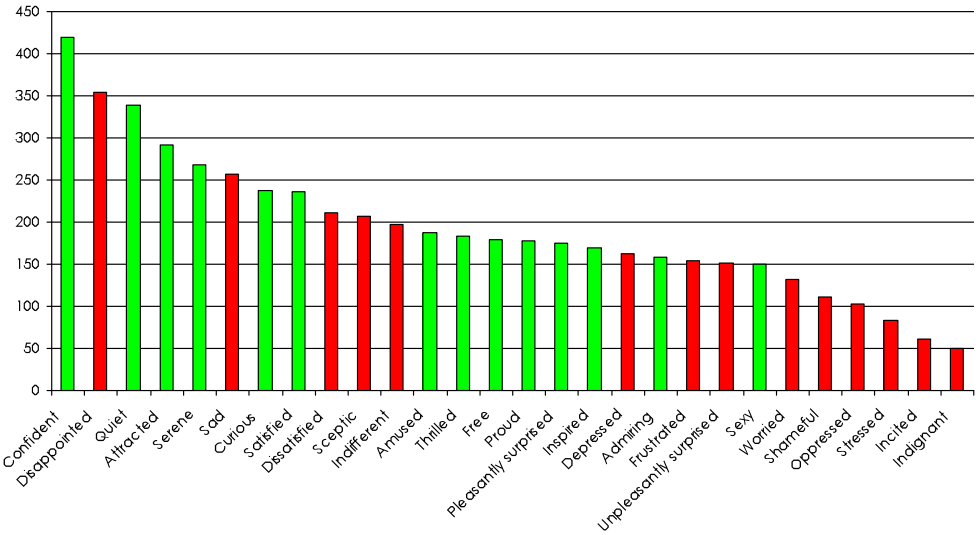

Figure 3: Number of selection of each emotion

Then, we had a look at the number of positive and negative emotions selected by car seat. There is a significant difference (Khi^2; $p<0.0001$) in the number of positive and negative emotions selected by seat. J, O, M, L, E, B and A have a positive emotional profile and N, G, I and K have a negative emotional profile. Correspondence Analysis allowed us to position the seats on a map according to their emotional profile (Figure 4). The positive emotions are in green and the negative ones in red. The emotional profile of each seat can be obtained regarding

the proximity between the seat and each emotion. Something interesting is that we can explain the first axis by a gradient of pleasure and the second axis by a gradient of energy. In fact, at the left of the figure, there are positive emotions like *Thrilled*, *Admiring*, *Proud*, *Attracted* or *Satisfied*. At the right of the figure, there are negative emotions like *Shameful*, *Dissatisfied* or *Disappointed*. Emotions with low energy or low activation rate like *Serene*, *Quiet* or *Indifferent* are at the bottom of the figure. Emotions with high energy or high activation rate like *Stressed*, *Incited*, *Curious* or *Amused* are at the top of the figure.

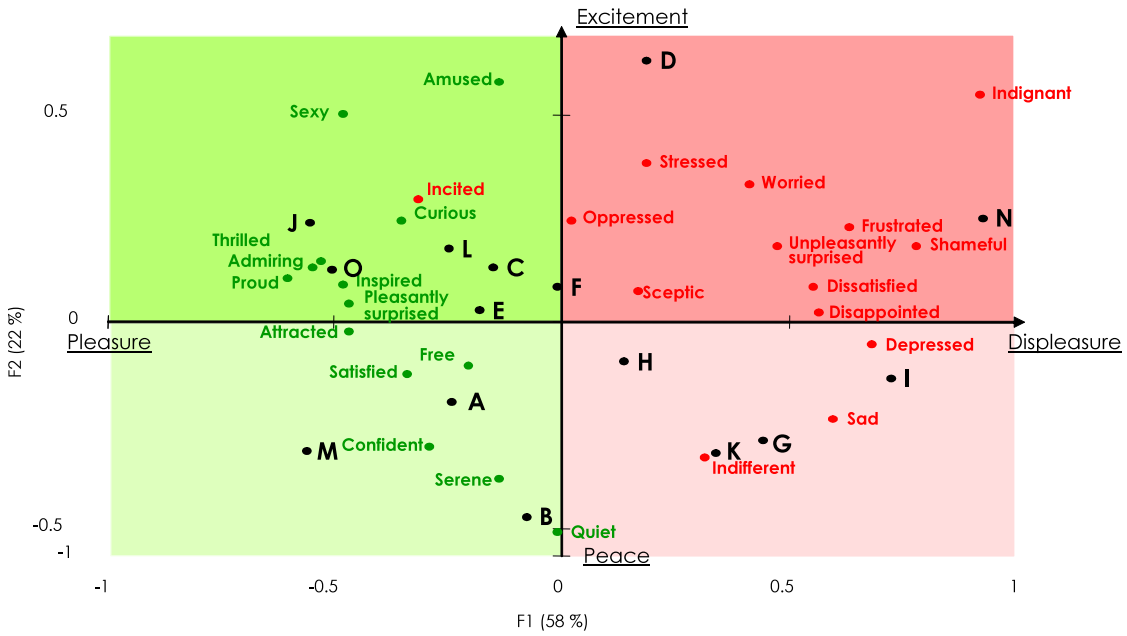

Figure 4: The emotional profile of the seats obtained by Correspondence Analysis

4.4. Explaining satisfaction, comfort & emotions by the sensory characteristics of the seats

External Preference Mapping (Prefmap) is one of the methods used in Sensory Science to establish relationships between sensory and consumers data in order to understand consumers' preferences [2]. The objective of this type of methodology is to explain customers' preferences with the sensory attributes of the products. This methodology is based on linear regression of each customer's preference scores with the two first axes of the PCA obtained from the sensory attributes.

We performed Prefmap using the sensory scores obtained through the sensory profile (PCA on Figure 2) and the satisfaction scores (Figure 5) or the comfort scores (Figure 6). On Figures 5 and 6, the blue color indicates that the seat is little appreciated or seems little comfortable. The red color indicates that the seat is highly appreciated or seems highly comfortable. The seats the most appreciated are located on a vertical line going from F to O, which means that you can do what you want with cushion and backrest bolsters without troubling satisfaction. However, if you play with headrest, coating, backrest or cushion characteristics, satisfaction may decrease. The results are approximately the same for the comfort perception of the seats. You will notice on Figures 5 and 6 that the optimums are close to each other, located between seats J and M. The highest perception of comfort is obtained for the seats located on the right part of the map, going from F, to O and to C. The seat C was quite appealing but it seems comfortable. If you are going to the left of the map by increasing *Headrest3*, *Coating5* or *Backrest6* sensations or by

decreasing *Headrest1*, *Backrest3* or *Global seat2* sensations, the comfort perception will fall fast and deeply.

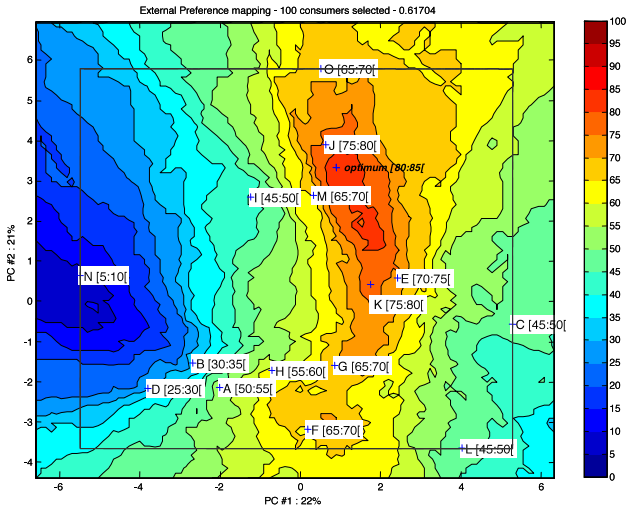

Figure 5: Prefmap on satisfaction scores

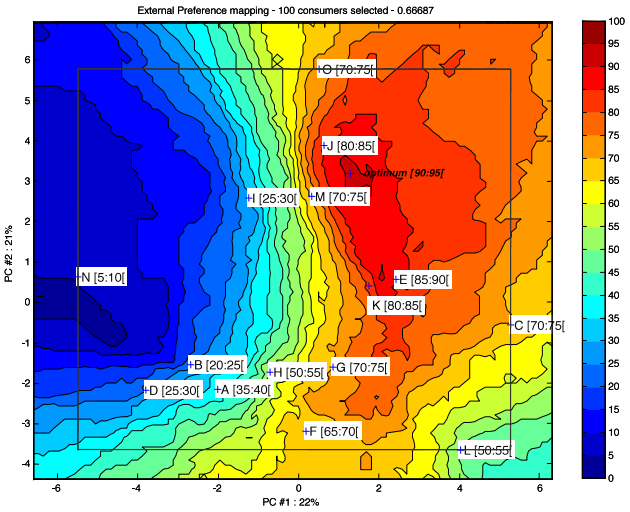

Figure 6: Prefmap on comfort scores

Dealing with the emotional perception of the seats, for each customer and each seat, we calculated an average emotional score by adding the number of positive emotions and subtracting the number of negative emotions. Then, we performed Prefmap (Figure 7).

There is a valley of low emotional scores between seats N and C. On each side of this valley, seat F at the bottom of the map or seats J and O at the top of the map have a high emotional score. Consequently, if you modify cushion and backrest bolsters sensations, you should not be shy: put them high (as in seats O and J) or low (as in seat F) or you will fall down the valley. The seat with the lowest emotional score is N, so you must avoid high *Headrest3*, *Coating5* or *Backrest6* sensations in future car seats.

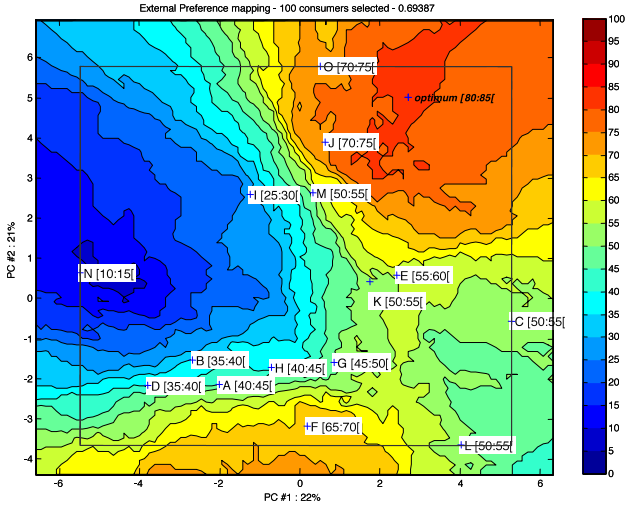

Figure 7: Prefmap on emotional scores

5. CONCLUSION

This study on car seat visual perception allowed us to develop a method to investigate the relationships between the customer emotional perception and the characteristics of the seat. The method is based on a list of emotional attributes and a sensory profile. The relationships between these data are established using Preference Mapping. As mentioned above, evaluating the emotional perception of the seats was complementary to the preference scores. Indeed, seat K is quite appreciated but not so emotional. We managed to recommend to the designer the seat's best shape taking into account the seat characteristics that appeal to customers, that evoke emotions and that enhance the comfort appearance.

As a continuation of this study, our list of emotions can be some more refined. It would be of a great interest to verify if the emotions have the same meaning to each customer. To improve our methodology, we would like to check the relationships between the emotions. Maybe less than ten emotions would be enough to describe the overall perception of the customers. As a result, it would be possible to model each emotion individually and predict which characteristics of the seat would improve pride and serenity for example.

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