Accuracy of Cross-Media Colour Memory

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ABSTRACT

This work is concerned with the investigation of colour memory of users (designers, printers, students, etc.) in cross-media situations, particularly, between physical (printed) and digital (on-screen) colours. The preliminary experiment reported here supports findings by other researchers that there are systematic shifts between the memory colours of observers and the target colours that are being memorized. The results also confirm our hypothesis that when users are asked to select a colour on screen to represent a memorized target (or, we argue, to represent a colour that they have imagined) there are additional systematic colorimetric shifts. Users tend to select colours that are much more saturated then the target. There are implications of this work for soft-proofing and the use of imaging software by designers.

1. INTRODUCTION

There is evidence that memory colours in successive matching experiments systematically deviate from the original target colours in terms of lightness and brightness attributes whilst hue also deviates but in a less predictable manner (de Fez et al. 1993). The literature reveals that colour memory is complex, however. Seliger noted that there are in fact three types of colour memory; short-term delayed matching and two types of long-term recall (Seliger 2002). Long-term colour memory seems to have a cognitive component in terms of users' preferred colours and is also influenced by an individual's precision of matching. Users' preferences have been shown to be influenced by an association of certain colours with certain familiar objects (Yendrikhovskij, Blommaert and de Ridder 2001; Bodrogi and Tarczali 2002; Hunt 2004). It has also been shown that younger adults are better than elderly adults in memorizing colours (Perez-Carpinell et al. 2006). However, relatively little work has been carried out to compare the accuracy of memory colour in cross-media situations. This study explicitly seeks to determine whether there is a systematic difference between memory colours selected in a digital (on-screen) environment and those selected using physical (printed) samples. Note that this work is not specifically concerned with the fact that certain objects may have so-called 'associated' colours (blue sky etc.) although such cognitive factors may contribute to the results.

2. METHOD

In the experiment an observer would view one of the six physical target samples (15 × 12 cm on a white background) for as long as they considered necessary to memorize the colour (in practice observers viewed each colour sample for about 20 secs). Following memorization the target colour was removed from view and the observer was asked to select an appropriate match to the

memorized target colour from a hard copy version of the Ned Graphics Printer Colour Atlas. The atlas coordinates of the selected match were recorded and the observer moved on to the next target sample. Once an observer had selected a match for each of the target samples the process was repeated but this time the observer selected the match from an on-screen display using a conventional colour-picker tool based on HSB. A total of 6 observers with normal colour vision were recruited to take part in the experiment. Following the experiment the CIE XYZ values of the selected samples from the hard-copy atlas were measured. The CIE XYZ values of the samples selected on screen were also measured. The XYZ values of the selected matches were compared with the XYZ values of the target colours which were obtained in advance via measurement with the Minolta CM-2600 instrument.

3. RESULTS

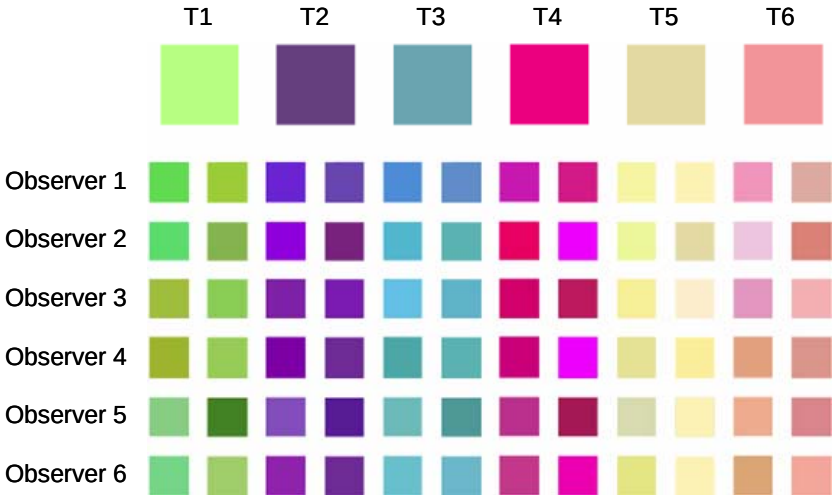

Figure 1: sRGB representations of the six targets and the matches made by the six observers on-screen (odd columns) and in print (even columns).

Figure 1 shows an illustration (using sRGB representation but subject to the vagaries of colour management) of the six targets (T1–T6) and the matches made by the six observers on-screen and in print. The CIELAB colour coordinates (illuminant D65; 1964 CIE standard observer) for the six target samples are displayed in Table 1.

Table 1: CIELAB coordinates of target colours.

targets	L*	a*	b*
T1	74.06	-27.15	15.73
T2	42.98	21.88	-30.92
T3	66.50	-19.19	-27.50
T4	48.83	57.58	0.65
T5	85.50	-1.86	8.28
T6	70.28	27.55	-1.00

Table 2 shows the CIELAB colour differences (averaged over all observers) between the matches made in the two media and the target colours. It is evident that the accuracy (in

colorimetric terms) of the observers was far greater when using the print medium than when using the digital on-screen medium. However, these summary data don't easily show whether there were any systematic differences between the two media. Figure 2 shows the CIELAB coordinates of one of the targets T1 (circle) and the matches made by the six observers on-screen (asterisk) and in print (cross). It is evident that there are systematic deviations. The matches made by the print medium are all more saturated than the original target and this would seem to indicate a systematic memory effect consistent with previous studies. However, the matches made using the screen are even more saturated and would suggest that there is an effect of display medium on colour memory. The L*-C* space shows the memory shifts where the differences in mean chroma between the matches made in hard copy and on screen are more evident. Note that the observers were able to make good matches to the Lightness of the samples (and also to their hue) using either medium. The pattern shown in Figure 2 was strongly replicated in four of the other five target colours.

Table 2: Average CIELAB colour differences of matches.

targets	CIELAB ΔE	
	on-screen	print
T1	39.44	18.08
T2	51.00	6.65
T3	15.64	9.93
T4	22.98	10.44
T5	33.37	6.07
T6	26.53	8.22
average	31.49	9.90

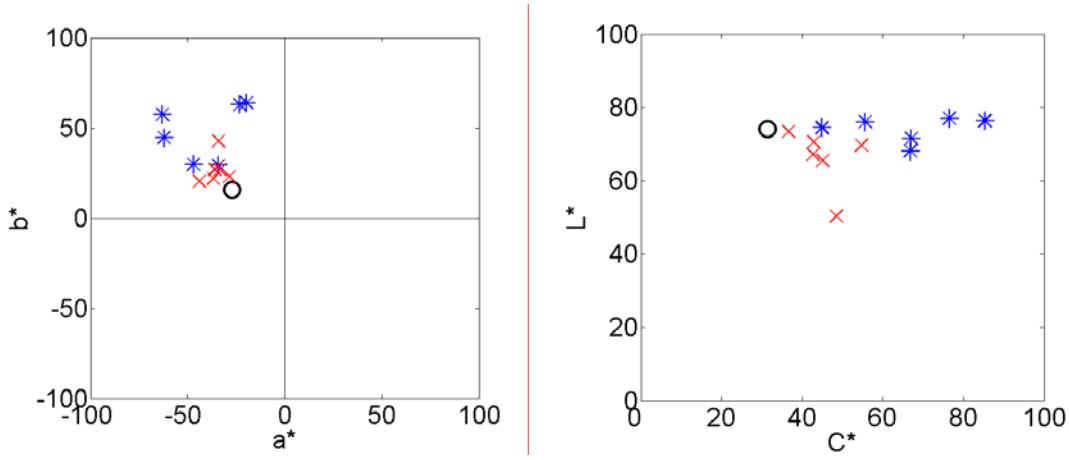

Figure 2: CIELAB a-b* (left) and L*-C* coordinates (right) of one of the six targets (circle) and the matches made by the six observers on-screen (asterisk) and in print (cross).*

Matches for target colour T3 were much closer on average to the target colour in the case of both media. The reason why the mean colour difference for T3 is quite high despite the matches being much closer on average is the non-directional nature of ΔE. So for example, the high values for T3 in Table 2 therefore indicate variability between observers' responses rather than the accuracy of the average response. In Table 3 the ΔE values have been computed in a different

way; Table 3 shows the ΔE between the target colour and the average match made by the six observers.

Table 3: CIELAB colour differences of the average match by the six observers .

targets	CIELAB ΔE	
	on-screen	print
T1	35.27	16.11
T2	50.29	3.62
T3	2.53	3.45
T4	14.92	7.02
T5	33.14	2.97
T6	15.60	5.63
average	25.29	6.47

4. CONCLUSIONS

The preliminary experiment reported here supports findings by other researchers that there are systematic shifts between the memory colours of observers and the target colours that are being memorized1. The experimental results also confirm our hypothesis that when users are asked to select a colour on screen to represent a memorized target (or, we argue, to represent a colour that they have imagined) there are additional systematic colorimetric shifts. Users tend to select colours that are much more saturated then the target or imagined colours. There are implications of this work for softproofing and the use of imaging software by designers. However, at this stage the results need to be considered with caution. The experimental paradigm that was used resulted in users being asked to select colours differently (and from a different range) in the cases of the two media. This difference could, in theory, have been responsible for the differences that we attribute to a difference in medium. Further experiments (using more observers and a greater number of target colours) are already underway using an improved paradigm.

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