PAINTING VIEWED UNDER DIFFERENT ILLUMINANTS: DOES IT CHANGE THE MEANING?

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ABSTRACT

*In museum, the choice of light, with a particular color temperature, impact the visual appearance of artworks. Visual appearance is part of observer's perception and contributes to the appraisal of the object. When we change the visual appearance of an artwork, does it modify the meaning given by the artist and does it disturb our comprehension of this object? In order to evaluate influence of color temperature on artworks appraisal, we conduct a psychophysical experiment with 12 observers. We show artworks using two light sources having color temperature of 2800K and 6500K. We use three non figurative paintings as well as six photographic images. We also measure the paintings to obtain colorimetric data XYZ and L*a*b* under two reference illuminants, A and D65. If colorimetric measures change when illuminant is different, it seems that observers' perceptions stay constant. Their preference judgments remain the same while judging artworks under both illuminants.*

Keywords: art, illuminant, color temperature, preference

1. INTRODUCTION

The museums where are exposed artworks often have rooms lighted with natural sun during daylight and artificial lights when sun has gone. Museums also present artworks in blind rooms with no window using artificial lights. Because colors of artworks depend upon illuminant, what is the right light to choose for showing art objects? Probably a white light with a continuous spectral composition, but with which colour temperature? This light could be 3000K, 5000K or 8000K as natural variation of daylight. Previous study by Sève[1] reveals that the sensation of white light is obtained with 7000K and 50 cd/m², that is different from halogens lamp traditionally used in museums.

Choosing an artificial light, with particular color temperature, influence visual appearance of observers and contributes to the appraisal of the artwork. Which is the best light to illuminate art objects could not be the only question. We usually talk about visual appearance but not about visual expression and feeling. But, in the context of museum and arts galleries, it is clearly those elements that should be similar when you change the light. When we change the visual appearance of an art object, does it modify the meaning given by the artist and does it disturb our comprehension of this object?

We propose here to explore the idea that, when you change the colour temperature of a light source from 2800 K to 6500 K, the appraisal and feeling of an observer in front of a coloured painting stay constant. We do two distinct experiments, one testing the preference judgements of observers in front of paintings or photographies while the light is changed and one color difference evaluation experiment.

This study is related to previous experiment conducted for museum about color perception after illuminant change due to solar protection tinted glazing [2].

2. PREFERENCE EXPERIMENTS

In order to study the relationship between the light source used to show an art object and observers' appraisal, we conduct two preference experiments. The first is done with modern paintings and the second one with photographic objects.

We choose to test two particular illuminants : D65 (6500K) that represents typical daylight and A (2850K) that represents incandescent light source and is commonly used in museum. The change between A and D65 is quite severe. If D65 is approximately a "white" source, A is "warm"

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with lack of short radiation in blue region and over representation of red ones (Figure 1).

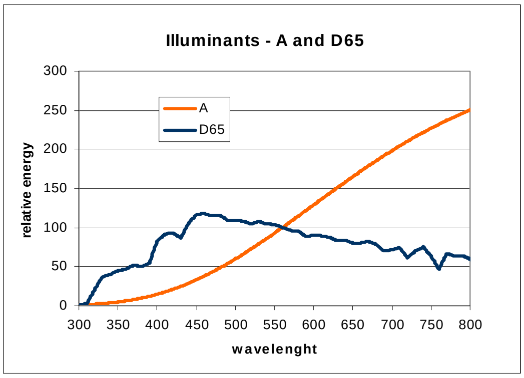

Figure 1. Wavelength distribution of A and D65 illuminants

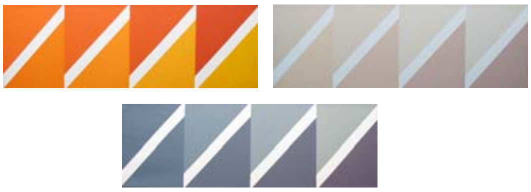

Figure 2. "Les automnales". Orange painting (top left), pink (top right) and blue one (down).

Figure 3. Photographies used in preference experiment

2.1 Art objects shown on experiments

2.1.1 Paintings

The objects of study are non-figurative paintings called *Les Automnales* of the painter George Ayatt. He bases his work on fine variations of chromaticity of monochromic surfaces. We have three paintings containing each eight uniform areas of colours. One painting contains variations of colours in blue area, the others in orange and pink (Figure 2).

2.1.2 Photographies

We use photographic images of 6 natural scenes from Photodisc photo CD (Figure 3). The images were modified by an image expert during a previous study (3). The expert used Adobe Photoshop software to modify attributes as lightness, chroma or contrast on the whole image or in partial elements of the image. We obtain enhanced versions of the 6 natural scenes. We use those 12 images printed on paper to conduct our tests.

2.2 Protocol for preference experiments

We conduct the experiments with 12 observers with normal or corrected vision, six men and six women. Objects are shown in a Gamain light booth offering a colour temperature of 2850K (A) or 6500K (D65). The illuminances are 1400 lux and 2800 lux respectively.

In order to test if observers' appraisal of artworks change when the light change, we conduct a psychophysical experiment of preference using a paired comparison protocol (4).

As we have three paintings, we collect the answers for three pairs (orange painting next to blue one, orange with pink, blue with pink). For photographies, we show an image next to it modified version. As we have 6 images, we collected 6 answers.

For each pair, we ask observers "which image do you prefer?" They answer with the position of their preferred image: right or left. We do three repetitions and the right or left positions of images are equally distributed.

An observer completes the painting experiment with repetitions and then do the photography experiment with repetitions. The experiment is first conduct under A illuminant and the following day under D65. For each observer, 24 hours separate the illuminant change. When an observer enters the experiment room, only the test illuminant in light booth is lighting the room. We wait several minutes before running the experiment in order to adapt the observers to the color temperature of the test illuminant.

In paired comparison experiment, matrices of results are constructed by giving one point to the preferred object and zero to the non chosen object. For one object, answers are summed and then divided by the number of observers and the number of repetitions. We obtain the percentage of preference for each object.

2.3 Results

2.3.1 Paintings

We obtain the percentage of preference for paintings (orange, blue or pink) under D65 and A illuminants.

The aim of this protocol is to test if preference changes when we change the illuminant. Each observer has his own criteria to choose which painting he does prefer. All observers do not prefer the same painting so we present the results in three groups depending on preferred painting. Figure 4a shows the results for the 6 observers who choose the orange painting as their preferred. Figure 4b shows the results for the 2 observers who prefer the blue painting and then the last figure 4c shows the results for the 4 observers who choose the pink one.

If we look at the results in Figure 4a, we see that under D65 illuminant, observers prefer the orange painting in 100% of case, i.e. they choose the orange painting each time it was present in front of another color painting. Observers prefer the blue painting in 41,7% of case and the pink one in 8,3%. When we compare the results in D65 with those obtained under A illuminant, we see that preference is not affected by the change of illuminant. Observers still prefer the orange one for 97,2% and the blue one for 38,9%. The preference results are similar when the painting are seen under A and D65 illuminant.

Similar results appear with other paintings. When an observer prefers a painting, whatever the reasons why, he keeps it feeling despite the visual

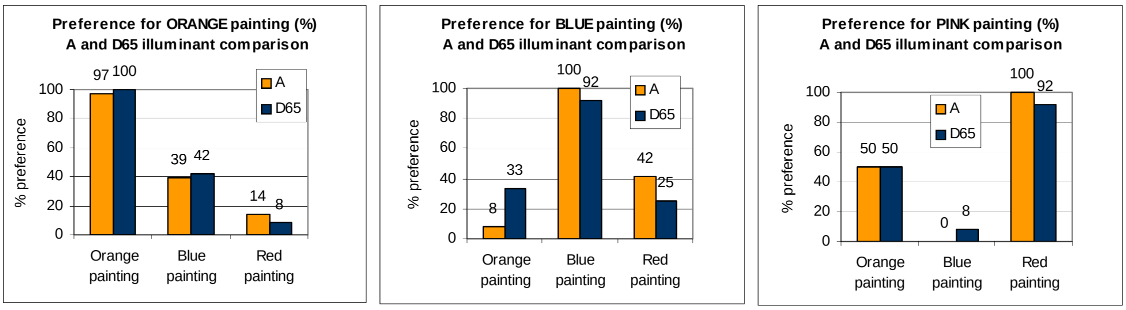

Figure 4 a),b),c). Percentage of preference of paintings under A and D65 illuminants

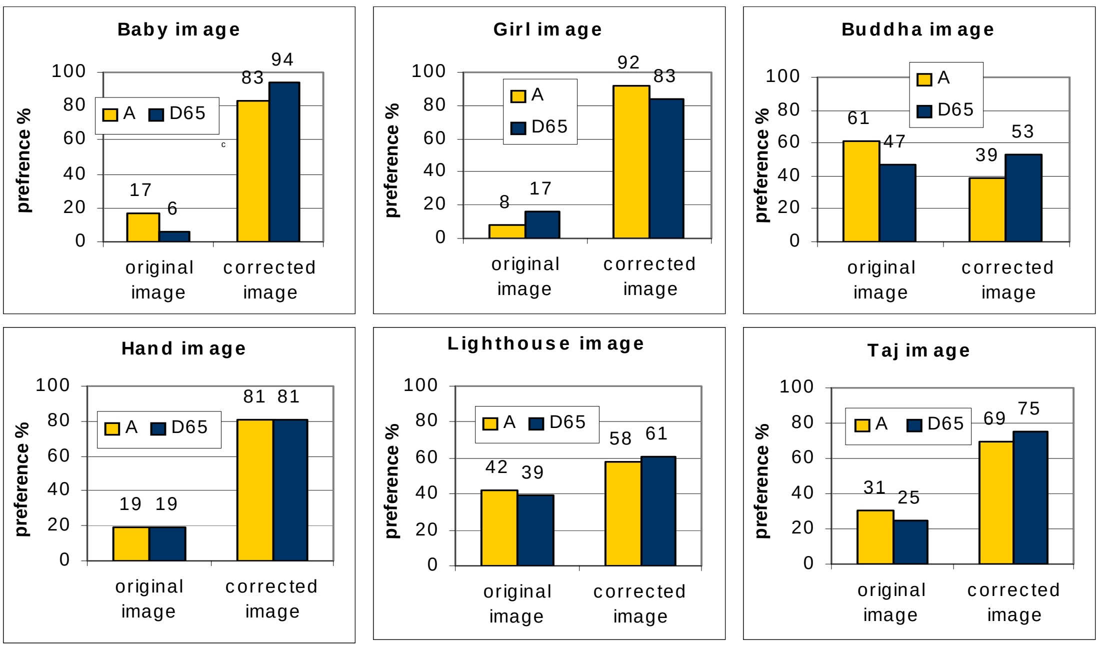

Figure 5. Preference between original and modified photographies under A and D65 illuminant

appearance modification due to the illuminant change.

2.3.1 Photographies

We obtain preferences for original or modified image by expert for each of the six photographic images (Figure 5).

For the baby image, the corrected image by the expert is largely preferred under both illuminant D65 and A (respectively 94% and 83% of preference). For 5 images upon 6, the corrected image is preferred under both illuminants. Illuminant's change does not modify the appraisal of observers. The preference is quite clear and the preferences scores are similar between A and D65. In deed, the average preference percentage of the 5 images is 77% for A illuminant and 79% for D65 illuminant.

For one image (Buddha), the preferred image is different depending on illuminant. Observers prefer the original image under A illuminant (for 61%) and the modified one under D65 (53%). We can notice that, contrary to previous 5 images, observers seem to hesitate between the original and the modified version as percentages are close to 50%.

Previous study [(3)] shows that this image of a Buddha statue has particular color and observers have difficulties to choose their preferred one. This image seems to be out of the experience range of observers because it is taken in an unknown exotic country. For this image, no memory colors are associated with presented object and this leads to difficulties in preference judgments. Literature reports [(3, 7)] that image appraisal is dependant of memory colors, that are the colors recalled in memory in association with well-known object, like sky, grass of skin. Memory colors are linked to observer's experiences. Observers do prefer images where colors match the colors recalled in their memory in association with the represented object. Interestingly, the memory color often is not found in the real objects. Green grass or blue sky are typically remembered as being more saturated than the real stimuli. When an image expert modifies a photographic image, he adjusts colors in order to make them match with memory colors.

2.4 Discussion

In painting and photography preference experiments, the illuminant seems not to be an influent factor. Despite the color appearance of object is changed by illuminant change, observers keep their appreciation about artworks.

In the experiments, observers are completely adapted to each illuminant. Human visual system is capable to adjust to widely varying colors of illuminations in order to approximately preserve the appearance of object colors. This is called chromatic adaptation. Important spectral change in illuminant from A to D65 is partially compensated by chromatic adaptation. Chromatic adaptation is a complex phenomenon. It relies on two mechanisms[(5)], a sensory mechanism that is some sort of automatic response to changes in the stimulus configuration and a cognitive mechanism based upon observers' knowledge of the scene content.

In our experiment, because appearance is changing between A and D65 without affecting observers' preferences, cognitive mechanisms seem to be dominating. If cognitive mechanisms are recognised in literature, they are difficult to quantify.

Previous study conducted under D65 illuminant showed that image preference is linked with memory colors [(3)], which are cognitive phenomena. Unfortunately, what happens to memory colors when the illuminant is changed is unclear, as there is little literature on this subject [(6)]. We could have several memory colors references in mind depending on the illuminant.

More research on this subject should be conducted to better understand cognitive factors imply in artworks' appraisal.

3. COLOR DIFFERENCE EVALUATION EXPERIMENT

3.1 Observers evaluation of color differences

We want to test if illuminant changes modify the color difference magnitude estimation made by observers. We do a psychophysical experiment with 12 observers, six men and women. We use a light booth with A and D65 lights. Observers are completely adapted to illuminants. We work with the three paintings “Les automnales”. We show one painting and ask an observer to quantify the color difference between adjacent areas of colors that constitute the painting. We test the zone a with the zone c, c with e, e-g, b-d, d-f and f-h (see Figure 6). Observers answer using the following scale we constructed: 1 identical / 2 almost identical / 3 not very different / 4 different / 5 very different. We obtain for each painting the color differences evaluation made by observers. We do this test under A and D65 illuminants and perform three repetitions.

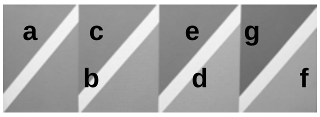

Figure 6. Areas on paintings

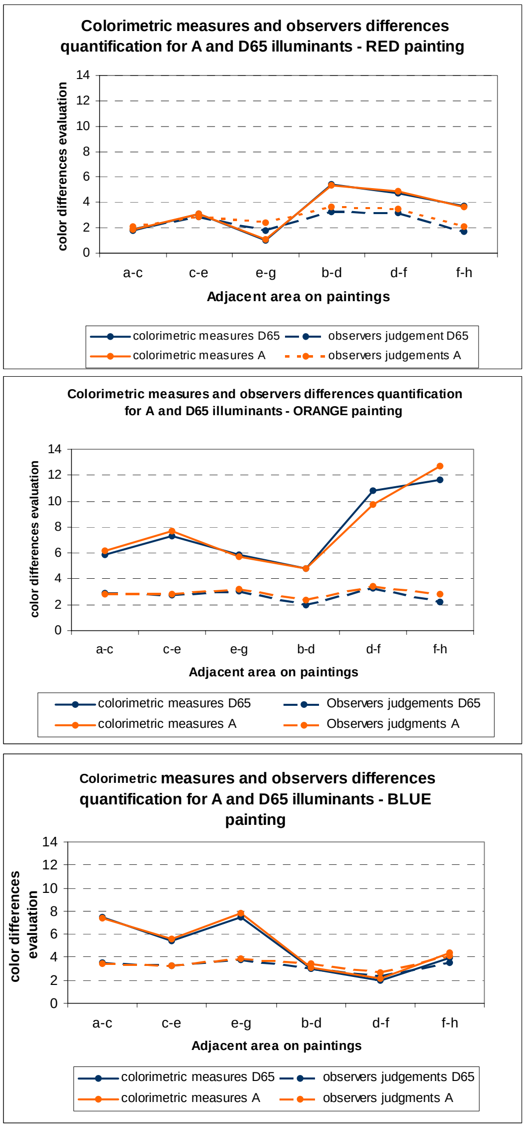

Figure 7. Observers’ difference quantification versus colorimetric delta E ; A and D65 illuminants

3.2 Colorimetric measures

In order to correlate observers’ answers with colorimetric values, we measure the three paintings “Les Automnales” with the Minolta spectrocolorimeter CM-2500d. We obtain XYZ and L*a*b* colorimetric values for each color zone of the paintings: a, b, c, d, e, f, g and h. We do the measures with the two reference illuminants, A and D65. Observers judge color differences so we calculate Delta E between adjacent colors of each paintings, a-c, c-e, e-g, b-d, d-f and f-h for each illuminant.

3.4 Results and discussion

We work on measured data to calculate color differences and link them to observers’ appraisals. For each painting, we represent the delta E between adjacent zones of paintings for one illuminant (Figure 7). We show the results under A illuminant (orange continuous line) and D65 illuminants (blue bold continuous line). The measured delta E scale is linked with the word scales used by observers but is not strictly identical. However, we learn if observers estimate that two areas are more different than two others and are able to compare those answers with difference estimation made by spectrocolorimeter. We present the answers of the observers on color difference evaluation on the same graph that colorimetric delta E differences (Figure 7).

The first result is that observers do judge color differences similar under A and D65 illuminants (dotted lines). Answers for the orange and blue painting for A and D65 could mostly be superimposed. For the pink painting, observers perceive little more differences between areas under A illuminant as the average answer is 3,24 for D65 and 3,46 for A (see table 1). Due to our answer scales, it is difficult to evaluate if this 0,2 difference is significant or not. Globally, it seems that the color distortions introduced by changing the color temperature of the illuminant does not lead observers to modify their color difference evaluation.

The second result is that observers’ responses are not completely correlated with colorimetric measures. The colorimetric measures shows that the color differences on paintings between zones a to f are not constant. In orange painting, delta E of adjacent areas varies between 6 and 12, under D65 and A illuminants. Observers seem to perceive the paintings as regular progression of colors because the answers curves are quite flat with no significant variations. The average variation is 0.35 and 0.38 for blue painting under A and D65 (see Table 2.). Variations are higher on pink painting with 0,57 and 0,67. Even if the scale of observers' answers is not proportional to delta E scale, it is surprising to not notice such difference in observers' judgements. It seems that, when the color difference is too high, observers are not able to quantify it with accuracy. They are able to judge similarity but not to quantify important color difference. The correlation between measures and observers judgements is possible for differences comparisons. When one pair of adjacent color is judged more different than another, usually the colorimetric data confirms it. This occurs in most of the cases except for the d-f and f-h parts of the orange painting.

At this step of our experiments, we can say that the color temperature modification do not leads to major changes in the relationship between pairs of colors. As absolute colorimetric coordinates change, color differences stay constants. Those results can be linked to the concept of "Relational color constancy" [8]. Relational color constancy is defined as the invariance of perceived relations between the colors of surfaces under different illuminants. In our experiment, this could explain why the color differences stay constant when illuminant is changed.

Table 1. Observers' estimation of color differences; average by paintings

	Orange		Pink		Blue	
	A	D65	A	D65	A	D65
Average answer	2,91	2,69	2,75	2,45	3,46	3,24
Average variation	0,28	0,40	0,57	0,67	0,35	0,38

5. GENERAL CONCLUSION

Museums usually use artificial light to expose artworks. Our problematic was to evaluate impact of color temperature on artworks appraisal by visitors. In our experiments, we saw that observers' preferences judgement do not change when artworks are sawn under 2850K and 6500K and that color difference evaluation remain similar under both illuminants. These results are linked with visual chromatic adaptation. It is a complex phenomenon with sensory and cognitive mechanisms and here, in artworks' appraisal, cognitive factors are probably decisive.

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