Influence of Different Cultures and Display Media on Colour Emotions

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Abstract

This study investigates whether colour emotions are affected by different cultures, display media, and subject's educational backgrounds. Psychophysical experiments were carried out at three locations, two in Britain and the other in Taiwan. In the experiments single colours and colour pairs were presented on Cathode Ray Tube (CRT) monitors and were assessed on four colour-emotion scales. Colour samples used in the previous experiment were accurately reproduced in the present experiments onto CRT monitors. This allows the same colours to be assessed at different locations. The four colour-emotion scales used in the experiments include 'warm-cool', 'heavy-light', 'active-passive', and 'like-dislike'. A total of 49 subjects took part in the experiments. The experimental data obtained from the three locations were compared. The results show little difference in colour emotions for colour pairs between different cultures (British vs. Taiwanese), different display media (CRT vs. surface colours), and different backgrounds of subjects (design vs. non-design). However, for single colours the scale 'like-dislike' show low correlation between data sets. In the previous study an 'additivity theory' was developed for predicting colour-pair emotions. The theory predicts the intensity of a colour emotion for a colour pair by the mean value of the colour emotion for individual colours in that pair. The present experimental results show the 'additivity theory', which was developed originally for surface colours, also applies to CRT colours.

Keywords: colour design, cross-cultural, cross-media, colour emotion, colour meaning, colour preference, colour pair

Introduction

Colours can evoke emotional feelings and associated meanings that can be described by affective words, such as 'warm-cool' and 'active-passive'. These affective words, associated with either single colours or colour combinations, are called colour emotions or colour meanings. The phenomenon of colour emotions is of importance to designers especially when the design work is to create a specific atmosphere or association with real products.

In our previous studies (Ou and Luo, 2002; Ou *et al*., 2004a-c), a number of colour emotion models were developed for both single colours and colour pairs by means of psychophysical experiments. Since the subjects participating in the experiments included British and Chinese, we compared the experimental data between the two subject groups in order to investigate cultural difference in colour emotions. Note, however, that among the subjects both British and Chinese were members of the same institution, the Colour & Imaging Institute (CII), University of Derby, UK. The subject sampling was considered to be very limited. The Chinese subjects were all members of the CII and have been in Britain for at least 6 months. They may have been influenced by British culture before the experiments, and accordingly the comparison results may be biased.

To overcome the problem of subject sampling, we carried out the same experiment in different countries. Physical colour samples used in the previous studies were not preferred for use in the present experiment. We chose CRT displays to present colour samples, and the reasons include: a) by using CRT displays the experiment can be repeated in different countries (or areas) without worrying about likely damages to physical colour samples due to changes in climate and humidity from an area to another, which can occur when physical colour samples are used, b) the viewing conditions can be well controlled by using CRT displays and c) using CRT displays is a convenient way of preparing a large number of stimuli.

A question may arise here as to whether experimental results for CRT colours correspond to those for *surface colours* (physical colour samples) in the case that both data sets are obtained from the same subject group. This is examined in the present article as we made the same subject group take part in both experiments. Note that CRT displays today are able to accurately reproduce colour images thanks to the standardisation of CRT characterisation techniques (Berns, 1996). As such CRT displays have become popular for designers either to perform design process or to present their design work.

Another concern about colour emotions comes to the effect of educational background. This is of importance to designers because designers would like to develop products that evoke common emotional feelings shared by both designers and customers with non-design background. The effect of educational background on colour emotions is also investigated in the present study as we conducted the experiments with subjects coming from both design and non-design background.

Methods

Psychophysical experiments were carried out in three areas, as described below:

(1) CII: Colour & Imaging Institute, University of Derby, UK,
(2) Coventry: Coventry School of Art and Design, Coventry University, UK, and
(3) NYUST: Department of Visual Communication Design, National Yunlin University of Science and Technology, Taiwan.

CII subjects were 7 males; no female participated. Five of the subjects were Chinese and two were British. They were all PhD students from non-design background. Coventry subjects were all British, including 9 males and 3 females. They were all students at Coventry School of Art and Design. NYUST subjects were all Taiwanese design students, including 16 males and 14 females. Note that two languages, English and Chinese, were used in the experiments according to subject's native language.

Twenty colours were used for assessment on 4 colour-emotion scales in the experiments. The 20 colours were selected to give a reasonable coverage in the entire range of colours. Figure 1 shows the 20 colours in the CIELAB colour space, which is a uniform colour space recommended by the CIE in 1976 (Hunt, 1998). The 20 colours were exactly the same as those used in our previous studies (Ou and Luo, 2002; Ou *et al*., 2004a-c), in order that the two experimental results can be directly compared. In the present experiments, all the colour samples were displayed on CRT monitors, which were all calibrated by the GOG model (Berns, 1996). All the monitors were tested on accuracy of colour reproduction and the test results show a mean colour difference (ΔE^*_{ab}) of 0.7, which is under the threshold of 'good accuracy', 1.0.

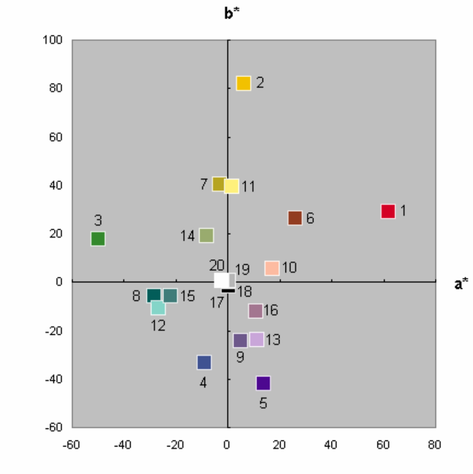

Figure 1, The 20 colour samples in the CIELAB colour space

The 4 scales, ‘warm-cool’, ‘heavy-light’, ‘active-passive’, and ‘like-dislike’, were used in the experiment. These were selected from the 10 colour-emotion scales used in our previous studies. Each scale was in the form of categorical judgement and consisted of 10 categories, which can be divided into two sides, e.g. ‘active’ and ‘passive’ on the scale ‘active-passive’. Each side contained five categories: ‘just perceptibly, ‘slightly, ‘moderately, ‘very much, and ‘extremely, labelled from ‘1’ to ‘5’, as shown in Figures 2 (a) and (b), for single colours and colour pairs, respectively.

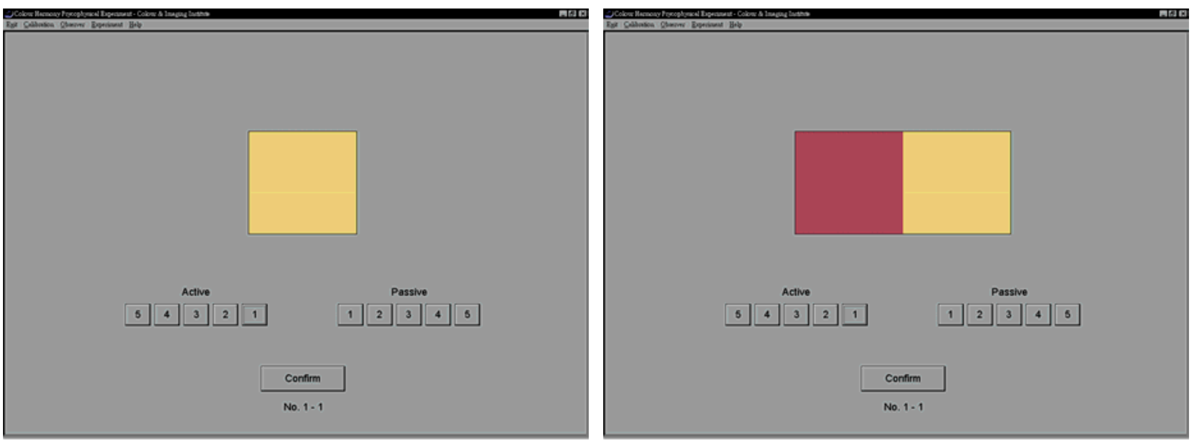

Figure 2, The experiment layout for (a) single colours and (b) colour pairs

It would take a long time for each subject to complete all the assessments at one time, and thus we divided the experiment into four sessions—the first session was single colour assessments, in which the 20 single colours were assessed on the 4 scales; the other three were colour pair assessments, with 190 colour pairs assessed on the 4 scales. Note that CII subjects attended only Sessions 2 to 4, while the other two subject groups, Coventry and NYUST, attended all the four sessions.

Results and discussion

Experimental data were collected in the method of categorical judgement (Torgerson, 1958), by which the scale values were calculated.

Cultural Difference in Colour Emotions

To investigate whether cultural difference affects colour emotions, the experimental results were compared between the three groups, CII, Coventry, and NYUST. The comparisons were made by Pearson product-moment correlation coefficient (r) between data sets. Pearson r is a measure of linear correlation between data sets and ranges from -1 to 1, where 1 indicates perfect positive correlation, -1 perfect negative correlation, and 0 no linear correlation.

Table 1 (a) shows the comparison results for single-colour emotions. As mentioned earlier, CII subjects attended only Sessions 2 to 4, and accordingly the comparisons here are made between Coventry and NYUST only. The Coventry and NYUST data were found to agree well with each other for all the scales but ‘like-dislike’, which shows the Pearson r of 0.46. Note that Coventry data were obtained from the UK and NYUST data were from Taiwan, and thus the low correlation in ‘like-dislike’ can be referred to as result of cultural difference. Note, however, that the number of single-colour samples was only twenty and the subject accuracy in ‘like-dislike’ was found poorer than in the other scales. These may also have affected the comparison results.

Table 1 (b) shows comparison results for colour pairs. The results indicate high correlation between the three data sets for all the scales but ‘like-dislike’. Low correlation was found in ‘like-dislike’ both between CII and Coventry and between CII and NYUST, with Pearson r of 0.56 and 0.65, respectively. Note that CII subjects were from non-design background, and both Coventry and NYUST subjects were from design background. Therefore the low correlation in ‘like-dislike’ can be regarded as result of the effect of educational background.

It also shows fairly high correlation between Coventry and NYUST for all the four scales, including 'like-dislike', with the Pearson r of 0.73. This suggests that cultural difference was insignificant in colour-pair emotions between British and Taiwanese.

Note that Table 1 (a) shows relatively low correlation in 'like-dislike' for single colours between Coventry and NYUST, with Pearson r of 0.46, and that in Table 1 (b) is shown high correlation of the same scale 'like-dislike' for colour pairs between Coventry and NYUST, with Pearson r of 0.73. This is perhaps because the number of single-colour samples was too small, as mentioned earlier, and thus the experimental results cannot show the whole picture. It would suggest that colour preference judgement tends to be affected by 'personal taste' more often on single colours than on colour pairs.

	warm-cool	heavy-light	active-passive	like-dislike
Coventry vs NYUST	0.85	0.98	0.83	0.46

Table 1a

	warm-cool	heavy-light	active-passive	like-dislike
CII vs Coventry	0.81	0.84	0.83	0.56
CII vs NYUST	0.86	0.88	0.80	0.65
Coventry vs NYUST	0.83	0.90	0.79	0.73

Table 1b

Table 1, Comparisons between observer groups for (a) single colours and (b) colour pairs

Media effect on colour emotions

Comparisons were also made between experimental data in the present study (CRT colours) and those in our previous research work (surface colours) so as to investigate media effect on colour emotions.

Table 2 (a) shows comparison results for single colours, with fairly high correlation between the two media for all the scales but 'like-dislike', with Pearson r of 0.45 for 'CII-surface vs. Coventry' and 0.48 for 'CII-surface vs. NYUST'. The results for 'CII-surface vs. Coventry' are also depicted in Figure 3. These results suggest somewhat media effect on ‘like-dislike’ for single colours. But again, the low correlation in ‘like-dislike’ may also be due to the number of single-colour samples and the subject accuracy in ‘like-dislike’, which was found relatively poorer than that in the other scales.

Table 2 (b) shows comparison results for colour pairs between the two media. The CRT-colour data for comparison included CII, Coventry, and NYUST. The comparison results show high correlation between two media for all the four scales, although the correlation coefficients for ‘like-dislike’ were not as high as those for the other three. This suggests that for colour pairs the media effect is not significant on colour emotions.

Note that Table 2 (a) shows low correlation in ‘like-dislike’ between the two media, while Table 2 (b) shows high correlation in the same scale. Again, this may be resulted from the fact that the number of single-colour samples was too small and the subject accuracy in ‘like-dislike’ was poorer than that in the other scales. More single-colour samples are needed for testing the media effect in future work.

	warm-cool	heavy-light	active-passive	like-dislike
CII-surface vs Coventry	0.85	0.91	0.90	0.45
CII-surface vs NYUST	0.93	0.92	0.86	0.48

Table 2a

	warm-cool	heavy-light	active-passive	like-dislike
CII-surface vs CII	0.86	0.84	0.80	0.68
CII-surface vs Coventry	0.78	0.84	0.75	0.56
CII-surface vs NYUST	0.83	0.88	0.71	0.69

Table 2b

Table 2, Comparisons between surface-colour data (CII-surface) and CRT-colour data for (a) single colours and (b) colour pairs

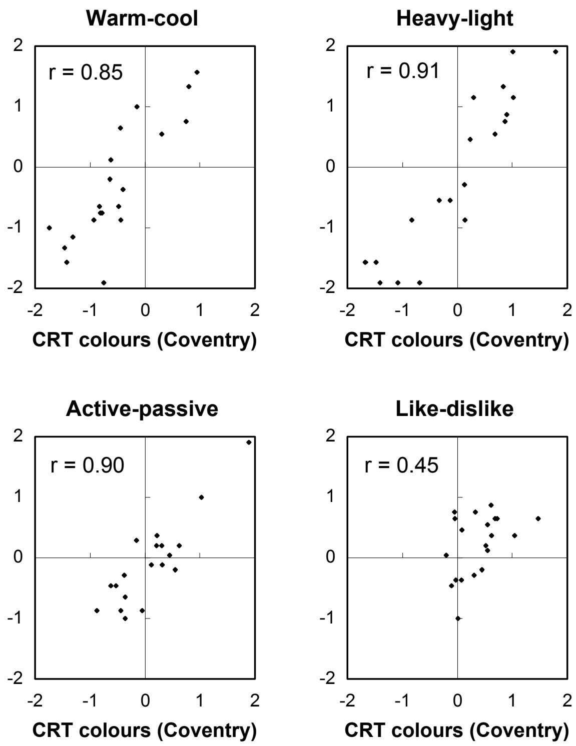

Figure 3, Comparisons of single-colour emotions between CII-surface and Coventry

Testing the additivity theory of colour emotions

Our previous study (Ou *et al*., 2004b) confirmed that the intensity of a colour emotion for a colour pair can be predicted by the mean of colour emotions for individual colours that generate the pair, as described by

$E = (E1 + E2) / 2$ (1)

where E is the intensity of a colour emotion for a colour pair that is made by Colours 1 and 2, $E1$ is the intensity of a colour emotion for Colour 1, and $E2$ is the intensity of a colour emotion for Colour 2.

Note that this equation, called *additivity theory*, was obtained from experimental results of surface colours. The present experimental data were tested to examine whether this equation also applies to CRT colours. Table 3 shows high correlation between experimental results and the predicted values by Equation (1) for the three scales, 'warm-cool', 'heavy-light', and 'active-passive', indicating that the additivity theory also applies to CRT colours. Note that ‘like-dislike’ was not among the test scales, because the additivity theory has been found inapplicable to ‘like-dislike’ (Ou *et al*., 2004b).

	warm-cool	heavy-light	active-passive
Coventry	0.84	0.85	0.82
NYUST	0.86	0.89	0.85

Table 3, Test results of additivity theory for scales ‘warm-cool’, ‘heavy-light’, and ‘active-passive’ on Coventry and NYUST data

Conclusions

This article investigates colour emotions across different cultures, different educational backgrounds, and different display media. Psychophysical experiments were carried out on CRT displays at the three areas: CII (UK), Coventry (UK), and NYUST (Taiwan). The experimental results are summarised below:

a) Cultural difference. Comparisons of colour-emotion scores were made between Coventry (UK) and NYUST data (Taiwan). The results show high correlation between the two data sets for all the scales but ‘like-dislike’. The correlation of ‘like-dislike’ for single colours was found even lower than that for colour pairs. This suggests that there is cultural difference in colour preference between British and Chinese.

b) Effect of educational-background. Comparisons were also made between CII (non-design), Coventry (design), and NYUST data (design) for colour pairs. The results show high correlation between the three data sets for all but ‘like-dislike’. Low correlation was found in ‘like-dislike’ both between CII and Coventry and between CII and NYUST. This would suggest that educational background affects colour preference judgement.

c) Media effect. The present experimental data (CRT colours) were compared with those in previous studies (surface colours). The comparison results show high correlation between the two media in scales ‘warm-cool’, ‘heavy-light’, and ‘active-passive’, for both single colours and colour pairs. ‘Like-dislike’ shows low correlation for single colours but high correlation for colour pairs.

The present study confirms that the additivity theory, which was originally developed for surface-colour emotions, also applies to CRT colours, indicating that CRT-colour emotions for colour pairs can also be predicted by averaging individual colours that generate the pair.

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