Colour Emotional Visualisation

Sea-hwa WON, Stephen WESTLAND
School of Design, University of Leeds

ABSTRACT

This work is concerned with visualisation of colour emotion. Colour emotion relates to psychological responses and symbolic meanings of colour. However, which colours explicitly are relevant to certain emotions such as warm and cool is difficult to gauge because everybody owns different feelings and various cultural backgrounds. Nevertheless, the emotional effect of colour is important to achieve successful designs. In this work, the definition and the importance of colour emotion in design are illustrated. Specifically, which colours are actually associated with certain emotional words is explored through experimental work. This paper will present the result of a colour survey conducted within one cultural context. A total of 16 participants were given a task to draw freely using a set of coloured paints that were provided to represent 6 word terms (constituting 3 bi-polar characteristics: warm-cool, heavy-light, and masculine-feminine). Previous experiments in this field used scaling to obtain participants' responses to colours displayed on a screen or asked participants to choose one of several colour patches (such as munsell or pantone) to correspond to a word. However, this work is not constrained by a small number of samples and engages the participant in a creative task which might allow a closer relationship between colour and emotional response. Moreover, the drawings produced provide interesting visualisations *per se* of the semiotic (or emotional) responses. The colours of the drawings were analysed using MATLAB software to extract quantitative colorimetric data and with respect to previous models of colour emotion (e.g. those of Ou *et al.* 2004). Broadly speaking this new work supported the models of Ou *et al.*

1. INTRODUCTION

Colour semiotics is concerned with the meanings that colours are able to communicate. Colours can evoke strong emotional responses in viewers and can also communicate meanings and or concepts through association. There seem to be at least three different origins for colour semiotics. Firstly, there is the emotional or visceral impact of colours. Colours can have a strong emotional impact and can even affect our physiological state. For example, red colours have been cited to raise blood pressure and affect muscular strength. We fear the dark. Perhaps these effects are *innate* and have been present since the earliest days. Secondly, there are *socio-economic* origins. In western society purple became associated with wealth and royalty because purple dyestuff was expensive and was adopted by organizations and individuals to communicate the idea that they were wealthy and powerful. Thirdly, some colour meanings may be *cultural* in origin. The association of red with good luck in China and the link between pink and blue with gender in western society may originate in and be reinforced by cultural behaviour and shared understanding. Colour semiotics can have a powerful effect and hence the appropriate use of colour can impact greatly on the success of a design (particularly one that has a branding or marketing requirement). However, how robust are these colour associations and to what extent do they depend upon the context in which the colour is used? Colour meaning has been shown to depend upon other aspects of visual appearance such as gloss and texture. Some authors suggest that social groups that share common purposes around colour are often relatively small and specialized and, indeed,

that colour *per se* (that is, without context) does not even elicit a response but the particular meaning or significance of colour is context-bound and varies from one person or situation to another (Grieve 2001). Despite this, most robust studies that have explored colour semiotics have done so for colour patches viewed in the abstract sense, devoid of context. The colour science community often use the term colour emotion instead of colour semiotics and study bi-polar pairs of semantic words such as 'soft-hard'; in these circumstances although some effects of culture have been found they have been weak effects. Even the medium (e.g. digital display or hardcopy) has been shown to have little effect of the emotions or meanings that observers attribute to different colours (Suk and Irtel 2010). Gao *et al.* (2007) studied observers from seven countries who were asked to rate 214 colour samples each in terms of 12 bi-polar word pairs and found only small differences between the nationality groups. However, experiments that are carried in the laboratory necessarily suffer from a number of limitations. For example, such studies typical involve relatively few participants (~30) and therefore cannot easily address questions about the wider robustness of findings. However, a further limitation is that the studies tend to be quite clinical and it would be interesting to see whether the same sort of findings would result from studies carried out in a more creative environment; this was the purpose of the current study.

2. METHOD

Participants were provided with eight water-based colorants (red, yellow, green, blue, orange, black, white and violet) and given facility for mixing the eight primaries to produce a wide range of colours. The participants were asked to use the inks (and associated brushes provided) to create a visualization of each of six words; the words formed three sets of bi-polar characteristics: warm-cool, heavy-light and masculine-feminine. Each participant therefore produced 6 images (approximately 20 cm by 20 cm) and a total of 16 participants were involved. Therefore, for each of the six words being studied a set of 16 images was produced. An example of the 16 images for the word 'feminine' is presented as Figure 1.
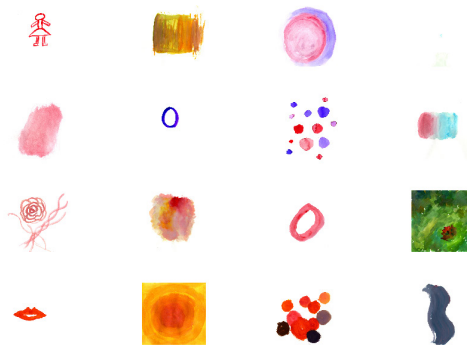

*Figure 1: The sixteen images produced to represent the term, feminine.
Each image was created by a different participant.*

Each of the images was scanned and the resultant digital images were assumed to be in sRGB format. The images were processed using software written in the MATLAB programming environment to perform a cluster analysis in RGB space. The MATLAB command *kmeans* was employed which implements the k-means clustering method (MacQueen 1967); this is a method of cluster analysis which aims to partition *n* observations into *k* clusters in

which each observation belongs to the cluster with the nearest mean. A total of 15 clusters were extracted from each of the six sets of images. In all cases the most populous cluster was white and this is because the participants drew their images on a white background. The first (white) cluster was removed from the analysis since whether or not the participants intended the background to be representative of their compositions was ambiguous. This left 14 clusters for each word term and these were ranked in terms of how many pixels each contained; the most prominent 8 clusters were used in subsequent analyses.

3. RESULTS AND DISCUSSION

In Figure 1 it is evident that although participants have used colour to represent the term feminine, they have also used form and imagery (for example, the red lips on the left-hand side of the bottom row). Participants also used symbolism in their representations of other words. Figure 2 shows the colours of the eight more populous clusters that were generated from the k-means analysis of the pooled images for each of the six word terms.
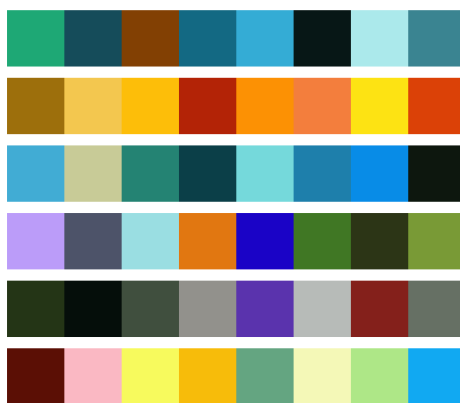

Figure 2: The eight most prominent cluster for each word. Each row contains cluster for one word (from top downwards: cool, warm, masculine, feminine, heavy, light) and the most prominent clusters are on the left in each case.

Each row in Figure 2 represents the clusters that were derived from one of the six sets of images (from top downwards: cool, warm, masculine, feminine, heavy, light). The sRGB values of the colours (Figure 2) were converted into CIELAB colour coordinates and were then used with equations developed by Ou et al. (2004) that predict warm-cool and heavy-light responses. Figure 3 shows the predictions from Ou's model for the heavy-light response for the colours from Figure 2 that were extracted from the light and heavy images respectively (for Ou's model the more positive the value the heavier and the more negative the lighter the colour). In general, the model's predictions are good. The mean lightness index (averaged over all eight colours) is -0.74 and the mean heaviness index is 1.03. However, there are some inconsistencies.
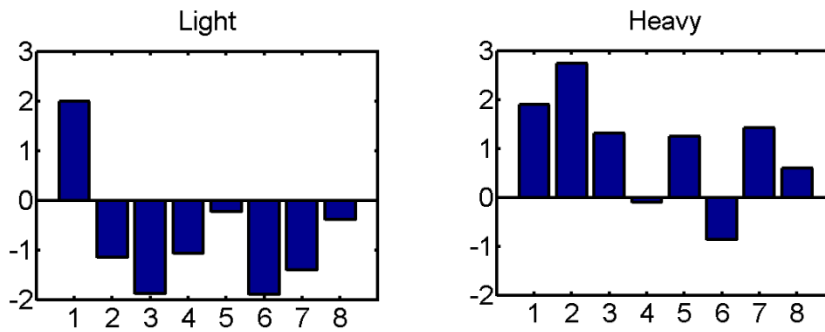
Light   Heavy

Figure 3: Ou prediction of heavy-light for light colours (left) and heavy colours (right) for each of 8 colours (denoted 1-8 on the abscissa). According to Ou's model more positive scores (plotted as the ordinate in this case) are heavier and more negative scores are lighter.

4. CONCLUSIONS

This work concerned psychological responses and symbolic meanings of colours. A total of participants engaged in a creative task and the images that were produced were analysed. A model developed by Ou *et al.* (2004) was used to predict the heavy-light associations of colours that were extracted from the heavy and light images using k-means clustering. Broadly speaking the new data were consistent with Ou's model.

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Address: Sea-hwa Won, School of Design,
University of Leeds, Leeds LS2 9JT, UK
E-mails: sdsw@leeds.ac.uk, s.westland@leeds.ac.uk