Assessing Different Methods of Measuring Colour Constancy

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Aim

To assess the suitability of an asynchronous achromatic adjustment paradigm in the measurement of colour constancy,

Method

Mondrians were simulated under D67, Extreme blue, Extreme Yellow, Extreme Red and Extreme Green illuminations. Each surface of the Mondrian was assigned a patch number at random, pertaining to one of the patches in the physical box. This patch number would be used to specify the patches chromaticity under the changing illuminations, by selecting that patches chromaticity from a lookup table; the lookup table contained the Yxy values of the patches collected with the hyperspectral camera. Thus, the relationships between the patches remains as the illumination changes, this was done deliberately as this is what happens in the physical box.

We used an asynchronous achromatic adjustment paradigm, which utilised a double staircase. This allowed observers to select whether a test patch was either: Redder, Greener, Bluer or Yellower. If R or G was selected the R-G staircase, controlling the u' axis, was evaluated. Likewise, If the B or Y was selected the B-Y, controlling the v' axis, staircase was evaluated. This allowed one staircase to be 'put on hold' until it was needed. If one staircase finished first, then that options (R-G or B-Y) would not be given, and manipulations could only be made on the other (This prevented having a red and being asked if the patch was B-Y, or a blue and being asked if the patch was R-G; once one staircase had converged, there should only be amount of the other directions contributing to the patch chromaticity as perceived by the adapted observer).

At the start of the experiment we adapted to the Mondrian under D67 for 3 minutes. In each block we then adapted to the Mondrian under D67 for 30 seconds followed by the Mondrian under the test illumination for 2 minutes. Then, the test patch could be adjusted. This gave us an achromatic match for each Mondrian under the 5 illuminations: D67 and the 4 chromatic extremes (see Figure 1).

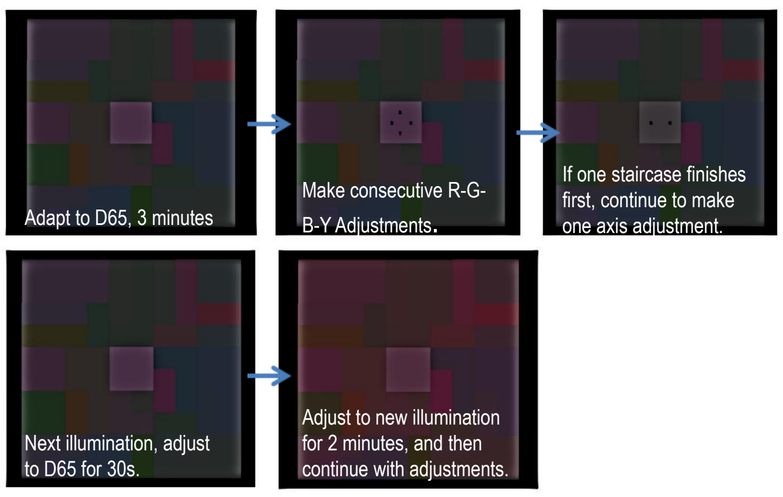

Figure 1. Flowchart of the experiment; Screenshots from Psychtoolbox.

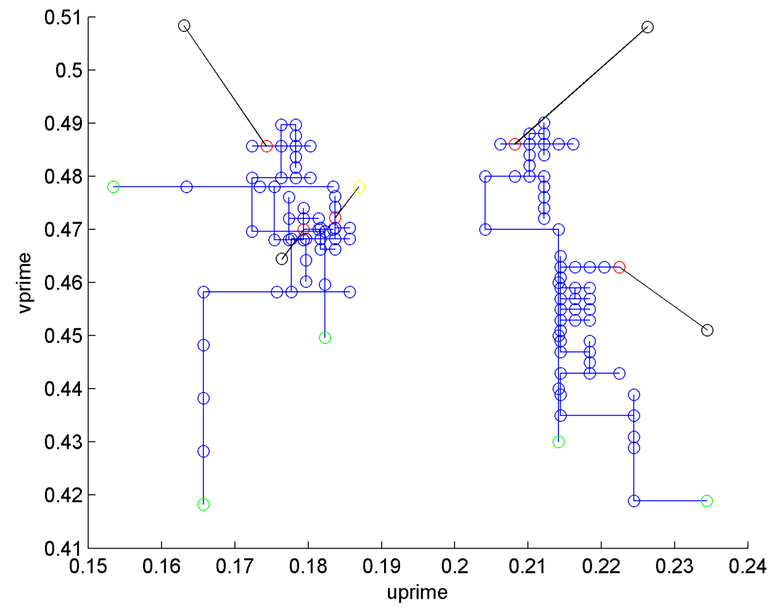

Figure 2. A's matches.

Starting points are in Green, Achromatic Matches are in Red. Black rings are the illumination chromaticity, and the black spline is the distance from the match to the illumination chromaticity. The Blue spaghetti are the adjustments by trial, yellow is D67.

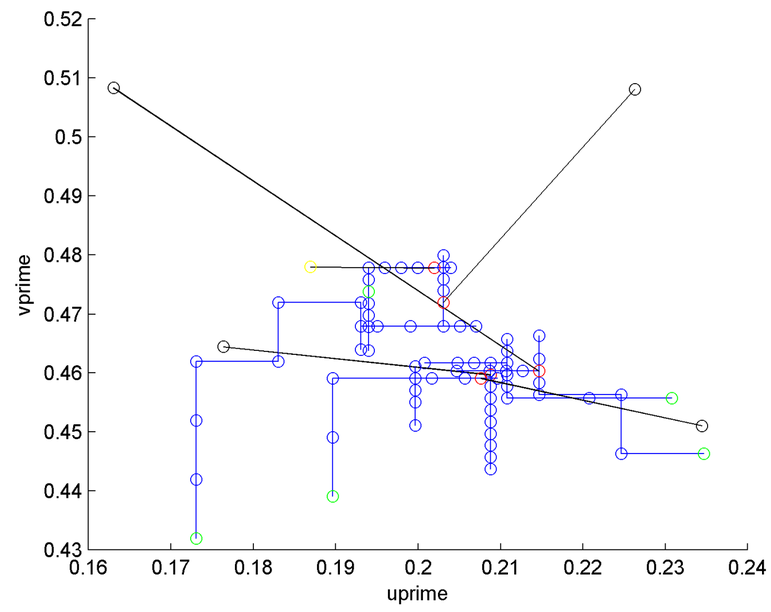

Figure 3. B's matches.

Starting points are in Green, Achromatic Matches are in Red. Black rings are the illumination chromaticity, and the black spline is the distance from the match to the illumination chromaticity. The Blue spaghetti are the adjustments by trial, yellow is D67.

Results

We used a constancy index as a predictor of constancy. We averaged all the achromatic matches of both observers individually to get both observers' perceptual white point. We then took the Euclidean distance between the perceptual white point and each achromatic match in Lu'v' colour space to give us the perceptual shift for each illumination. To get the physical shift, we took the Euclidean distance between D67 and the scene illumination. We then calculated the CI as Perceptual Shift/ Physical Shift for each illumination condition; giving us a value of 1 for the D67 condition as the Physical Shift was 0. Table 1 shows the CI for both observers; plots of the adjustments can also be seen in Figure 2 and 3.

Observer	Constancy Index D65	Blue	Green	Yellow	Red	Mean
A	1	0.886528	0.56573	0.364525	0.574684	0.597867
B	1	0.364777	0.238598	0.150155	0.122741	0.219068

Table 1. Constancy index by observer, by illumination direction.

Conclusion

The results suggest that this method is less ideal for measuring colour constancy compared to methods like measuring colour discrimination thresholds but further research is required to ascertain which components of the set-up utilised was the reason for this.