

# Visual Impression of the Colour of Football Uniforms: Investigation using Moving and Static Images of Football Games

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## Summary

Various colours are used in sportswear and sport goods and, in football in particular, the team colours are selected to easily distinguish players of one team from an opponent and the referee(s), and are also often chosen according to the colours that are relevant to their sponsors. In this study, the colours of football uniforms are the focus but from the perspective of the viewers of the game. Viewers' impressions about the football team uniforms were first surveyed. Then, psychophysical experiments were carried out to investigate the impressions of the colours of the uniforms using images of actual football games and those of created static images. Significant influences on the colour were found for those impressions described as 'not clear–clear' and 'undistinguishable–distinguishable'. The experimental results also suggested that our impression of 'undistinguishable–distinguishable' were influenced not by a colour difference between a pair of uniforms, but by the sum of colour differences between a pair of uniforms and between each uniform and a colour of football pitch.

## Introduction

Colours used in sportswear and sport goods have been found to get more and more saturated over the years [1]. This may be due to commercial reasons, such as the demand from sport sponsors to get the attention of viewers. But perhaps a more important reason is that players need to easily distinguish themselves from the other team on the field and thus increase their chances of winning the game. If the uniforms<sup>†</sup> of both teams are similar in colour, the players will find it difficult to distinguish between their team mates and their opponents [2]. But, if the colour of a uniform has a high contrast colour against the background colour, say red uniform against green grass, the high colour contrast may improve the team's performance [1]. In some ball games, ball colours are changed from white to more vivid tones so that the ball is easier to locate [3]. Such distinguishable uniform and/or ball colours also helps the referee to judge and,

<sup>†</sup> In this paper, the phrase 'uniform' is utilised throughout to refer to the shirt (top), shorts and socks combination of a player's outfit in a football team; in some countries this phrase is interchangeable with a 'football strip' or 'football kit'

of course, the viewers to distinguish the teams. Moreover, the actual colours chosen may affect the viewers' impression. Thus, when selecting the colours of football uniforms and related goods, it should be carried out from the perspective of the players, referees and the viewers.

The study presented in this paper focuses only on the colours of players' uniforms from the perspective of viewers. This is a novel approach and no other studies on this specific topic have been carried out, although there have been some research investigating the relationship between colour and sportswear. There was a study undertaken by Barton *et al.* in which the relationship between the match results of sports, such as boxing, tae kwon do, Greco-Roman wrestling and free style wrestling, and the colour of competitors wear was investigated [4–6]. This study concluded that the colour of the competitors' sportswear did affect the players' performance, and wearing red resulted in a superior performance. Kazama *et al.* [7] studied colour emotions induced by sportswear for two sports (American football and skiing) using digital images of sportswear presented on an LCD panel. This study found that red uniforms were most likely to attract the attention of game viewers. Sato *et al.* investigated the impression of words for sportswear colours using a questionnaire to understand how customers chose the colours of their sportswear [8–12]. They found that uniform colours can evoke various impressions and feelings, in terms of excitement, energy and strength. Iwase *et al.* studied the relationship between our impression and a colour of a sports uniform under different background conditions [13]. There is little understanding, however, as to what role colour plays in a game from a viewer's point of view, i.e. whether and how colour affects viewers' impressions about a game they are watching.

To investigate the impression of football games from the perspective of the viewers, two questionnaire surveys were initially carried out in our study. The first was to find the degrees of attention of viewers to the football uniform when they were watching a football game; this told us the importance of uniforms in a football game. The other questionnaire collected terms (adjectives) which the viewer chose to express an impression about the football uniforms; this informed us of their impressions of football uniforms in general. The obtained data were then used in a psychophysical experiment. Then, in a psychophysical experiment, the degrees of impressions about colour combinations of football uniforms were scaled by subjects using actual football images from the 2002 FIFA World Cup Korea/Japan as visual stimuli. In this study, the degrees of impressions about colour combinations were also assessed using static images as visual stimuli.

## Preliminary Investigations

### Attention of viewers to football uniforms

At the outset of our study, the degree of attention of viewers to uniforms in comparison with other objects that appeared in football games (such as the ball, goal, referees, etc.) was not known. A survey was therefore carried out to investigate the degree of viewers' attention to uniforms, when they watch football games.

A moving image (video) of a football game was used in this survey as a visual stimulus. A continuous scene of 1 minute duration was extracted from a game played during the 2002 FIFA World Cup Korea/Japan. The game was obtained by recording the broadcasted game on a television (TV) using a SONY DVgate Plus recorder. In this study, the moving image presented to subjects had no sound and no goal scenes were selected, so that subjects could focus on the play. Moreover, the scenes selected for this experiment included: dribbling, passing, corner kick scenes, etc. Subjects were first instructed to watch the moving image presented on a screen

(PCV-RZ62L7 SONY LCD). Afterwards, the subjects were asked to write down the objects to which they paid most attention in the presented moving image. In total, 50 people took part in this survey, including 38 males and 12 females all of Japanese origin within a range of 19 to 29 years with an average age of 25. The survey was carried out in the Kyoto Institute of Technology (KIT), Japan.

The results of the survey are summarised in Table 1. The highest ranked object, to which greatest attention was paid within the moving image, was 'ball' (82%), followed by 'player' (68%), 'goal' (58%) and then 36% of the subjects answered that 'uniform' was one of the objects to which they paid attention. The ranking of 'uniform' was not remarkably high. However, it can be considered that 'uniform' may be included in the subjects' answer of 'player' because, in the survey, the subjects were asked to list names of objects and there was no list of objects from which the subjects could select. In any case, the 'uniform' comes into view, if people watch the 'player', although it is not clear whether a great deal of attention was paid to the 'uniform' or not. Therefore, it can be concluded that 'uniform' can be considered as one of the important objects that viewers pay attention to in football games.

**Table 1** Ranking of the objects to which the subjects paid attention whilst watching the moving image of the football game

Ranking	Objects	Percentage (%)
1	Ball	82
2	Player	68
3	Goal	58
4	Team shirt	36
5	Grass	34
6	Audience	32
7	Referee	24
8	Flag	24
9	Advertisement	24
10	Score board	14

### Terms for expressing the impression of uniforms

The aim of the survey carried out in this section was to investigate terms (words) used to express visual impressions about football uniforms. Another aim was to develop a database of semantic differential scales [14] which were then used in a psychophysical experiment introduced in a following session.

The survey was carried out by asking subjects to write down terms (adjective words) which are suitable to express impression of football uniforms. A total of 65 subjects including 50 males and 15 females, all of Japanese origin, whose age range was from 18 to 34 with an average age of 28 years, participated in this survey at KIT.

The results are summarised in Table 2. The highest ranked term used to express impression about football uniforms was 'stylish' (41%) followed by 'gaudy' (29%), 'light (weight)' (23%) and 'light (colour)' (18%). The results of the survey were used in an experiment introduced in the following section.

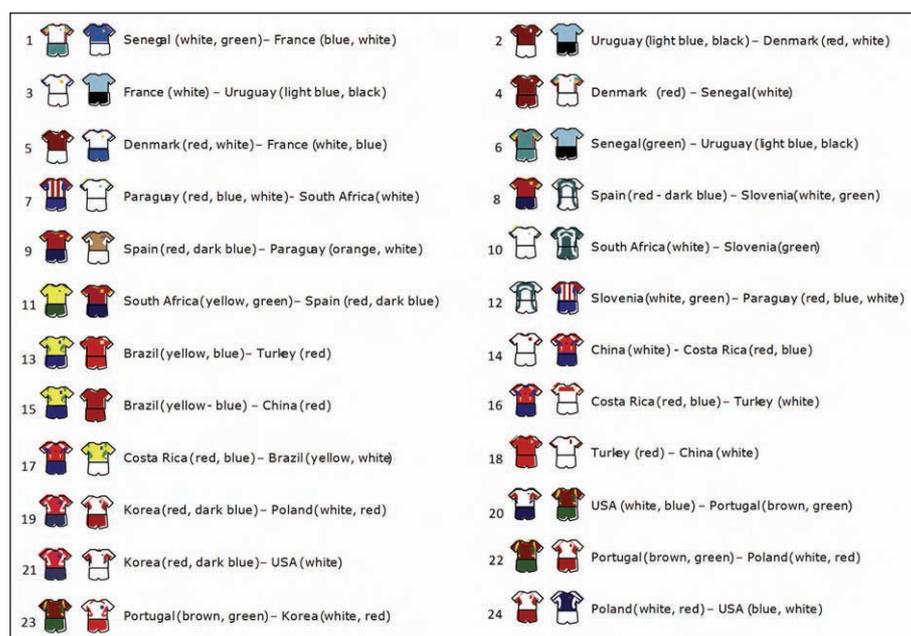
**Table 2** Ranking of the terms for expressing the impression of the football uniforms selected by the subjects in Japanese and English

Ranking	Adjective	Percentage (%)
1	<i>Kakkoi</i> / stylish	41
2	<i>Hade</i> / gaudy	29
3	<i>Karui</i> / light (weight)	23
4	<i>Akarui</i> / light (colour)	18
5	<i>Karafuru</i> / colourful	10
5	<i>Kubetsugatsuku</i> / distinguishable	10
7	<i>Tsuyoi</i> / strong	7
7	<i>Hayai</i> / fast	7
7	<i>Kirei</i> / beautiful	7
7	<i>Aoi</i> / blue	7

## Impression of Colour Combinations Using Moving Images

### Experimental set up

Impressions of football uniforms were also investigated in this part of the study. We mainly focused on colour combinations of two uniforms in a game. A psychophysical experiment was carried out using actual football games as visual stimuli. Similar to the surveys detailed earlier in this paper, the visual stimuli were selected from in the 2002 FIFA World Cup Korea/Japan. In this experiment, 24 moving images from the preliminary matches that took place in Korea were used for Japanese subjects. Each image was 1 minute in duration and was extracted from 24 individual games. The teams and the colour combinations of the uniforms selected for this experiment are given in Figure 1 together with the illustrated uniforms. These images were



**Figure 1** Illustration listing the 24 games and the colour combinations of the uniforms used in the assessment of moving images

obtained from the recorded broadcasted TV using the SONY DVgate Plus recorder. Similarly, the scenes from the football games that selected for this experiment including dribbling, passing, corner kick scenes, etc. The moving images had no sound and no goal scenes were included.

In order to investigate the impression of the viewer using moving images, a semantic differential (SD) method was applied. The order of the SD word pairs were randomised from questionnaires. This method has been used frequently for measuring social attitudes of people toward stimulus words and concepts in terms of ratings on a five to seven point scale, which are called SD scales, defined with contrasting adjectives at each end. In this study, pairs of adjectives (SD words) for SD scales were defined based on the results of the previous survey (see Table 2). A list of the selected SD word pairs is given in Table 3. A seven point scale was used, thus, subjects were asked to assign a number for each scale regarding their impressions about combinations of uniforms in the moving images. For example, the categories for the 'vivid–dull' scale were: –3, 'extremely dull'; –2, 'quite dull'; –1, 'slightly dull'; 0, 'neither vivid nor dull'; 1, 'slightly vivid'; 2, 'quite vivid'; and 3, 'extremely vivid'.

**Table 3** Semantic differential (SD) word pairs used in the experiment

No.	SD word pair
1	Plain–gaudy
2	Fresh–not fresh
3	Vivid–dull
4	Fast–slow
5	Not clear–clear
6	Dirty–clean
7	Heavy–light
8	Distinguishable–undistinguishable
9	Light–dark
10	Cool–hot
11	Strong–weak
12	Stylish–not stylish

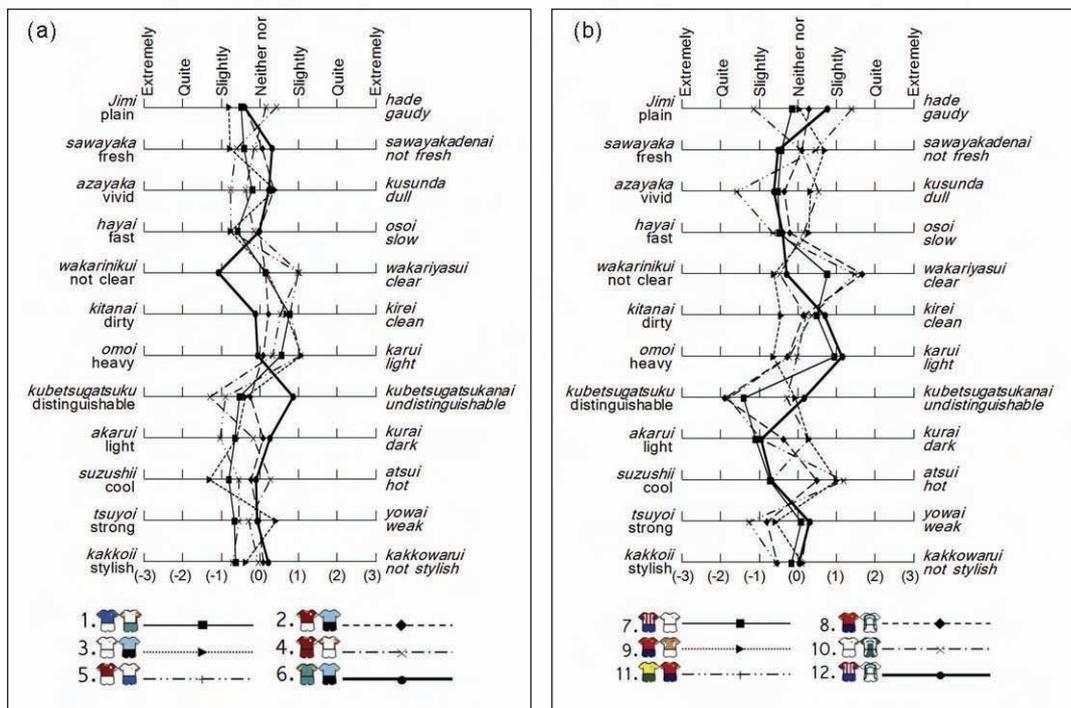
In the experiment, a total of 50 subjects including 35 males and 15 females, all of Japanese original, took part in the experiment at KIT. Their ages ranged from 18 to 26 years old with an average of 22 years. The subjects assessed the moving images presented on the LCD panel from a distance of 1.5 m. The display size of the LCD used in the experiment was 17 inch and the images were presented on a full screen. The presented images were 'a 1 minute scene' (a continuous scene of 1 minute duration) extracted from the broadcasted World Cup game. Hence, the 1 minute scene included various scenes such as the scenes with a zoomed-in and zoomed-out of players, etc., with sizes of the players on the display screen ranging from 1 inch to 12 inch. The experimental conditions are shown in Figure 2. The assessments were carried out in a lit room under fluorescent lights with the subjects sitting 1.5 m away from the screen. In each session, two to five subjects performed the visual assessment at the same time. Each moving image was played for 1 minute and each subject reported the scores for all 12 SD word pairs by writing down the scores on a sheet.



**Figure 2** Experimental conditions for assessing the impression of colour combinations using moving images

**Analysis and results: moving images**

The raw experimental data consisted of the category numbers assigned by the subjects to each word pair for the individual 24 games. The averages of the raw data were used to represent SD score for each word pair. These results are given in Figure 3, which is divided into four groups in order to make the result of each scale legible (Figure 3a, for games 1–6; Figure 3b, for games 7–12; Figure 3c, for games 13–18; and Figure 3d, for games 19–24). Each number in Figure 3 represents the games (the combination of the uniforms) as described in Figure 1. Figure 4 shows the scores of all 24 games on two scales: ‘not clear–clear’ (Figure 4a) and ‘undistinguishable–distinguishable’ (Figure 4b). Each number in Figure 4 represents the colour combination of each game in Figure 1. In the case of a perfect agreement between the



**Figure 3** Semantic differential scores for each word pair for: (a) games 1–6; (b) games 7–12 (continued on p7)

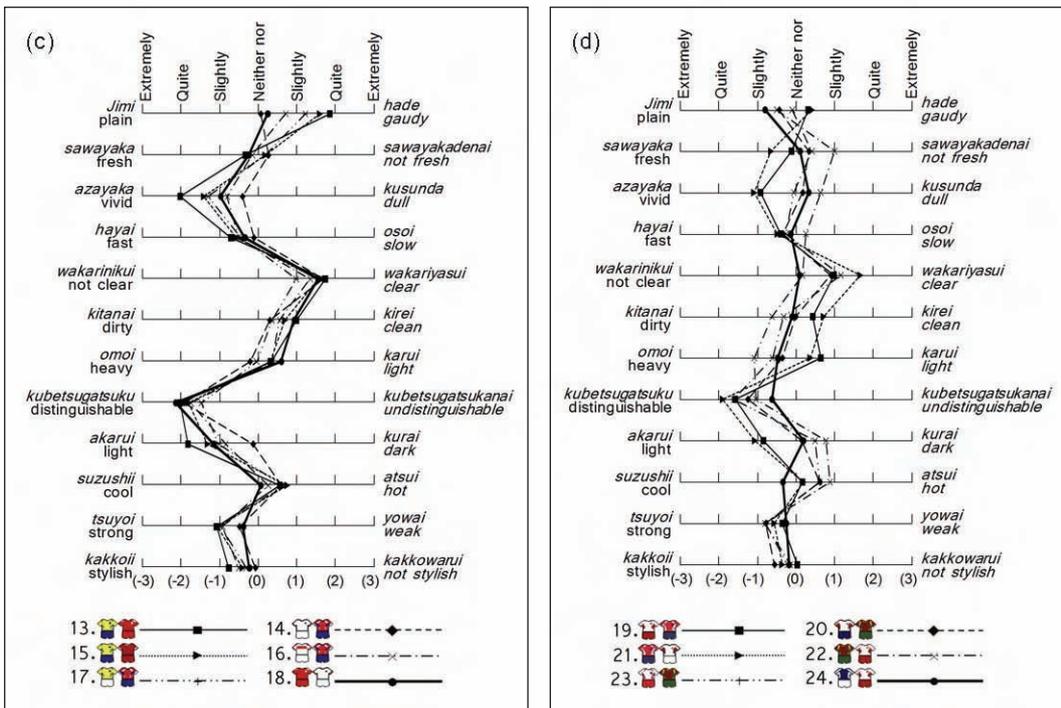


Figure 3 Continued Semantic differential scores for each word pair for: (c) games 13–18; and (d) games 19–24

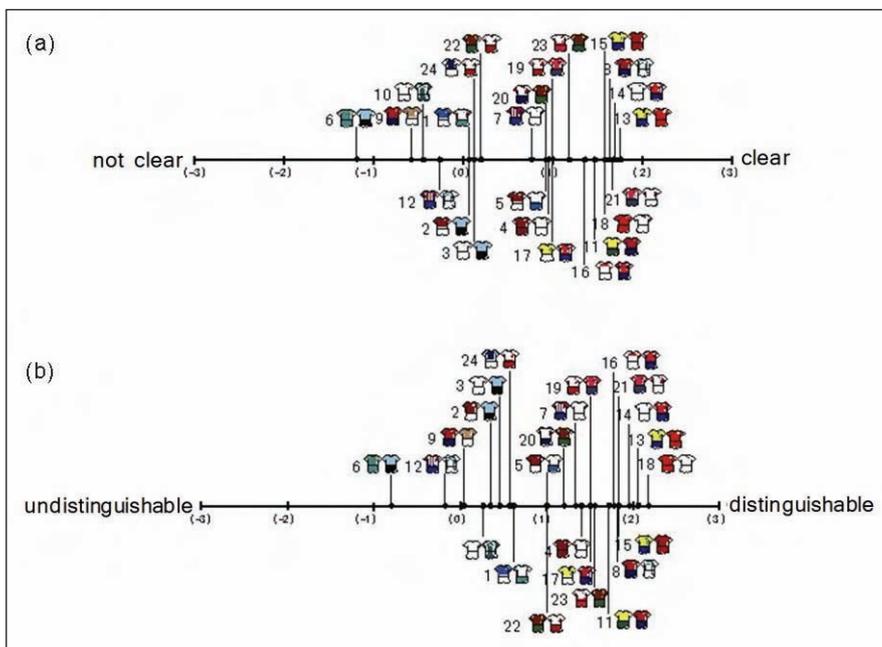


Figure 4 Semantic differential scores of the all 24 game on two scales (a) 'not clear–clear' and (b) 'undistinguishable–distinguishable'

results of the 24 games, all points should be overlapped with each other and this indicates no effect of the colour of the uniforms. A small spread of data suggests a little influence of colour combinations of uniforms to viewers' judgements. From the results shown in Figure 3, the scales little affected by the uniform colours were 'fast–slow' and 'stylish–not stylish'. On the other hand, a large spread of data indicates a large influence of the uniform colours to viewers' judgements. A large spread of data was found from the red and yellow combinations and the

red and white combinations regarding to the tops of the uniforms. Two scales in particular had significant influence on the viewers' impressions of the uniform colour: 'not clear–clear' and 'undistinguishable–distinguishable' as shown in Figure 4. The variations of the average scores of the 24 games for each SD word pair is given in Table 4 and a similar result is observed. The large variations of these two word pairs indicate a large spread of data; namely indicate the influence of uniform colour to the viewers' impressions.

**Table 4** Variations of the average scores of the 24 games for the SD word pair

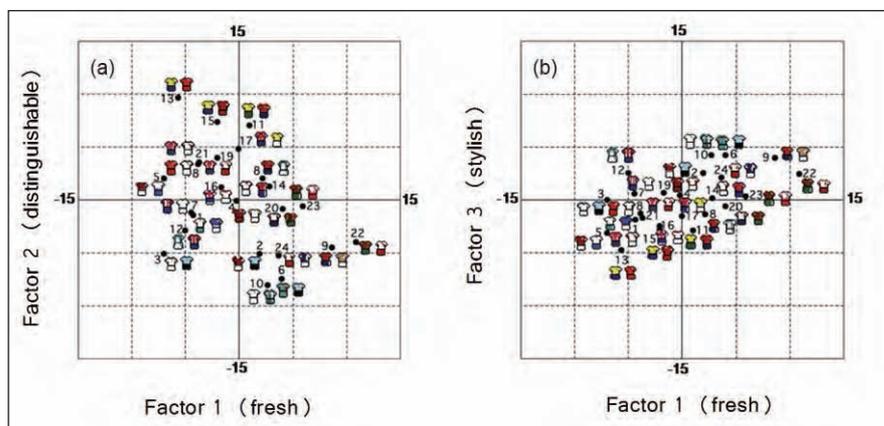
SD word pair	Variation
Plain–gaudy	0.60
Fresh–not fresh	0.20
Vivid–dull	0.51
Fast–slow	0.10
Not clear–clear	0.68
Dirty–clean	0.17
Heavy–light	0.31
Distinguishable–undistinguishable	0.61
Light–dark	0.45
Cool–hot	0.44
Strong–weak	0.20
Stylish–not stylish	0.08

The factor analysis was also carried out and the result is shown in Table 5. It was found that the 12 word pairs investigated in this experiment can be categorised into three factors, as summarised. The varimax method was used for rotation of the factor axes and then rotated factor matrixes were calculated as given in Table 5 [15]. Factor 1 was found to explain the total variance to the extent of 38.5%, followed by 36.0% and 13.8% for factors 2 and 3, respectively. Factor 1 is associated closely with 'heavy–light' word pairs including 'fresh–not fresh', 'dirty–clean', 'light–dark', 'fast–slow' and 'cool–hot'; factor 2 is associated with 'plain–gaudy', 'vivid–dull', 'not clear–clear', 'distinguishable–undistinguishable' and 'strong–weak'; factor 3 is associated with 'stylish–not stylish'. In Figure 5, the 24 uniform pairs are plotted in terms of their factor loadings for factors 1 and 2 (Figure 5a), and factors 1 and 3 (Figure 5b). Figure 5a shows that the uniform pairs appear more distinguishable on the upper side than on the lower side of the chart. This implies that factor 2 is related to distinguishable of uniforms in a game. According to both parts of Figure 5, factor 1 seems to be related to freshness. Factor 3 was found to be associated strongly with stylishness of the uniforms. Thus the three factors were labelled 'fresh', 'distinguishable' and 'stylish'.

The experimental results suggest that the colour of the uniforms influence our impression, in particular, the impressions of 'not clear–clear' and 'undistinguishable–distinguishable'. However, it was difficult to examine details of the characteristic of the colours, since the actual game scenes were used as the visual stimuli and thus we could not control many parameters that could affect the viewers' judgements such as time, venue, weather, temperature, lighting conditions and the angles of a TV camera.

**Table 5** Rotated factor matrix for the obtained SD scores

Factor	SD word pair	Rotated factor matrix		
		Factor1	Factor2	Factor3
1	Heavy–light	–0.9709	0.0255	0.0537
	Fresh–not fresh	0.9423	0.1091	0.1550
	Dirty–clean	–0.8574	0.4003	–0.1573
	Light–dark	0.7546	–0.6047	0.1475
	Fast–slow	0.7305	–0.2945	0.4889
	Cool–hot	0.7167	0.6933	–0.0041
2	Plain–gaudy	–0.1562	0.8898	–0.064
	Vivid–dull	0.4180	–0.8847	0.1240
	Not clear–clear	–0.0963	0.7452	–0.3857
	Distinguishable–undistinguishable	0.0228	–0.7211	0.3576
	Strong–weak	–0.3721	–0.6870	0.5184
3	Stylish–not stylish	0.2959	–0.3028	0.8728
	<i>Rate of contribution (%)</i>	<i>38.48</i>	<i>35.99</i>	<i>13.66</i>
	<i>Rate of accumulation contribution (%)</i>	<i>38.48</i>	<i>74.47</i>	<i>88.13</i>

**Figure 5** Factor scores for each game for (a) factor 1 (fresh) and factor 2 (distinguishable) and (b) factor 1 (fresh) and factor 3 (stylish)

## Impression of Colour Combinations Using Static Images

### Experimental set up

As it has been mentioned, it was difficult to investigate the detail of the influence of colour on the impression of the viewers because of the limitations of the actual game scenes used as visual stimuli in the previous experiment. Hence, an additional experiment was carried out using created static images which were simulating a scene of a football game under simplified viewing conditions. In this experiment, only assessments of ‘distinguishable’ and ‘preference’



**Figure 6** Design of the static image

of football uniforms were carried out. Figure 6 shows the design of an image, which includes two pairs of players on a football pitch.

Seven colours were selected as uniforms in terms of RGB values, including black ( $R = G = B = 0$ ), white ( $R = G = B = 255$ ), grey ( $R = G = B = 112$ ), red ( $R = 255, G = B = 0$ ), green ( $R = 0, G = 255, B = 0$ ), yellow ( $R = G = 255, B = 0$ ) and blue ( $R = G = 0, B = 255$ ). A single colour was used as a skin colour for all the players. This colour was also arbitrarily selected not to be too dark or too white, referring to the images of the World Cup teams. In this experiment, black was used as the shoe colour, as this was the colour of choice for many players in the World Cup teams. As a background colour of the static images, a green football pitch colour was used. Colours of the football pitch in the games used for the previous experiment were taken at three places and an average of them was chosen as a background colour. The spectral power distribution of these colours displayed on the LCD panel (PCV-RZ62L7: SONY) were measured using a MINOLTA CS1000 telespectroradiometer. Then, the CIELAB values were calculated (Table 6) [16,17]. In Table 7, a list of the 21 combination pairs of the seven colours (black, blue, green, grey, red, white and yellow) is given together with their colour difference  $\Delta E^*_{ab}$  which were calculated from their CIELAB values [18]. In addition, a sum of the three components of the colour differences (the first one being  $\Delta E^*_{ab}$  between a pair of uniforms; the second,  $\Delta E^*_{ab}$  between one of the pair of the uniforms and the football pitch; and the third,  $\Delta E^*_{ab}$  between the other uniforms and the football pitch) resulted in 21 combination pairs and these are given in Table 8.

**Table 6** Specification of the colour used in the static images in terms of CIELAB values

Colour	$L^*$	$a^*$	$b^*$
White	100.00	0.00	0.00
Black	2.09	-0.25	-0.52
Grey	43.15	-0.89	-13.01
Red	39.43	57.43	58.43
Green	38.38	-50.32	30.77
Yellow	91.88	-27.47	88.44
Blue	8.92	25.85	-44.03
Football pitch	36.23	-31.34	35.49
Player's skin	37.38	7.08	24.01

**Table 7** Listing of the 21 combination pairs of the seven colours of the uniforms together with their colour difference  $\Delta E^*_{ab}$  between the pairs of the uniform colours<sup>a</sup>

Order	Combination of team shirt colour	$\Delta E^*_{ab}$
1	Yellow–Blue	165.15
2	Black–Yellow	129.29
3	Grey–Yellow	115.64
4	Red–Blue	111.47
5	Red–Green	111.25
6	Green–Blue	110.75
7	White–Blue	104.42
8	Yellow–Red	104.22
9	White–Red	101.89
10	White–Black	97.91
11	White–Yellow	92.96
12	Grey–Red	92.29
13	Black–Red	90.74
14	White–Green	85.29
15	Yellow–Green	81.91
16	Black–Green	69.16
17	Grey–Green	66.20
18	White–Grey	58.33
19	Grey–Blue	53.38
20	Black–Blue	51.25
21	Grey–Black	42.47

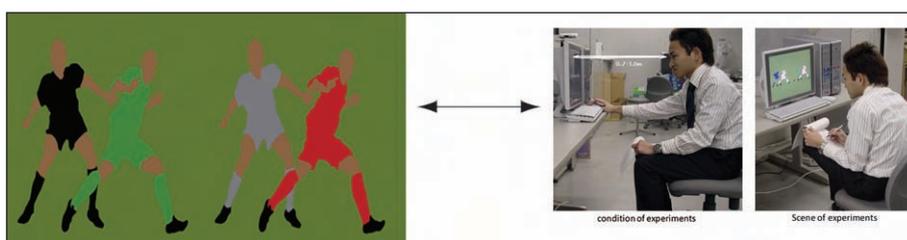
<sup>a</sup> Colour difference values are listed in descending order

**Table 8** Listing of the 21 combination pairs of the seven colours of the uniforms together with the sum of colour differences  $\Delta E^*_{ab}$  between a pair of the uniforms, between one of the pair of the uniforms and the football pitch, between the other uniforms and the football pitch<sup>a</sup>

Order	Combination of team shirt colour	Sum of $\Delta E^*_{ab}$
1	Yellow–Blue	343.74
2	Red–Blue	304.89
3	White–Blue	285.53
4	White–Red	273.06
5	Yellow–Red	272.87
6	Black–Yellow	264.67
7	Grey–Yellow	250.23
8	White–Yellow	249.30
9	Grey–Red	241.71
10	Black–Red	240.95
11	White–Black	235.80
12	Green–Blue	232.11
13	Red–Green	222.67
14	Grey–Blue	153.11
15	Black–Blue	130.11
16	White–Grey	116.28
17	White–Green	110.54
18	Yellow–Green	106.73
19	Grey–Black	103.94
20	Black–Green	100.24
21	Grey–Green	78.12

<sup>a</sup> Colour difference values are listed in descending order

A paired comparison method [18,19] was applied to assess ‘distinguishable’ and ‘preference’ of the football uniforms. As can be seen in Figure 7, two pairs of the uniforms were presented to a subject each time and a subject was asked to compare them in terms of ‘distinguishable’ and ‘preferred’. A subject was asked to compare a left pair (e.g. black–green) and a right pair (e.g. grey–red) and then to assess which pair (i.e. the left pair or the right pair) was more ‘distinguishable’ and which pair was more ‘preferred’. A total of 210 pairs were assessed by 50 subjects including 39 males and 11 females, all of Japanese origin. Their ages ranged from 18 to 30 years old with an average of 24 years. Each subject was seated in front of the LCD at a viewing distance of about 0.7 to 1.0 metres. The assessments were carried out in a lit room at KIT. For each subject, the entire assessment took about 1 hour to finish.



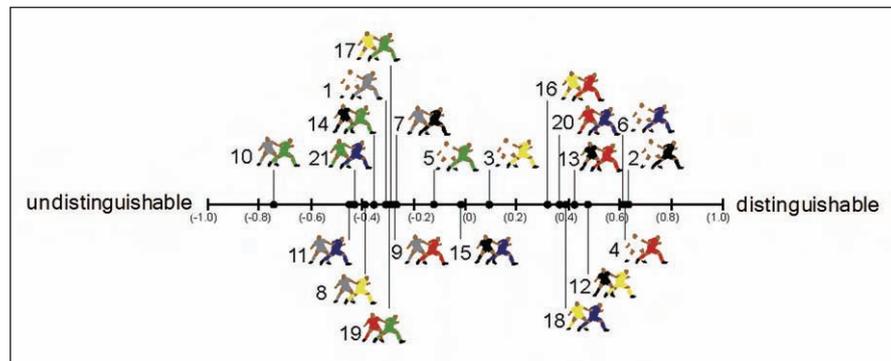
**Figure 7** Example of a sample image on the left-hand side, with the experimental conditions shown on the right-hand side

**Analysis and results: static images**

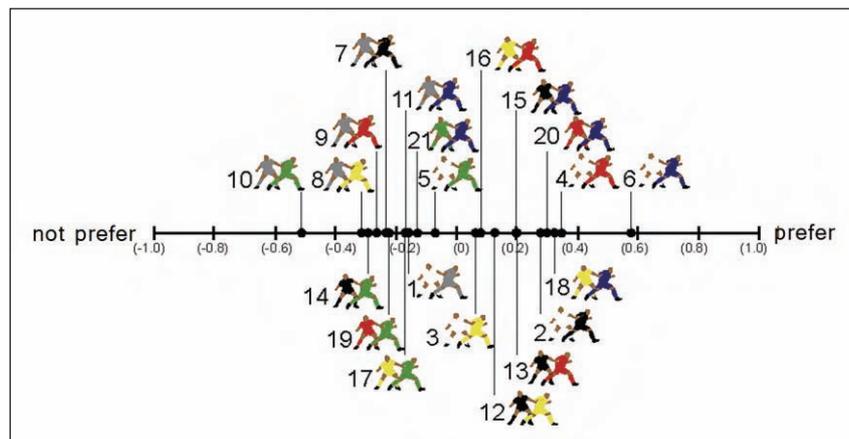
The method of Scheffe’s paired comparison was used to analyse the data [19,20]. Scheffe’s paired comparison score ( $\alpha_i$ ) was calculated according to Eqn 1:

$$\alpha_i = X_i / (t \times n) \tag{1}$$

where  $t$  is the number of types,  $n$  is the number of subjects and  $X_i$  is the preferred number of samples. The results are shown in Figure 8 for ‘distinguishable’ (undistinguishable–distinguishable scale) and in Figure 9 for ‘preference’ (not prefer–prefer scale). The uniform pairs are plotted on the ‘distinguishable’ or ‘preference’ scale. In both cases, it can be clearly seen that the impressions are influenced by the combinations of the uniform colours.



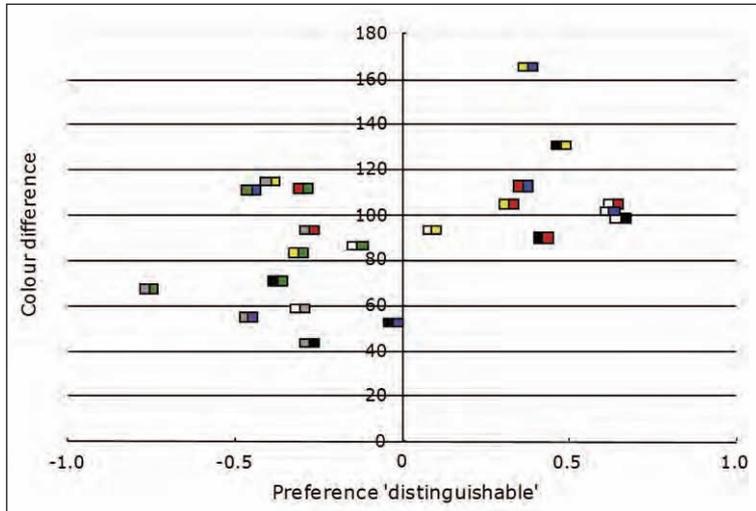
**Figure 8** Results of the experiment using static images for the ‘distinguishable–undistinguishable’ scale by Scheffe’s paired comparison



**Figure 9** Results of the experiment using static images for the ‘prefer–not prefer’ scale by Scheffe’s paired comparison

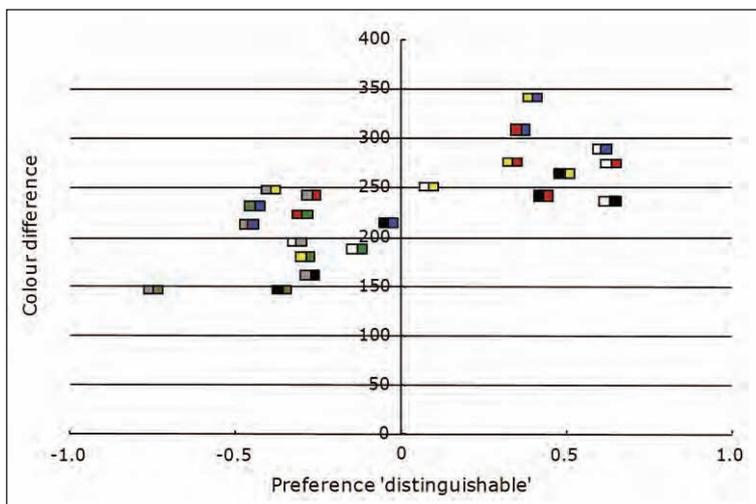
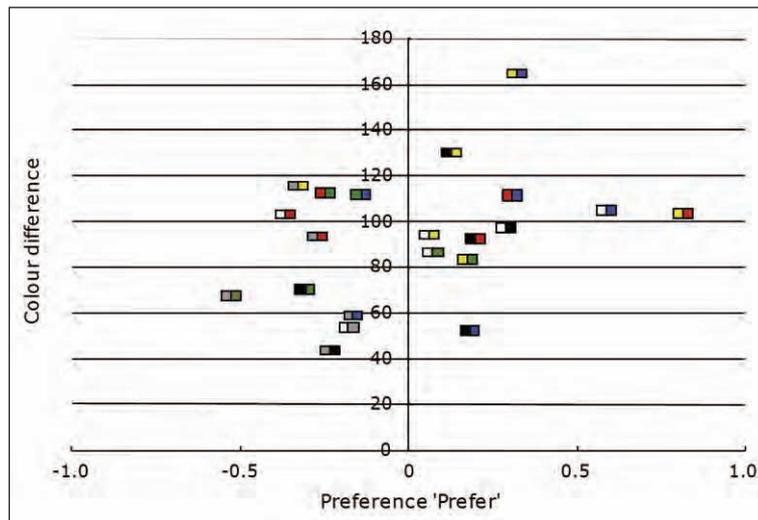
In order to investigate the influence of colours, the experimental results of ‘distinguishable’ and ‘preference’ are plotted against the colour difference of the pair of the uniforms’ colours in Figure 10 and Figure 11, respectively. From the results, no strong relationships can be distinguished in either case. However, it is clear that the subjects tend to feel less distinguishable and prefer it when a pair of the uniforms has a small colour difference. When we watch a football game, a colour difference between the colours of the two teams can be considered as a factor which influences our impression. Another factor is colour differences

between the uniform and the background, i.e. the football pitch that occupies a large area of view in a football game. Therefore, the colour differences between the uniforms and the football pitch used in this experiment was taken into account. A sum of the colour differences between two uniforms and between each uniform and the football pitch were calculated and they are plotted against 'distinguishable' and 'preference' in Figure 12 and Figure 13, respectively. For

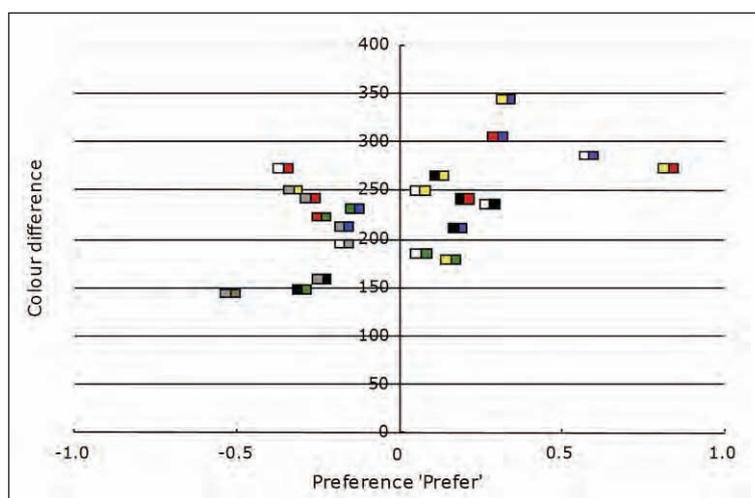


**Figure 10** Relationship between preference of 'distinguishable' and the colour difference of the pairs of the uniforms' colours ( $r = 0.50$ )

**Figure 11** Relation between preference of 'prefer' and the colour difference of the pairs of the uniforms' colours ( $r = 0.35$ )



**Figure 12** Relation between preference of 'distinguishable' and the sum of the colour differences between the pair of uniforms' colours and between each uniform's colour and the football pitch ( $r = 0.71$ )



**Figure 13** Relation between preference of 'prefer' and the sum of the colour differences between the pair of uniforms' colours and between each uniform's colour and football pitch ( $r = 0.55$ )

the result of 'preference', although the small colour difference combinations tend to be less preferred as in the previous result (shown in Figure 13), a overall correlation coefficient ( $r$ ) between the sums of the colour differences and 'preference' of a value 0.55, is obtained which represents poor correlation. On the other hand, an  $r$  value of 0.71 was obtained from the results of 'distinguishable' (Figure 12). Although this is not a much higher correlation, the result suggests that the colour difference between the two uniforms and between the uniforms and the pitch influences our impression of 'distinguishable'. When the colour difference is small, it is difficult to distinguish between the uniforms. On the other hand, the large colour difference helps people to distinguish the uniforms in a football game.

In addition, from Figures 8, 10 and 12, it can be seen that the pairs including the green uniform appear to give the impression of 'undistinguishable'. We also considered that this was because the colours of the green uniform and the green pitch were similar. Also, from the result shown in Figure 12, the pairs including the grey uniform give the impression of 'undistinguishable'. These results indicate that the colour differences not only between the pair of the uniforms but also between the uniforms and the pitch were important. In regard to the 'prefer–not prefer' impression, we asked the subjects to evaluate whether they preferred or did not prefer the pair of the uniforms. We did not guide them to connect the impression of 'prefer–not prefer' with that of 'distinguish–undistinguishable'. Although we can see from Figures 8 and 9 that the subjects did not prefer the pairs including the green uniform and the grey uniform as well as the 'undistinguishable' pairs, the correlation between them was not so high ( $r = 0.67$ ).

## Conclusions

This study was intended to investigate the impression of colour usage in football from the viewpoint of the viewers. At first, a survey was carried out to investigate the attention of viewers to football uniforms when they were watching a football game. As we can imagine, the subjects selected a ball as an object to which they most paid attention. The answers of 'uniform' and 'player' were obtained from 36% and 68% of the subjects, respectively. In this study, the degrees of the impressions of combinations of the uniform colours as seen in football games were also investigated using actual football games as moving images' stimuli. An SD method was applied to scale the degrees of the impressions scaled based on the SD words (adjective words) which are suitable to express the impression of football uniforms. It was found that

the scales little affected by colour combinations of uniforms were 'fast–slow' and 'stylish–not stylish' in this experiment. On the other hand, there were two scales largely affected by colours of uniforms: 'distinguishable–undistinguishable' and 'clear–not clear'. This means that the combination of the colours of the uniforms affected our impressions differently. However, it was difficult to investigate the detail of the influence of the colour to the impression of the viewers because of the limitations of the actual game scenes used as visual stimuli. Hence, an additional experiment was carried out using created static images which simulated a scene of a football game under simplified viewing conditions for the SD scales of 'distinguishable' and 'preference'. From the experimental results, the relationship between the viewers' preference and the colour could not be found. However, the results indicate the correlation between the viewers' impression of 'distinguishable' and the sum of the colour difference between the pair of the uniforms and between each of two uniforms and the football pitch. This result suggested that it is important for football teams and their managers, when selecting the colour of the uniform, to take into account not only the colour of the uniform but also the colour combination of the uniform and the football pitch.

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