

# Facial Expressions, Colours and Basic Emotions

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We investigated whether the pairing of facial expressions of emotion with colours is consistent among different cultures, in particular between Australian and European people. Two groups, one consisting mainly of younger and the other of older people, participated in two experiments. For each of six faces, which expressed the basic emotions anger, surprise, disgust, sadness, happiness and fear, single colours and combinations of three colours were selected for the best visual 'fit' with the faces. The performance by the two groups was essentially identical. The different emotions appear well characterised by the paired colours. Two approaches were used for analysing the results of the experiments: one using techniques from the discipline of psychology, the other from the discipline of design. The six emotions were compared with regard to the position of each colour in the CIELAB colour space, the warm/cold characteristics, and the contrast between the three colours of the triplets. The process whereby facial expressions were 'translated' into colours and colours into faces could also be demonstrated. From an examination of the successes and failures in communication it is possible to propose single colours and colour combinations for each face that could be described as 'correct' and which can serve as a guide for designers.

## Introduction

Two experiments are described in this paper. The experiments were concerned with the relationships between emotions, facial expressions and colours. Following brief accounts of the nature of emotion and the expression of emotions in art and design, the experiments are described in detail. The results of each experiment are illustrated and analysed. The consensus of those who participated in the experiments is used as justification for proposing single colours and colour combinations which represent a 'correct' fit between colours and facial expressions of emotion, and which can be used by designers as a point of reference.

## Emotions, Facial Expressions and Colours

Emotions are complex states of mind which include physiological correlates, social roles and cognitive factors. Emotions give a person the energy for a reactive behaviour with the possibility of delaying and thus controlling the actual response [1]. Some emotions are considered basic [2], as they are not reducible to others, and their external manifestation plays an essential role in social adaptive interactions [3]. Basic emotions seem to be fundamentally universal, and their external manifestation seems to be independent of culture and personal experience [4]. For this reason they can be revealed by facial expressions without the intervention of verbal language [5]. Six basic emotions, with corresponding facial expressions, have been identified: anger, surprise, disgust, sadness, happiness and fear. Revelation of one's emotional state through facial expression can be involuntary but, to some extent, it is possible to exercise conscious control over facial expression to serve particular social goals. According

to Michael Argyle, 'the final verdict is that facial expressions are partly deliberate social signals, but that they also reflect true emotional states.' [6].

Emotional states are most clearly signalled by facial expressions, but the human face does also have a limited repertoire of colour changes; emotions can be accompanied by an increase or decrease of blood flow to the face leading to blushing or pallor. An unusual example of a case where face colour was more telling than facial expression as an indicator of emotional state is reported by John Berendt [7]. In his account of the fire which destroyed the Fenice Opera House in Venice, and the subsequent court proceedings, Berendt describes a remarkable characteristic of the prosecutor Felice Casson (p.79):

It was his tendency, when he was angered, for his face to turn pink, then red, then scarlet, from the top of his forehead to the neckband of his collarless shirt. Neither his expression nor his voice betrayed the slightest emotion, but there was no disguising the litmus of his face. He was known for it. Defendants due to be cross-examined by Casson were cautioned to watch for the crimson blush and to be guided accordingly.

A fundamental role of colours is to give the viewer information about the nature of objects. Colours can also stimulate the viewer to respond to a set of circumstances in a particular way. Among the perceivable characteristics of objects we can count their positive and negative values for the observer. If facial expression constitutes a pre-language medium of communication, the same might be claimed for colour with the possibility that colours, like facial expressions, can be linked to emotions. There is increasing evidence that the link between emotions and colours is rooted in human biology. The way we blush and turn pale may be part of the story, but the range of colours that can communicate emotions goes far beyond the range from pink to scarlet exhibited by Felice Casson. It seems possible, therefore, to describe some correspondence rules between colours and emotions [8,9]. In this research we aimed at verifying that Australian and European observers associate colours with emotional expressions in a similar way.

## Expressing Emotions in Art and Design

The expression of emotions, and emotional responses, can be a central concern of artists and designers. Their aim may be to express their own emotions, to induce a particular emotional response in others, or both. Another possibility is that emotion itself might be the subject matter of a painting. Edvard Munch and Vincent van Gogh are well known for the emotional intensity of their work.

### **Colour and Emotion in Art – Edvard Munch and Vincent van Gogh**

Munch described the experience which inspired his most famous painting *The Scream*: 'I was walking along a road one evening... The sun went down – the clouds were stained red, as if with blood. I felt as though the whole of nature was screaming... I painted that picture, painting the clouds like real blood. The colours screamed.' [10]. In a later painting he drew heavily on the compositional elements in *The Scream* to express *Anxiety*. An observation about Munch by his friend, the poet Sigbjorn Obstfelder, is quoted by John Gage [11]: 'He feels colours and he reveals his feelings through colours; he does not see them in isolation. He does not just see yellow, red and blue and violet; he sees sorrow and screaming and melancholy and decay.'

Van Gogh wrote passionately about his ideas [12]. He regarded colour as one of the keys: 'instead of trying to reproduce exactly what I have before my eyes, I use colour more arbitrarily, in order to express myself forcibly.' (p.6). In letters to his brother he describes his intentions for his painting *The Night Café*: 'I have tried to express the terrible passions of humanity by means of red and green' (p.28). And then: 'In my picture of the Night Café, I have tried to express the idea that the café is a place where one can ruin oneself, go mad or commit a crime.' (p.31). In a letter to fellow painter Émile Bernard, written from the asylum in St Rémy, van Gogh links a particular colour combination specifically to a particular emotional state: 'this combination of red ochre, of green gloomed over by gray, the black streaks surrounding the contours, produces something of the sensation of anguish, called 'noir-rouge' (black-red), from which certain of my companions in misfortune frequently suffer.' (p.524).

### **Colour and Emotion in Design – Léon Bakst**

For artists, whose concern may be to express their own emotions, getting the colours 'right' may not be an issue. Their choice of colours is dictated by their own feelings. Designers, on the other hand, may be required to express feelings which they may not be experiencing themselves. In this sense they must be like actors. A designer's choice of colours must be more objective; colours must be chosen with the same conscious deliberation that actors use when they put on particular facial expressions in a play. Antonio Damasio explains how there is a difference between facial expressions that are unconscious natural expressions of emotion and those that are consciously assumed in a social situation: 'In order to smile 'naturally', you have only a few options: learn to act, or get somebody to tickle you or tell you a good joke.' [13].

Designers may have confidence in their own judgements, but the results of these workshop exercises show that not all will get the colours 'right'. The single colours and colour combinations, that represent the consensus of the group, can be used as a point of reference by designers who do not have their own feelings to guide them.

Designers working in the theatre, especially, need to respect the needs of the drama. Sets, lighting and costumes can add to the impact by providing a supporting atmosphere. This was recognised by Léon Bakst in his work for the Russian Ballet. Not only did Bakst recognise the link between his use of colour and the emotional response of the audience, he was also aware of the subtleties and how there are nuances of colour corresponding to nuances of emotion. Bakst's ideas, expressed in an interview, are recorded by Mary Fanton Roberts [14]:

I have often noticed that in each color of the prism there exists a gradation which sometimes expresses frankness and chastity, sometimes sensuality and even bestiality, sometimes pride, sometimes despair. This can be felt and given over to the public by the effect one makes of the various shadings. That is what I tried to do in *Schéhérazade*. Against a lugubrious green I put a blue full of despair, paradoxical as it may seem.

There are reds which are triumphal and there are reds which assassinate. ... The painter who knows how to make use of this... can draw from the spectator the exact emotion which he wants him to feel.

As can be seen in the choices made by those who participated in the exercises, which are illustrated below, reds feature strongly as single colours, and in combinations, both for anger and for happiness, but they are not the same reds. The differences are of nuance. In each case the reds are highly chromatic but 'angry' reds are blackish while 'happy' reds are not.

## The Experiments

The research took the form of experiments conducted as workshop exercises during a conference in Fremantle, Western Australia, in September 2005. The conference was the tenth biennial conference of the Colour Society of Australia. Keynote speaker at the conference was Osvaldo da Pos who also devised the experiments and, with Paul Green-Armytage, conducted the workshop exercises. The arrangements for the conference determined the circumstances under which the experiments were carried out. Time was limited. Participants were not subject to colour vision tests. They also worked together at tables where they could see what others were doing. While it is possible that some were influenced by the work of others, the participants in general seemed to be focussed on their own work; the level of concentration is evident in the photographs taken at the time (Figures 1 and 2).



Figure 1 Morning group at work



Figure 2 Afternoon group at work

The room was lit by daylight which was stronger in the morning than in the afternoon. Additional lighting was provided by overhead fluorescent lamps and tungsten spotlights. The quality of the lighting does not seem to have been an influencing factor since the morning and afternoon groups, working under slightly different conditions of lighting, made very similar colour choices.

### Participants

Most of those who attended the conference and participated in the workshop exercises were designers or students of design. Personal details were not recorded; the following information is from personal knowledge of the participants. Of those that were not designers or students, three had frequent dealings with designers being concerned with colour measurement and the coatings industry. Of the remainder, one was a philosopher of science and three were interested lay-people. Most of the participants were native born Australians. Known exceptions were three who had been born in Great Britain, two from New Zealand and two students from Malaysia studying in Australia. The ages of the participants were not recorded but most of the students were under 25. The other participants were older, most in their 40s or 50s, a few in their 20s and 30s and a few in their 60s. The participants were divided into two groups of 22 people each. The 16 younger students, three male and 13 female, were in the second group. For these students the workshop exercises and attendance at the conference were treated as part of their design course. The other six in that second group were older, one male and five female. In the first group, 17 were female and five were male. The responses of the male and female participants were not recorded separately. The only comparison that can be made is that between the responses of the two groups since these were collected separately. Since the

average age of the second group was somewhat lower than that of the first group it is possible to look for a difference in response according to age.

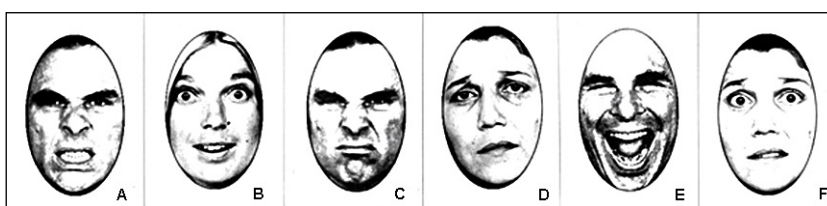
### The Exercises

The workshop exercises gave participants the opportunity to experience, first hand, the research methods of psychology and to discuss how the findings of such research might be applicable to design. Participants were asked to choose single colours and combinations of three colours that best 'fit' each of six faces. The faces were expressive of the six basic emotions, but the emotions themselves were not named. By choosing colours to fit the faces participants were expected to respond directly to facial expression and to associate the faces with colours without verbal language as an intermediary. In the accounts which follow, the exercise linking faces to single colours (Experiment A) is described first. However, during the workshop itself, participants were asked to begin by choosing three-colour combinations (Experiment B). This was to avoid the possibility that participants would approach the three-colour task with the idea that one of the colours had already been chosen. In the event not all the participants were able to complete both exercises. One member of the first group and six from the second group were not able to complete both exercises in the time available.

### Experiment A

In experiment A we studied which colours a selected group of people associate with faces showing specific emotions. Six basic emotions were studied: anger, surprise, disgust, sadness, happiness, and fear. To reduce the verbal influence in combining colour and emotion we used black and white pictures of faces chosen from a collection which Ekman and Friesen (1978) selected as universal representatives of the basic emotions (Figure 3) [5]. These are reproduced in this paper with Dr Ekman's kind permission. Each picture was reduced to the same size and inserted into ovals ( $8.5 \times 5.3$  cm), then printed on white card and finally cut all around.

Colour samples from the Natural Color System (NCS), A7 size, were placed in envelopes next to pages from the NCS atlas on large tables for the use of the participants (Figure 4). The task of



**Figure 3** Faces expressive of the emotions anger (A), surprise (B), disgust (C), sadness (D), happiness (E) and fear (F) from the collection made by Ekman and Friesen [5]



**Figure 4** Participants selecting colours



the participants was to choose from the NCS collection colour samples which they considered best fit the faces and to paste the cut-out faces in the centre of the colour samples (Figure 5).



Figure 5 Matching faces to colours

### Results and Analysis

The degree of consensus about which colours best fit each face is easily seen when the faces, with their coloured surrounds, are displayed together (Figure 6).

The NCS notations for the selected colours were transformed into the CIELAB colour space (illuminant D65) for an easier analysis of the data. First of all a statistical comparison performed by a univariate ANOVA (variables: CIELAB notations of the chosen colours for all the six emotions, between subjects) showed no significant difference between the two groups of participants, which gave extremely similar results. Therefore their data were pooled for the following analyses. Figure 7 shows the average lightness and chromaticity of the colours associated with the different emotions. As regards the lightness, there are distinct groups of emotions: happiness, surprise and fear combined with very light colours ( $L^* > 63$ ), sadness and disgust with colours of intermediate lightness ( $50 < L^* < 60$ ), and anger with rather dark colours (usually black and red).

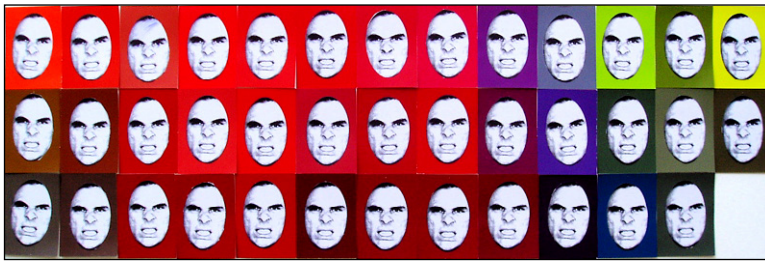
The colours relative to sadness and fear are very desaturated (close to 0,0), while happiness, surprise and anger are associated with highly chromatic colours. These results agree with the idea of considering 'active' these last three emotions and 'passive' the other three. The activity dimension in colour perception, already found by Sivik [15], has been recently confirmed by Xifu [16] and Ou *et al.* [17,18]. Moreover, our interpretation agrees with the finding that colours of higher saturation characterise active emotions [19], and increase the observer's arousal independently of their hue [20]. Lastly most colours belong to the yellow-red quadrant, indicating that the 'active' emotions show a warm appearance.

Figure 8 shows the average values, expressed as percentages, for the NCS colour attributes chosen for each emotion. For example, the average choice for anger was 40% blackness, 8% whiteness, 2% greenness, 3% blueness, 40% redness, 7% yellowness. Surprise, sadness, and fear are quite whitish (and therefore desaturated) as noted before; anger shows strong blackness, in agreement with previous findings [8]; surprise and happiness show little blackness and are strongly orange, as found in most previous research.

Figure 9 shows the plot of a multi-dimensional scaling operated on the colour distances in the CIELAB space. As in a previous European study [9], surprise and happiness are far from each other and from the other emotions. Anger, disgust and sadness are relatively close to each other, and fear apart (in that research a 3D space was better fitting the reciprocal colour relationships).

Figure 10 compares the results of two European studies with this Australian research. As in Figure 8, this shows the average values, expressed as percentages, for the NCS colour attributes chosen for each emotion.

Most emotions appear to share the same pattern of colour association, with few differences:



**Figure 6-A** Colours fitted by participants to faces expressing anger



**Figure 6-B** Colours fitted by participants to faces expressing surprise



**Figure 6-C** Colours fitted by participants to faces expressing disgust



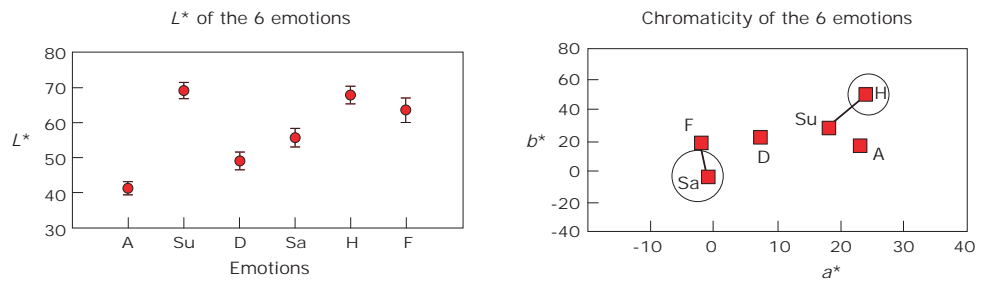
**Figure 6-D** Colours fitted by participants to faces expressing sadness



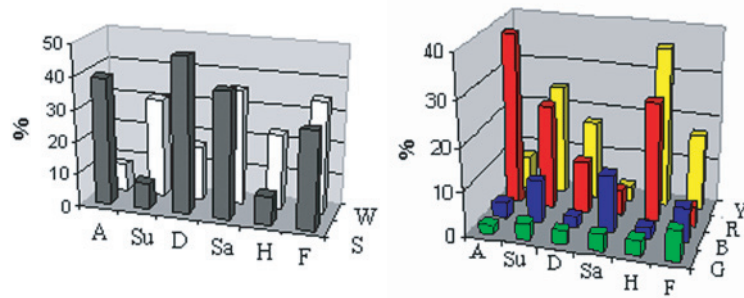
**Figure 6-E** Colours fitted by participants to faces expressing happiness



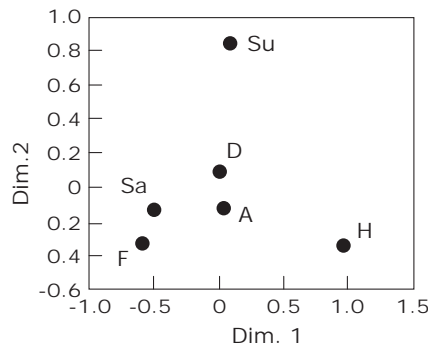
**Figure 6-F** Colours fitted by participants to faces expressing fear



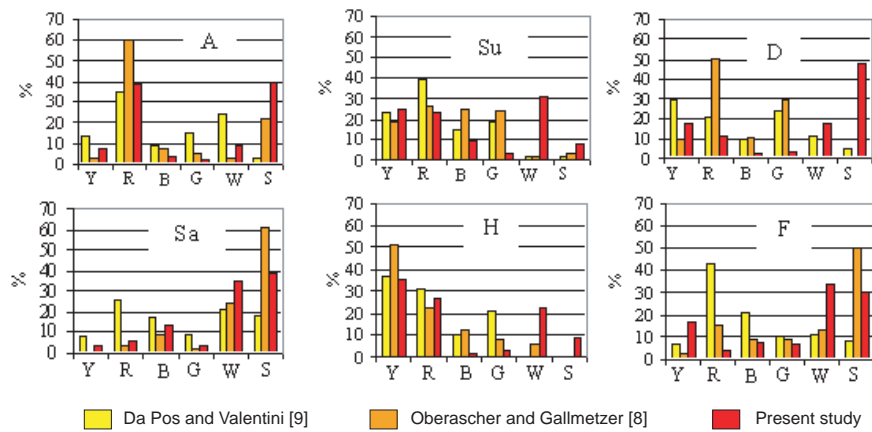
**Figure 7** Mean lightness ( $L^*$ ) and chromaticity ( $a^*b^*$ ) of the colours associated with the different emotions; A = anger, Su = surprise, D = disgust, Sa = sadness, H = happiness, F = fear



**Figure 8** NCS attributes of the colours associated with the different emotions



**Figure 9** A 2D representation of the distances between the six emotions in a Proxscale multi-dimensional scaling plot; A = anger, Su = surprise, D = disgust, Sa = sadness, H = happiness, F = fear



**Figure 10** The unique colours characterising the six emotions in two European studies and in this Australian work; A = anger, Su = surprise, D = disgust, Sa = sadness, H = happiness, F = fear



anger is characterised by redness in three and blackness in two studies, surprise by yellowness and redness in all three studies, happiness again by yellowness and redness in all three studies, sadness by whiteness/blackness in the three studies, fear by whiteness/blackness and some redness/blueness, and finally disgust appears a little more heterogeneous in the three studies.

The three studies have many similarities, all presenting rather warm colours (little blueness and still less greenness). This raises the possibility that the association of colours with emotions may depend, to a large extent, on some universal, biological factors. Probably this result is largely due to the purely perceptual task which requires a minimum of verbal language; the larger variability of the first study by da Pos and Valentini probably derives from the particular procedure by which observers could produce all the colours allowed on a computer monitor [9]. Nevertheless, the results in that case are still close to those of the other two studies.

### Experiment B

In this experiment the task was to select three colours which, in combination, best fitted each of the faces described above. Participants used paper samples (approx. 2 × 2 cm) from the whole set of 210 colours of Green-Armytage’s Colour Zones system [21,22]. The Colour Zones system, designed to serve as a bridge between everyday language and the Natural Colour System (NCS), provides a palette of 210 colours in which all areas of colour space are represented. Colour space is divided into hue zones, identified by colour names, and nuance zones, identified by modifying adjectives. In a composite diagram of the system (Figure 11) hue sequences in each nuance zone are arranged in a way that can be related to the NCS colour triangle. Participants worked with strips of colours from each hue zone and a strip of achromatic colours. A separate sheet, with all the colours arranged to correspond with the strips, was provided for reference (Figure 12).

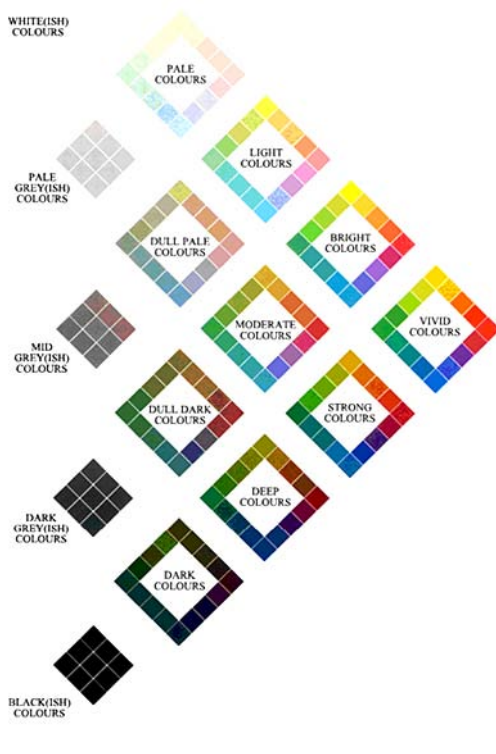


Figure 11 Composite diagram of the Colour Zones system

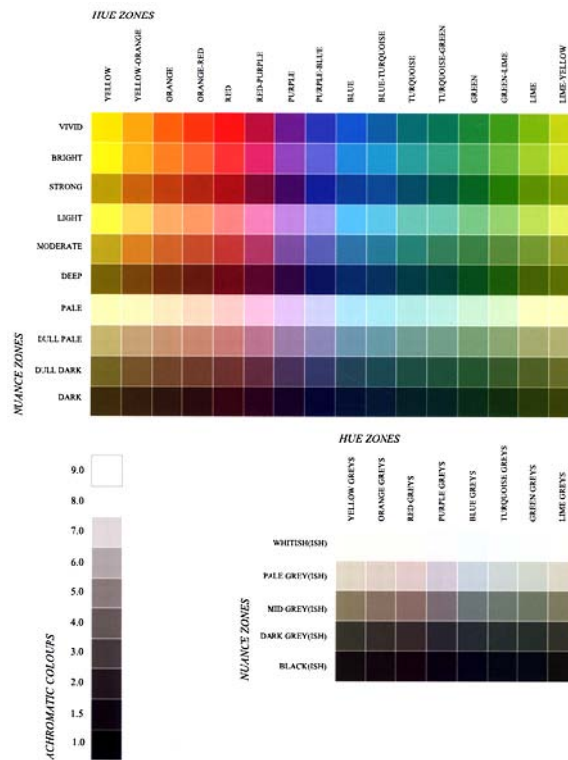


Figure 12 Reference sheet with colours arranged in rows for nuance zones and columns for hue zones

For each face, the three colour squares that, in combination, were judged to produce a colour impression that best fit the face, were glued side by side on a sheet of white card. Participants cut squares from the strips for their three-colour combinations and identified their choice of colours for each face by writing down the hue zone and nuance zone for each colour (Figures 13 and 14). Then, in a follow-up task, the three-colour combinations were collected and given to other participants whose task was to decide which face best fit each colour combination.

*Results and Analysis*

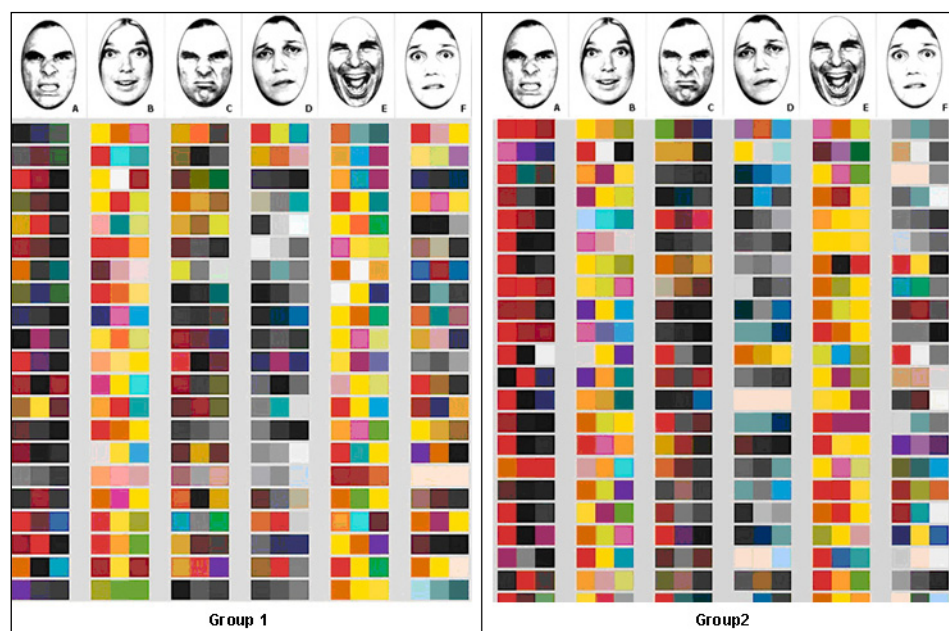
The degree of consensus about which colour combinations best fit each face is seen when the colour combinations are displayed together (Figure 15).



**Figure 13 (left)** Choosing three-colour combinations to fit each face



**Figure 14 (right)** Recording hue and nuance zones of chosen colours



**Figure 15** Colour combinations proposed by members of groups 1 and 2

The original colour notations were transformed into the CIELAB system by a visual procedure carried out by comparing the original samples with a complete collection of the RAL colour system. As in experiment A, the two groups of participants produced almost identical results. These were pooled for the following analyses. Each three-colour combination was treated as a triangle in CIELAB colour space, whose centres are shown in Figure 16.

Three groups of emotions are well separated by the lightness of the combinations: surprise and happiness are the lightest; anger and disgust are the darkest; sadness and fear are intermediate. The chromaticity of the combinations is quite similar to that of experiment A: happiness and surprise appear very saturated, yellowish and reddish; anger quite red; sadness and fear almost desaturated.

Figure 17 shows the colour contrast inside the colour triads for each emotion: surprise and happiness show the more highly contrasting colours, disgust and sadness the ones with lower contrast.

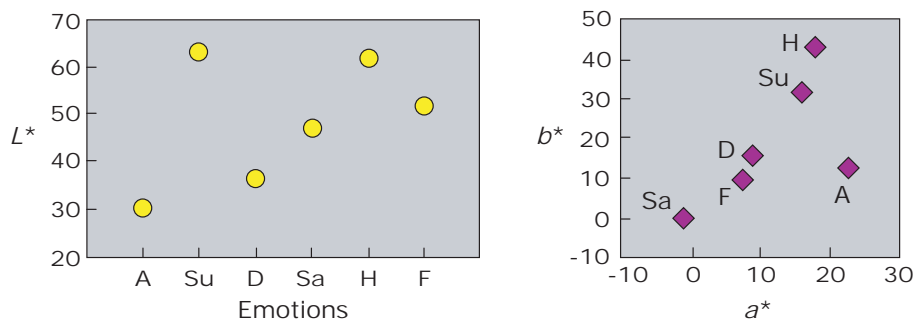


Figure 16 Lightness and chromaticity of the centres of the combinations for each emotion

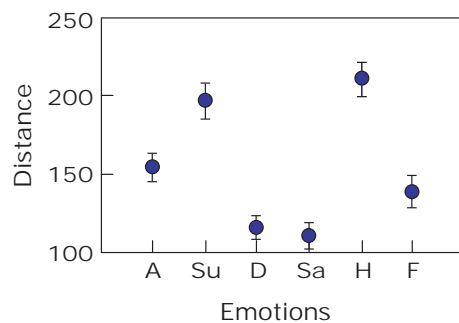


Figure 17 Distance of the three colours from their centre; larger distances mean that the three colours are quite different from each other; shorter distances indicates more similar colours

## Significance of Results for Colour in Design

The data presented above, in formats which allow for comparison with the results of previous research, support the idea that the pairing of facial expression of emotions with colours is consistent among different cultures. This finding has implications for artists and designers who use colours for communication. However, it may be difficult to base ‘correct’ colour choices on the information presented in Figures 7, 8, 16 and 17. The same data can be presented in other formats.

Visual presentation of information is one of many kinds of problem tackled by graphic designers. The ‘design method’ requires analysis of the needs of those who are to use the information. If the information derived from this research is to be used by other designers, the designers who work on the problem of how best to present that information need to understand

what it is that their fellow designers want to know. Designers may be reassured to know that Europeans and Australians make similar choices about the correspondences between colours and facial expressions of emotions but they are more interested in the colours themselves. In situations where they want to communicate a particular emotion they want to know which colours and colour combinations will communicate most successfully and with least risk of misunderstanding. It is possible to present the findings of this research in a way that shows, for each emotion, which colours and colour combinations can be regarded as 'correct'.

### **Single Colours**

There can be no single 'correct' colour for each emotion; emotions themselves are not one-dimensional. Degrees of intensity and subtle variations in emotion are reflected in facial expressions and this should also be the case with colours. The faces selected for these exercises were selected as best examples, not unique examples. In a group photograph, taken at a wedding, most faces will have happy expressions, but we can still distinguish between the ecstatic happiness of the bride and groom and the wistful happiness of parents who have 'lost a son, but gained a daughter'. The zones concept can be extended to facial expressions: the faces in the wedding photograph would look happy in different ways but would all belong in the 'happy' zone. In another photograph, taken at another wedding, one man in the group might have been an unsuccessful suitor and been unable to disguise his sadness. He would be easy to recognise as an outsider with his face in the 'sad' zone.

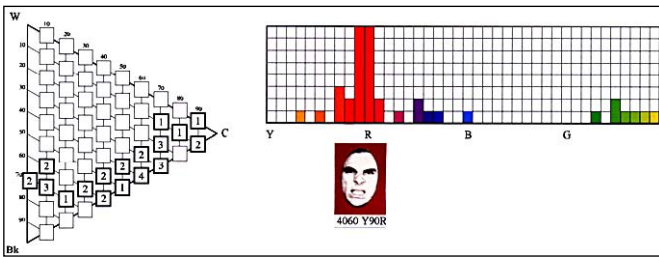
Degrees of intensity and variations can be seen in the colours chosen by participants for the six emotions presented in Figure 6. In the case of anger there was an overwhelming choice for colours that were mainly reddish. This strong consensus is the authority for determining which colours are 'correct' and so belong in the 'angry' zone. Colours that are bluish or greenish are outsiders and, therefore, 'wrong'. The choices for happiness show a similarly overwhelming consensus, in this case for colours that are both yellowish and reddish. Once again the outsiders are easy to recognise. For the other faces opinion is less unanimous. There are what might be called 'consensus clusters'. However, it is still possible to recognise outsiders such as the bright orange-red amongst the sad faces. The diverse response for fear might reflect the objects of fear rather than the individuals who were afraid. Participants might have responded to the facial expressions in ways that reflected their own fears. Fear of spiders would not feel the same as fear of tigers or enemy aircraft.

Designers are most likely to be interested in the consensus clusters as indications of the kinds of colours most commonly associated with each emotion. The colours in each cluster can be located in a three-dimensional colour order system such as the NCS. The clearest way to present the colours on a two-dimensional surface is to show the range of hues and the range of nuances in separate diagrams (Figure 18). The number of choices for each hue is represented in simple bar graphs. Nuances chosen are shown in heavy outline on the NCS colour triangle with a number to indicate how many chose that nuance. (Note that, for greater clarity, the hue choices are represented by highly chromatic colours in the bar graphs even in cases, such as sadness, where highly chromatic colours were not typically chosen. It is important to read the bar graphs and the nuance triangles together.) Also shown are representative examples from consensus clusters, colours chosen by participants, with their NCS notations. These colours can each be regarded as being acceptable as a 'correct' fit with the face.

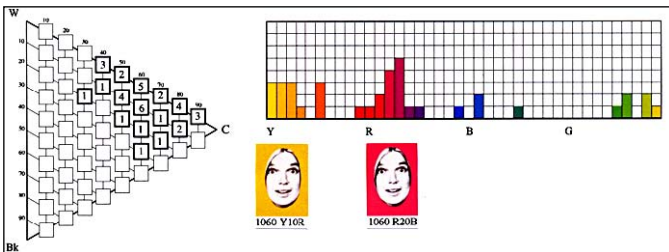
### **Three-colour Combinations**

Consensus clusters for three-colour combinations and combinations that are outsiders can also be recognised in Figure 15. The outsiders are combinations that would not communicate

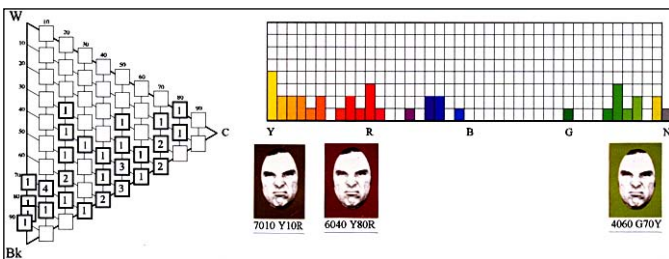




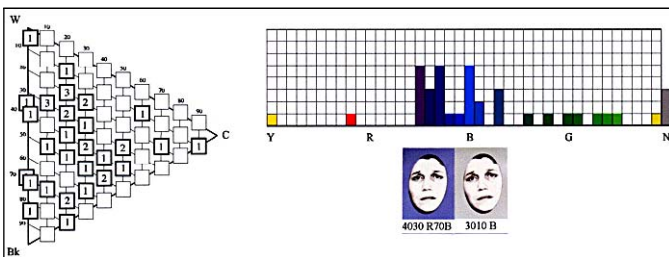
**Figure 18-A** Consensus choices of colour for anger



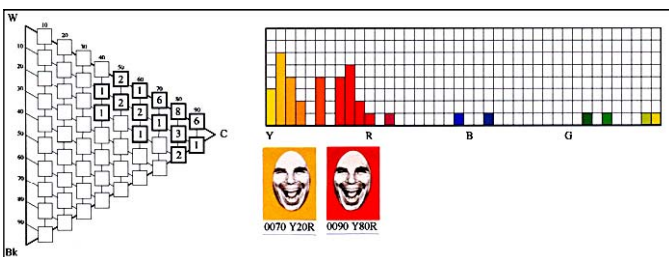
**Figure 18-B** Consensus choices of colours for surprise



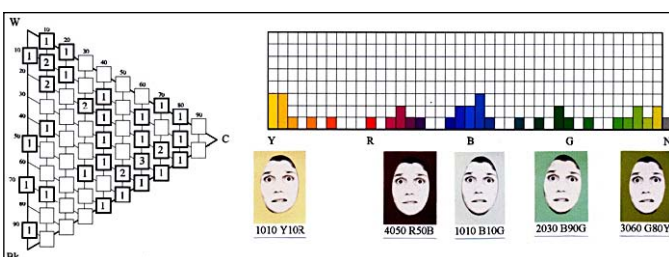
**Figure 18-C** Consensus choices of colours for disgust



**Figure 18-D** Consensus choices of colours for sadness



**Figure 18-E** Consensus choices of colours for happiness



**Figure 18-F** Consensus choices of colours for fear

the emotion successfully to a majority of people. The single colours chosen for experiment A and the three-colour combinations chosen for experiment B represent the judgements of the participants in relating facial expressions to colours. In experiment B, however, the process was taken a stage further. The process was reversed: participants were asked to relate colours to facial expressions. In this way it was possible to test the success or otherwise of the communication.

John Fiske defines communication as ‘social interaction through messages’ [23]. The process of communication can be described in terms of message, sender, sign, code and receiver. In Figure 15, with face A, the message is the emotion ‘anger’ and the sender was the angry man in the photograph. The first sign was the arrangement of the man’s features within the code of facial expressions. The receiver was the participant in the exercise whose task was to choose a three-colour combination to fit that face. In effect, this task involved interpretation of the first sign and its translation into a new sign in a new code, that of three-colour combinations. The receiver of this second sign translated it into a third sign from the original code of facial expressions.

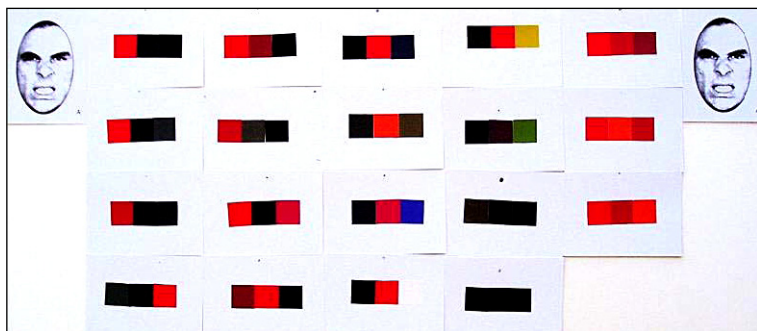
It is the relationships between the three signs – faces, colours and faces – that are of most interest to designers. The information derived from experiment B should be presented in such a way that it is easy to see how the signs were translated from one code to another. The simplest and clearest way to do this is to show the signs side by side with three-colour combinations between two faces. The three-colour combinations in the middle should be those that were composed to fit the face on the left and were also interpreted as fitting the face on the right. If the face on the left is the same as that on the right the communication was successful and it is possible to claim that the three-colour combinations are ‘correct’ choices for expressing the emotion shown by the faces. Where the face on the right does not match the face on the left there has been a breakdown in communication. Furthermore it can be possible to see where the breakdown occurred. In the event, the success rate was generally high (Table 1).

The three-colour combinations that were interpreted correctly are shown in Figure 19. In some cases it may be surprising that the colours were interpreted correctly but in most cases the colour combinations within each group are broadly similar. There are also some similarities between groups, especially between surprise and happiness and, to a lesser extent, between disgust and sadness.

In a number of cases the message went astray. Because we can refer to the range of ‘correct’ colour combinations, shown in Figure 19, it is generally quite easy to see whether it was the sender or the receiver of a three-colour sign who was responsible for the breakdown

**Table 1** Success rates of matching faces with emotions

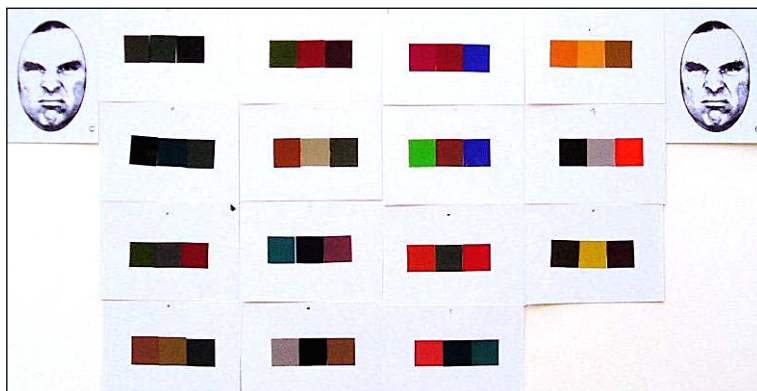
<i>Anger</i>	<i>Surprise</i>	<i>Disgust</i>
19 were interpreted correctly	22 were interpreted correctly	15 were interpreted correctly
9 as ‘disgust’	14 as ‘happiness’	15 as ‘sadness’
6 as ‘sadness’	3 as ‘disgust’	5 as ‘anger’
6 as ‘fear’	2 as ‘sadness’	3 as ‘fear’
2 as ‘surprise’	2 as ‘fear’	2 as ‘surprise’
1 as ‘happiness’	1 as ‘anger’	1 as ‘happiness’
<i>Sadness</i>	<i>Happiness</i>	<i>Fear</i>
21 were interpreted correctly	27 were interpreted correctly	10 were interpreted correctly
7 as ‘surprise’	14 as ‘surprise’	11 as ‘sadness’
6 as ‘anger’	2 as ‘fear’	8 as ‘disgust’
5 as ‘disgust’	1 as ‘anger’	4 as ‘anger’
5 as ‘fear’	1 as ‘sadness’	4 as ‘happiness’
		1 as ‘sadness’



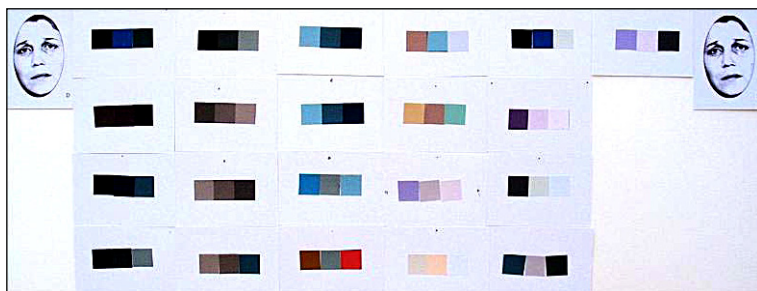
**Figure 19-A** Three-colour combinations composed and interpreted as 'anger'



**Figure 19-B** Three-colour combinations composed and interpreted as 'surprise'



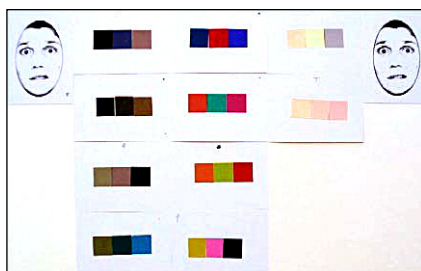
**Figure 19-C** Three-colour combinations composed and interpreted as 'disgust'



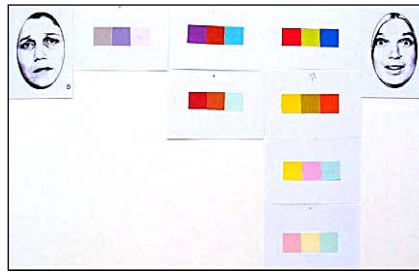
**Figure 19-D** Three-colour combinations composed and interpreted as 'sadness'



**Figure 19-E** Three-colour combinations composed and interpreted as 'happiness'



**Figure 19-F** Three-colour combinations composed and interpreted as 'fear'



**Figure 20** Three-colour combinations composed to communicate 'sadness' which were interpreted as 'surprise'



**Figure 21** Colour combinations that would be expected to communicate 'happiness' sent as 'anger' (above) and interpreted as 'anger' (below)

in communication or whether the sign itself was unclear. In Figure 20 colours that were intended to communicate 'sadness' were interpreted as 'surprise'. By comparing these colour combinations with those that were interpreted correctly it can be seen that the one on the left in Figure 20 belongs with those correctly interpreted as 'sadness' in Figure 19-D: the breakdown occurred at the receiver's end. Those on the right in Figure 20 belong with those interpreted as 'surprise' in Figure 19-B: the breakdown occurred at the sender's end. It is less clear where those in the middle belong.

In Figure 21 there are two similar colour combinations which clearly belong with those that were correctly interpreted as 'happiness'. In one case 'anger' was sent as 'happiness'; in the other case 'happiness' was interpreted as 'anger'. If it were the facial expressions and not the colour combinations that were being misinterpreted, such a breakdown in communication, in a social situation, could have unfortunate consequences.

### Emotions and Connotations

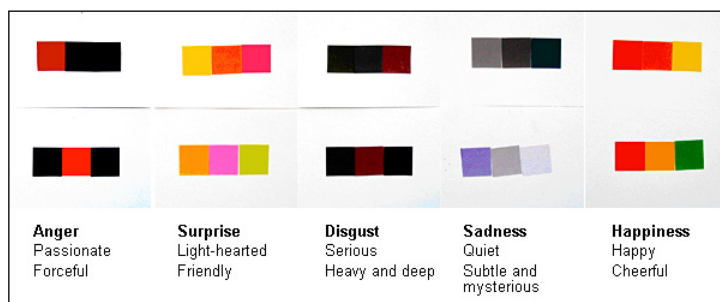
It is difficult to categorise colour combinations as opposed to single colours. The analysis presented in Figure 16 shows how colour combinations have a 'centre of gravity'; Figure 17 shows how it is possible to quantify the degree of contrast between colours in a combination. Systems have been developed for more detailed quantification of colour combinations [24–28]. For designers who have difficulty with such systems it may be more helpful simply to look at the colours and note the kinds of colours and colour contrasts in each group.

Familiarity with the visual characteristics of particular colour combinations means that designers need only use their eyes in order to make use of a system such as the Color Image Scale, developed by Shigenobu Kobayashi in 1981 [24]. Positions within Kobayashi's system, determined in relation to three scales, are associated with connotative meanings. These are referred to by Kobayashi as 'images' and are represented by words such as 'casual', 'fresh' and 'dignified'. While Kobayashi's system was developed as a marketing tool it may be possible to use it, without reference to connotative meanings, simply as a means of categorising



appearances. By making visual comparisons with the illustrations in Kobayashi's books it is possible to assign places within the system to single colours, colour combinations, materials, textures, pictures, objects and whole scenes [29,30].

The range of possible connotative meanings is large and includes emotions: 'happy' is one of Kobayashi's image words. Given the purpose for which the system was developed there is no place for images such as 'hostile' or 'depressing'. Nevertheless, Kobayashi's scales could still be used to locate the colour combinations for the emotions presented above, including the negative emotions. Representative examples from Figure 19 are shown in Figure 22, together with the images associated with similar colour combinations in Kobayashi's system. (The colour combinations for fear are too diverse to be localised in the system.)



**Figure 22** Representative examples of three-colour combinations for emotions with the images associated with similar colour combinations in Kobayashi's Color Image Scale

## Discussion

The experiments described here can be regarded as contributions to a larger project with two distinct lines of enquiry for future research. Psychologists are interested in the extent to which people from different cultural backgrounds associate the same or similar colours with facial expressions of emotion; designers are interested to know what those colours might be.

### Psychology

The present results suggest that Australians and Europeans associate colours with facial expressions of emotion in a similar way, but before making a firm claim that this must be because there are universal biological factors at work it would be desirable to extend the enquiry. There are strong cultural links between Europe and Australia. It would be desirable to carry out further experiments with other groups from other parts of the world, especially Asia and Africa. It would also be desirable to review the methodology of the experiments. It is possible that the present results might have been different if individuals had made their choices in isolation, with no possibility of outside influence, and under standardised illumination. The make-up of the group of participants might also have been an influencing factor. Although there was a broad range of ages, there were many more female than male participants and the majority had a strong interest in colour design. A larger group, from more diverse backgrounds and with both genders evenly represented, would have the potential to provide more convincing data. If personal details were recorded it would also be possible to compare the responses of different groups.

Another question to be answered conclusively is whether colour choices were influenced solely by the emotions conveyed by the facial expressions or whether there were any other factors involved. The faces used for the experiments were of three individuals, with the same man expressing: anger (A), disgust (C), and happiness (E), the same woman expressing sadness (D) and fear (F), and another woman expressing surprise (B). From the latter's expression it would seem that the surprise was a pleasant one; for an unpleasant surprise the expression

would have been different. If the faces had been of other people and, especially, if the genders had been reversed, it is possible that the colour choices would also have been different.

Evidence from the present experiments suggests that the dominant factor was indeed the emotions conveyed. The colours chosen for faces A, C and E, which were of the same man, were different and can be taken to reflect the different emotions. However, the colours chosen for faces B and E, one being female and the other male, were similar in some respects and may also be taken to reflect the emotions since there is a similarity between pleasant surprise and happiness. The differences that do exist between the colours chosen for faces B and E raise the possibility that there might be other factors at work. The range of nuances is very similar in each case; the difference lies in the choices of hues. For both faces many people chose reddish-yellows but of the remainder there were many who chose yellowish-reds for happiness and many who chose bluish-reds for surprise. The bluish-reds (pinks) may have been more to do with the fact that the face was of a female than because she looked surprised.

## Design

The three-colour combinations composed to express particular emotions can be compared with the overall colour character of paintings where there was a clear intention on the part of the artists to communicate specific emotions. A case in point is Munch's painting *The Scream* and his similar painting *Anxiety*, both of which relate to the basic emotion fear. The three-colour combinations for fear, shown in Figure 19-F are diverse but the two combinations at the bottom of the middle column echo, to some extent, the colours of Munch's paintings. Derek Jarman produced a series of paintings to express emotions using words and swirls of colour. Jarman painted his own *Scream*, in colours similar to Munch's. Another of Jarman's paintings is entitled *Drop Dead*, which relates to the basic emotion anger. Like the three-colour combinations composed to correspond to face A, expressing anger, the dominant colours in Jarman's painting are red and black.

The basic emotions can serve as a starting point but each has its variations and degrees of intensity and they are rarely present in isolation. There are also emotional states related to the basic emotions for which we have names such as ecstasy, love, jealousy, remorse, grief and despair. Anger, surprise, disgust, sadness, happiness and fear, as well as ecstasy, love, jealousy, remorse, grief and despair are all present in the choreographed story of *Scheherazade*, mentioned above. Léon Bakst faced a very complex challenge in his designs for the ballet.

Designers can learn from the work of artists like Munch, van Gogh and Jarman, and from the work of designers like Bakst, but they can also learn from the kind of experiments described here. With only six faces, however, this study was limited. Further experiments could be carried out with the needs of designers more specifically in mind. A larger range of photographs could be prepared, with actors expressing a more subtle range of emotions and emotional states. It would also be possible to explore Bakst's contention that 'there are reds which are triumphal and there are reds which assassinate'. Participants could be faced with a range of reds, some vivid, some dull, some yellowish, some bluish, some whitish and some blackish, and be asked to match them with faces. If consensus were to emerge it might then be possible to link quite specific reds with specific emotional states. A valuable accompaniment to such a program of research would be parallel work on definitions to clarify the distinctions between emotions, emotional states, moods, feelings, sensations, perceptions, denotations, connotations and cognition.

While it may be true that more controlled experiments, with participants making their responses in isolation, would better meet the expectations of psychologists, there was a great advantage for the designers in conducting the experiments as workshop exercises

during a conference. Participants got immediate feedback. They could see whether or not their own judgements corresponded with the choices most commonly made by others. Those who chose colours that identified the faces as ‘outsiders’ learned that they would be wise to consult with colleagues before making colour choices to make sure that their designs would communicate appropriately. Participants gained insights from the display of finished work and the discussions at the end of the workshop (Figure 23).



**Figure 23** Display and discussion of finished work at the end of the workshop

## Conclusion

The two groups that took part in this experiment agreed closely in producing colour associations with facial expressions of emotion and, despite different procedures and different sets of coloured papers, they generally agreed with participants in previous European studies. The results seem to confirm the concordance among humans in perceiving emotional expressions, colours and their relationships, possibly on the basis of universal biological roots. Further research, involving a wider range of participants, could help to confirm this proposition.

The results of the experiments, in the form of the colour choices made by those who participated in the workshop exercises, can also serve as a guide to designers in their use of colours for communication. Questions raised by the results suggest further lines of enquiry that could give designers more extensive insights and greater confidence.

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