

Colouring the emotions

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ABSTRACT

We studied the colour association with the seven basic emotions described by Ekman through an innovative procedure according to which 73 persons, young and aged, had to paint, in a CRT monitor, the background of a face to visually fit the emotion it expressed. Results show a large 3D distribution of colours for each emotion. Happiness and surprise are significantly different from the other emotions on the basis of the $L^*a^*b^*$ attributes, being lighter, and happiness also yellower. Further significant differences are found, for instance between fear and the other dark emotions, being redder and bluer. Results, described as a function of the relative presence of the main hues and of the achromatic white grey and black in the chosen colours, partially agree with Oberascher-Gallmetzer previous findings. A structural analysis of the colour relationships between the seven emotions (MDS, Cluster and Factorial analysis) suggests groupings in agreement with the psychological literature.

1. INTRODUCTION

The general assumptions underlying this research is that expressive characteristics of objects and events are essentially determined by their internal structure to which our perceptual faculty is adaptively tuned (Darwin¹); this would guarantee that all people react in the same ('proper?') way to relevant surrounding situations. Only in a second moment (from a logical point of view, not necessarily temporal) they can be modified by extrinsic factors like memory, verbal formulation, expectations, cognitive associations and so on (Ekman & Davidson², Lazarus³). On the basis of such considerations many researchers have proposed that emotions are fundamentally universal, in that their external expressions, specifically the correlated facial mimic, and the possibility of visually catching them is independent of culture and personal experience (Lane and Nadel⁴). In the same line of thought also emotional reactions to colours should be, at least partially, rooted in the human biological substrate and therefore a more or less natural link between emotions and colours seems plausible (Zentner⁵). Oberascher & Gallmetzer⁶, in a survey performed with European persons, found that some combinations of colour and emotion are better established than others, and that results derived by following different experimental procedures can be integrated in a quite simple picture.

This research, aimed at studying which colours are better fitting the basic emotions, is characterised by a completely new experimental method which allows the free choice from the observer of one among million colours. Moreover the expression of the emotion and the associated colour are both given in the visual modality without any direct involvement of verbal language.

2. METHOD

A crucial condition for reducing the verbal influence in combining colour and emotion is that the face to be observed express the wanted emotion in the most universal and immediate way. For this reason we used some white and black pictures of faces chosen from a collection which Ekman & Friesen⁷ selected as universal representatives of the main emotions. Each face was reduced to the same dimension and cut into an oval (subtending $5^\circ \times 8.5^\circ$ at a viewing distance of m 0.5) which was displayed at the centre of a grey rectangle (12°) in the middle of the screen of a CRT calibrated monitor (45°). Seven basic emotions were studied: happiness, surprise, sadness, fear, disgust, contempt and anger. 74 persons, with normal colour vision, took part in the experiment, half of which were between 20-30 years old, while the other half were between 50-60.

In the initial stage of the experiment, 3 or 4 Ekman faces, intended to express in a slightly different way the same emotion, were displayed in the screen, and the observer was asked to identify

which emotion they were conveying. After recording the answer, the observer was asked which face he considered the best representation of the intended emotion and which colour he would combine with it; that face would be then the experimental target in the following part of the experiment. Finally he was asked which colour he generally considered positive and which negative, and which he liked more and which he disliked more.

The experimental task consisted in adjusting the colour of the rectangle surrounding the oval face, presented in random order, to fit the included emotional expression. The observer could adjust the red-green appearance by pressing two corresponding keys, and the yellow-blue appearance by two different keys. A third couple of keys could be used to modify the colour brightness. This procedure was learnt without too much effort also by the aged group of subjects. When the observer was satisfied with the obtained colour, this was recorded and another trial was submitted.

3. RESULTS

Our observers recognized with relatively high precision the specific emotions expressed by the different faces (Tab. 1), except contempt often confused with disgust.

Table 1. Frequency and percentage of emotion identifications.

Identified	Sadness		Disgust		Surprise		Anger		Happiness		Contempt		Fear	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Yes	58	79	58	80	70	96	63	86	73	100	15	21	58	80
No	15	21	8	11	3	4	3	4			33	45	6	8
Other emotions			7	9			7	10			25	34	9	12
			<i>anger</i>				<i>wickedness</i>				<i>disgust</i>		<i>surprise</i>	

A first analysis of variance has been performed with the seven emotions as one factor and the three colour variables $L^*a^*b^*$ as a second factor. Happiness and surprise appear significantly different from all the other emotions ($F_6 = 15.83$, $p < 0.00001$) but not different one from the other. A second analysis considered the bidimensional a^* and b^* distributions of all colours, and for each emotion the relative presence of Yellow, Red, Purple, Blue and Green (as specified by the NCS) was picked out from all colours chosen by the observers for that emotional expression. Also from this analysis happiness and surprise appear highly correlated ($r = 0.926$, $p < 0.001$), and also sadness and contempt show a significantly high correlation ($r = 0.736$, $p < 0.037$).

By comparing all emotions by separately examining the L^*a^* and b^* dimensions, happiness and surprise appear very similar along the L^* dimension, and both are highly different from all the others emotions ($6.13 < t_{72} < 8.59$; $p < 0.00001$). Then they can be rightly labelled as bright emotions. Along the a^* dimension fear shows significantly higher values (i.e. it appears redder) than both disgust ($t_{72} = -3.569$, $p < 0.001$) and contempt ($t_{72} = 3.546$, $p < 0.001$), which on their side appear less connoted as regard to this dimension (more greyish). Along the b^* dimension, happiness significantly shows the highest values (i.e. it appears the most yellowish) than all the other emotions (surprise excluded); fear has the lowest values and it appears the most purplish (more reddish and more bluish) emotion among all (sadness excluded); disgust significantly differs from sadness in showing higher b^* values ($t_{72} = -4.017$, $p < 0.00001$; it appears more yellowish). Lastly anger, disgust and contempt do not differ one from the other along any $L^*a^*b^*$ dimension. No significant difference has been revealed between the young and adult groups.

Relevant relationships between the 7 studied emotions were derived from their chromatic differences. In a multidimensional scaling plot (Fig. 1) based on the colour distance between every two emotions, disgust, contempt, sadness and anger are closely located, while fear, happiness, and surprise occupy quite far and isolated positions. A multifactorial analysis (Tab. 3) confirms these findings and shows that contempt, disgust, anger, and sadness are included in one factor, while fear and surprise characterize two other different factors; interestingly happiness shows relatively high negative correlations with all the three factors. Analogous relationships are shown by a hierarchical cluster analysis (Fig. 2). Colour attributions to emotions reveal some basic differences and relevant similarities: happiness differs from all the other emotions expressed by our experimental faces probably for being the only positive feeling, as it is associated with preferred and positive colours

(Tab. 2); although surprise appears ambiguous (by principle it can be either positive or negative) in our study it lies between happiness and the other emotions; disgust and contempt almost coincide, while anger and sadness are quite close to them; fear seems to benefit of a certain individuality. It would be interesting to investigate and explain in further research the meaning of these relationships and relate them to the cognitive/physiological mechanisms which typify other works.

Table 2. Percentage verbal attribution of preferred/non preferred, positive/negative colours to each emotion.

	Sadness	Disgust	Surprise	Anger	Happiness	Contempt	Fear
most preferred	3	0	10	7	34	3	5
least preferred	10	12	3	12	1	<i>14</i>	11
positive	8	1	16	8	23	4	4
negative	<i>15</i>	11	3	12	1	10	<i>14</i>

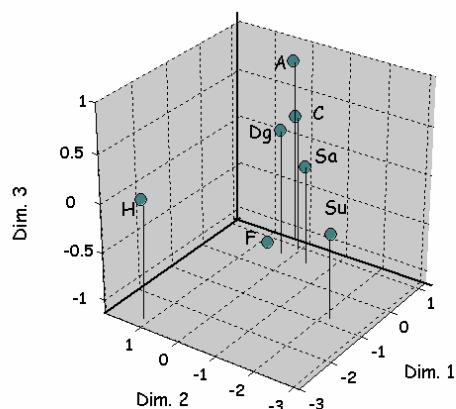


Figure 1. Position of the seven basic emotions in a multidimensional scaling plot. Sa = sadness, D = disgust, Su = surprise, A = anger, H = happiness, C = contempt, F = fear.

Table 3. Factorial Analysis performed on CIELAB colour distances. Principal component extraction. Variance explained: 75.78. Varimax Rotation and Kaiser normalization.

	Components		
	1	2	3
H	-.653	-.469	-.560
C	.807		
D	.750		
A	.743		
Sa	.666		
F		.970	
Su			.940

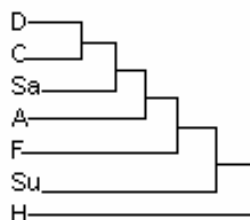


Figure 2. Dendrogram derived from a hierarchical cluster analysis (based on colour distances) showing the possible groupings of the different emotions.

The relationships between the seven emotions described here are derived by their association with colours in a purely visual task, and agree well with what obtained in other studies (Ekman & Davidson², Lazarus³, Lane and Nadel⁴) in which linguistic and physiological instruments were used. The colour characterization of the emotions obtained in this work seems therefore to be particularly robust.

Table 4. Relative presence (in %) of the main hues (YRGBP = yellow, red, blue, green, purple) and achromatic shades (W = white; Gr = grey; S = black) in the colours assigned to each emotion in the works by Valentini-da Pos (V.-dP) and Oberascher-Gallmetzer (O.-G.).

Sadness		Disgust		Surprise		Anger		Happiness		Contempt		Fear	
V.-dP	O.-G.	V.-dP	O.-G.	V.-dP	O.-G.	V.-dP	O.-G.	V.-dP	O.-G.	V.-dP	O.-G.	V.-dP	O.-G.
P 33	S 44	Y 29	R 44	R 32	G 24	R 27	R 55	Y 37	Y 51	P 22	P 25	P 38	S 46
Gr 25	Gr 34	G 24	G 29	Y 23	P 21	W 21	S 19	R 25	R 22	G 21	R 19	R 24	P 11
R.G.W 9	B 8	P 18	P 13	G 19	Y 19	P.G 15	P 8	G 21	B 12	Gr 21	W.Gr.S 11	G 10	R 10

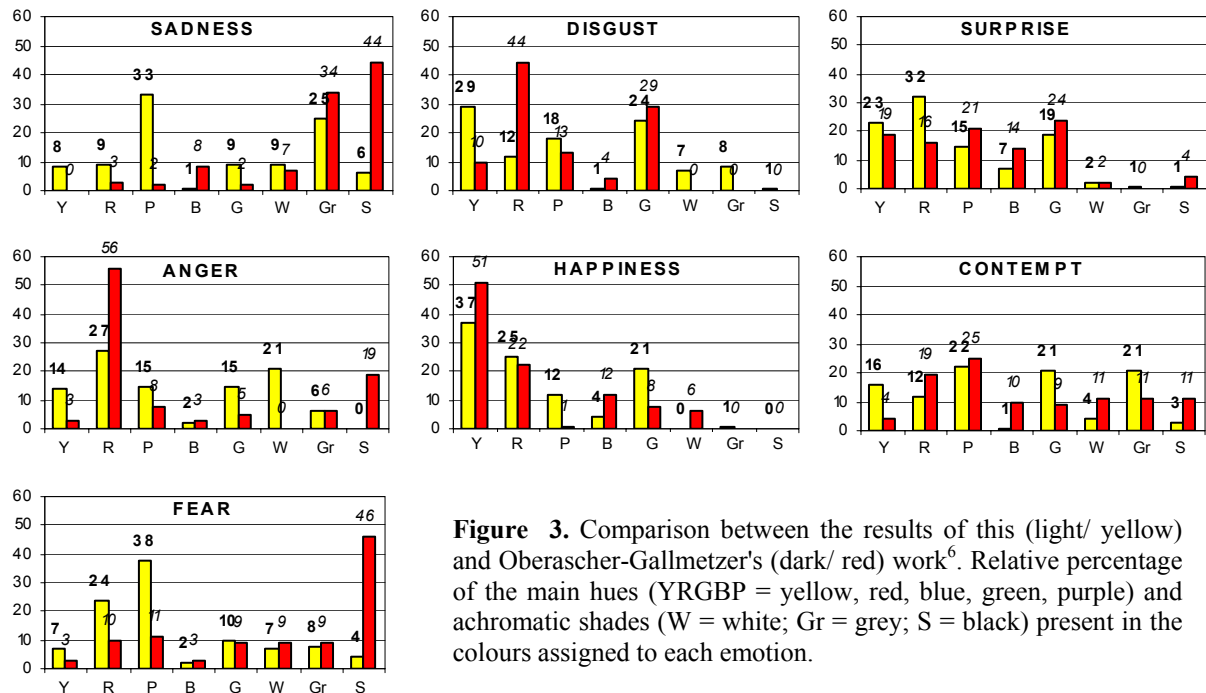


Figure 3. Comparison between the results of this (light/ yellow) and Oberascher-Gallmetzer's (dark/ red) work⁶. Relative percentage of the main hues (YRGBP = yellow, red, blue, green, purple) and achromatic shades (W = white; Gr = grey; S = black) present in the colours assigned to each emotion.

By comparing our results with the data by Oberascher and Gallmetzer⁶ (Tab. 4, Fig. 3) an overall similarity appears with some relevant differences: we have more purple and less blackness in sadness and fear, more light colours (yellow, white, and grey) than red in disgust and anger. Further research is needed to verify whether cultural or methodological reasons account for these differences.

4. CONCLUSIONS

The problem dealing with which colour is better fitting a particular emotion has been studied in this research through an original procedure which allowed the observer to easily generate the colour to be paired with the visually perceived emotion in a computer driven monitor. The extremely reduced role of verbal language in performing the task was intended to support a more universal, less cultural link between colour and emotions, to be tested in future work. We found that happiness and surprise are relatively close emotions from a colour point of view (both very light, happiness very yellowish); fear is bluer and redder, and on the whole more purplish than the other emotions; sadness less yellowish than disgust. Our results partially agree with those by Oberascher and Gallmetzer⁶. The large distribution of colours obtained by colouring the facial expressions makes comparisons difficult, but reveals fundamental aspects of emotions as well as their structural relationships, in good agreement with other theoretical approaches (Ekman and Davidson², Lane and Nadel⁴).

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