

A Categorical Model of Colour Emotion for Product Design

Maryam Mohammadzadeh and Stephen Westland

School of Design, University of Leeds, UK

ABSTRACT: This research aims to develop statistical methods to select the colour of a product based on emotional aspects of the colour and their suitability for the product. A psychophysical experiment was carried out to investigate the relationship between colour emotions and personality elements. 50 Iranian students were asked to assess each of 36 colours in terms of three scales: colour-meaning, emotion and design. The data were analyzed statistically to obtain a model with age and gender as parameters and scale properties as a response. A similar experiment was also carried out using a bi-polar scale that related to the design of a toothbrush. We concluded that based on the condition that a toothbrush must be produced in light, long-lasting, pleasant, easy and encouraging form as well as having a fair price; it should be coloured white or light red. Moreover, colours indicating higher price of the product were highly correlated to sex and age, the only feature of toothbrush, which is found directly related to the personality. The complex formulae of this correlation are simplified in a Mosaic Plot which puts in, the related components all together at once in a simple graphical way. It must be included that the students who were surveyed did not know that the product is actually a toothbrush and each color scale is analyzed and modeled separately, so the derived formulas of this research are compatible to any other product with the same element.

1. INTRODUCTION: Colours of products - specifically every-day products - are very important not just for influencing sales but also for making products pleasant to use. Indeed, attractive things do work better - their attractiveness produces positive emotions, causing mental processes to be more creative, and users to be more tolerant of minor difficulties [1]. The colour of a product should interact with its main use and should make the user anticipate that its use will be pleasant before even picking it up which leads us to the concept of colour emotion. The term colour emotion is used to describe the feeling induced in an observer when viewing a particular colour [2]. The process of designing a product and getting it into mass production is a lengthy and time-consuming procedure. Markets often changes their appetite for colours and it is therefore critical to be able to forecast a market's preferred colour for a given product (colour forecasting) [3]. The main characteristic of this work is that it formulates the risk of certain features of a product, based upon some colours which are categorized as binomial variables. This is in contrast with related research [e.g. 4] in the field of colour emotion where colours are defined by CIELAB values and formulae are developed to predict certain emotional scales.

2. METHOD : A psychophysical experiment was carried out to predict the suitability of colours for product design. A total of 36 colours (see Figure 1) were used in the experiment; some were selected from Itten's colour wheel and some others were added including black, white and grey, also ensuring a large range of hue, lightness and chroma. A total of 50 observers asked about their age, gender, birth and living place and

then to indicate which of the colours they associated with various bipolar color-concept, color-emotion and colour-design scales. The results of this part of the experiment are not reported here and will be reported elsewhere.



Figure 1. The 36 colours used in the survey

The above experiment was repeated using a different set of characteristics that related to the design of a toothbrush (though observers were unaware of the link between these characteristics and toothbrush design). A toothbrush was chosen as the target because it is a simple product which involves sight, sound, smell, taste and touch. The seven pairs of colour scales that were the main characteristics of the toothbrush are listed in Table 1. Each colour patch was numbered so the observers wrote down the numbers of the chosen colour in front of each word. So, for example, if an observer associates white with light they would write the number 1 next to the word light in the colour-concept scale. Note that this experiment was carried out in Iran using the Persian language – the terms in Table 1 have been translated to their closest English equivalents. Unfortunately, because a large number of colours were used, relative to the number of observers, any models that were developed lacked statistical significance. Therefore it was decided to categorize similar colours into groups for simplification. Each colour was assigned to one of eight categories: dark red, bright red, dark blue, light blue, dark yellow, light yellow, white and black. The categorization was carried out by a local artist. Each of these categorized colours was used as a binomial variable and was modeled into a logistic regression equation.

Table 1: The bi-polar characteristics of the toothbrush.

Toothbrush characters	
1	Light-Heavy
2	Clean-Unclean
3	Easy to use- Hard to use
4	Pleasant-Unpleasant
5	Cheap-Expensive
6	Long lasting-Fragile
7	Willingness - unwillingness

Logistic regression is a useful way of describing the relationship between one or more independent variables (e.g. age, sex, etc) and a binary response variable, expressed as a probability that has only two possible values, such as (heavy or not heavy). A positive regression coefficient means that, that explanatory variable increases the probability of the outcome, while a negative regression coefficient means that variable

decreases the probability of that outcome. A significant logistic regression model was derived for the probability of each of the characters in this experiment which contained the most affective colours as binomial variables.

3. RESULTS : Table 2 contains all the significant logistic regression models derived for the 7 bi-polar characteristics of the toothbrush. In Table 2, $x_1 \dots x_7$ represent dark red, bright red, dark blue, light blue, dark yellow, light yellow and white and have values either 0 (red not present) or 1 (red present). The top equation in Table 2 denote whether the colour - defined by the set $\{x_1 x_2 x_3 x_4 x_5 x_6 x_7\}$ - is likely to be light or heavy (the larger and more positive the number the likelier the colour is light). The other equations similarly can predict the other bi-polar characteristics [5]. Note that not all colours appear in every equation; this simply implies that they are not significant.

Table 2. Logistic regression models for the probability of each characteristic of toothbrush.

Bipolar characters of tooth brush	Logistic Regression model
Light-Heavy	$\ln \frac{P(y=1/x_1, x_2, x_3, x_4, x_5, x_6, x_7)}{P(y=0/x_1, x_2, x_3, x_4, x_5, x_6, x_7)} = -1.466 + 2.383x_2 + 3.412x_4 + 3.951x_7$
Clean-Unclean	$\ln \frac{P(y=1/x_1, x_2, x_3, x_4, x_5, x_6, x_7)}{P(y=0/x_1, x_2, x_3, x_4, x_5, x_6, x_7)} = -2.639 + 3.332x_2 + 2.842x_3 + 5.313x_7$
Easy to use- Hard to use	$\ln \frac{P(y=1/x_1, x_2, x_3, x_4, x_5, x_6, x_7)}{P(y=0/x_1, x_2, x_3, x_4, x_5, x_6, x_7)} = 22.812 + 3.344x_2$
Pleasant-Unpleasant	$\ln \frac{P(y=1/x_1, x_2, x_3, x_4, x_5, x_6, x_7)}{P(y=0/x_1, x_2, x_3, x_4, x_5, x_6, x_7)} = -2.303 + 3.314x_2$
Cheap-Expensive	$\ln \frac{P(y=1/x_1, x_2, x_3, x_4, x_5, x_6, x_7)}{P(y=0/x_1, x_2, x_3, x_4, x_5, x_6, x_7)} = -0.336 + 3.332x_6$
Long lasting-Fragile	$\ln \frac{P(y=1/x_1, x_2, x_3, x_4, x_5, x_6, x_7)}{P(y=0/x_1, x_2, x_3, x_4, x_5, x_6, x_7)} = 0.262 - 1.402x_6$
Willingness - Unwillingness	$\ln \frac{P(y=1/x_1, x_2, x_3)}{P(y=0/x_1, x_2, x_3)} = -0.754 + 1.575x_1$

A graphical representation of each model is displayed using pie charts in Figures 2 to 8. In Figure 2, for example, the model for light/heavy is illustrated.

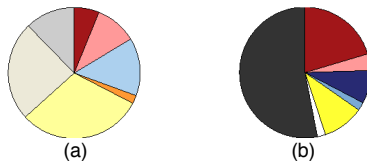


Figure 2. Pie chart for comparing the selected colours for (a) Light and (b) Heavy

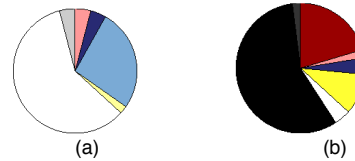


Figure 3. Pie chart for comparing the selected colours for (a) Clean and (b) Unclean.



(a)



(b)

Figure 4. Pie chart for comparing the selected colours for (a) Easy to use and (b) Hard to use.

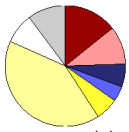


(a)



(b)

Figure 5. Pie chart for comparing the selected colours for (a) Pleasant and (b) Unpleasant.



(a)



(b)

Figure 6. Pie chart for comparing the selected colours for (a) Cheap and (b) Expensive.



(a)

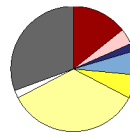


(b)

Figure 7. Pie chart for comparing the selected colours for (a) Fragile (b) Long lasting.



(a)



(b)

Figure 8. Pie chart for comparing the selected colours for (a) Willingness (b) Unwillingness.

Each of the bi-polar characteristics was also analysed with respect to age and gender of the observers. The most interesting of all was the relationship found between the variables age, gender and the colour chosen for the bi-polar term TMCheap/Expensive". By re-categorizing the colours into just three groups (red, yellow and blue) the mosaic plots of Figure 9 can be produced. In these plots, the area of a colour represents its importance. Note, for example, that young males and female equate red with expensive whereas older males and females predominantly equate blue (and yellow) with expensive.

4. CONCLUSIONS: A psychophysical study was carried out to investigate the relationship between colour and seven bi-polar characteristics that may relate to a particular product (a toothbrush). A categorical analysis was performed to generate seven logistic regression models. The models were visualised using pie charts and predict which colours (or possibly colour combinations) are likely to result in which colour emotions (in terms of the seven bi-polar characteristics that were studied). Based upon the observation that a toothbrush must be light in weight, easy to use, long lasting, cheap, give the feeling of cleanliness, pleasantness and willingness for use, the brightest colours would be a good option for a

toothbrush; specifically bright red. We also noted some influence of age and gender, most notably for the adjective Expensive, where younger observers, for example, preferred red and older observers preferred blue and yellow.

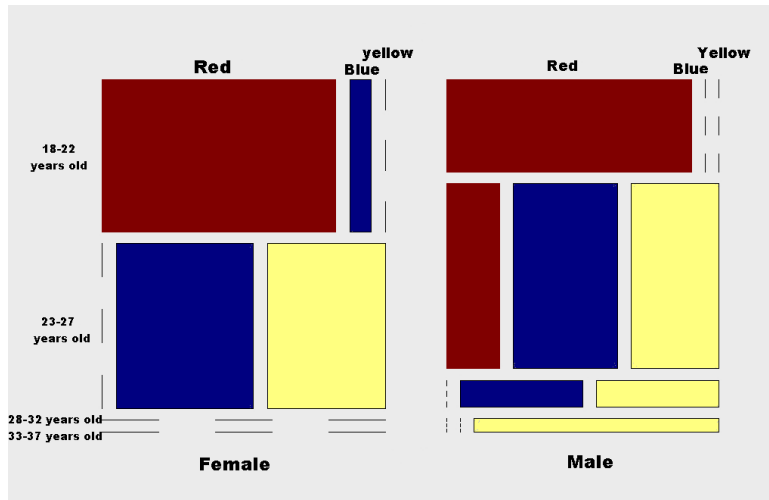


Figure 9. Mosaic plot for colours chosen to be expensive depending upon age and gender

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