Does colour really affect pulse rate and blood pressure?

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ABSTRACT

It is commonly believed that colour affects our heart rates and our blood pressure. However, evidence for this is limited. In this study, 42 participants took part in an experiment to explore the effect of the colour of an environment. Physiological measurements were taken of blood pressure and pulse rate after exposure to coloured-light environments for about 20 minutes. It was found that pulse rate was raised under red light compared with blue and green light. It was also found that blood pressure was raised under red light. However, no statistically significant effects were observed.

1. INTRODUCTION

There are two possibilities why a certain colour could induce a particular reaction (Kaiser, 1984). Firstly, it could be explained as physiological autonomic reactions to colour. Secondly, the responses could be evoked (possibly, for example, as colour associations) from observers' perception of the world. It is still debated *whether the reaction comes from nervous autonomic systems or a cognition process of past culturally based experiences with colour, or the two mechanisms simultaneously* (Kaiser, 1984).

For autonomic nervous systems typically, the following techniques have been employed: electroencephalogram (EEG), galvanic skin response (GSR), skin conductance response (SCR), palmar conductance, respiration movement, blood pressure, and heart rate. Although a significant effect of colour on these autonomic systems (except heart rate) was found by Gerard (1958), a later study found that only for GSR was there a significant physiological effect of colour (Jacobs and Hustmyer, 1974). A review of the literature in 1984 revealed very little evidence that colour can affect heart rate or blood pressure (Kaiser, 1984). More recently, Spath (2011) did find a decrease in blood pressure and heart rate when participants relaxed in a pink room; however, the experiment was not controlled and it is possible that participants may have shown a similar reduction if they had relaxed in a white room, for example. The question of whether colour (and coloured light in particular) can induce physiological changes is therefore still open and this study addresses it.

2. METHOD

The study was conducted in a lighting laboratory at University of Leeds (UK). The room was equipped with controllable LED lighting. A personal colour environment was constructed using a pop-up photographic studio (see Figure 1) which was illuminated externally with lighting of one of four colours (white, red, green and blue). The light inside the environment was diffuse (apart from a patch that was behind where the participants sat) and was adjusted so that a measurement of the interior of the environment had a luminance of 4.21-4.27 cd/m². Note that this level was determined primarily by the blue-light condition which has low luminance even at the brightest setting. Since it was important

that each light was set to the same luminance the luminance of the blue light was a controlling factor.

A total of 42 participants took part in the study; 22 females and 20 males aged 21-35 years. No major medical or visual disabilities were detected. All subjects were run separately. The subjects were divided (randomly but balanced with approximately equal gender and nationality in each group) into three groups according to the three different coloured lights (red, green, and blue). Therefore, there were 14 participants for each colour condition.

Figure 1: The personal-colour environment in the four different conditions. Note that the computer was only present during pre-experimental measurements and was not in the environment during the actual experiments.

Each participant was first exposed to the white-light condition (control) and asked to complete an action-behaviour tendency (ACS-90) questionnaire (Kuhl, 1994) during which they became adapted to the light. The questionnaire results are not being considered in this paper. After completing the ACS-90 questionnaire each participant's blood pressure and pulse were measured. The colour of the light was changed (to either red, green or blue, depending which group they were in) and in order that the participants spent the same amount of time under each light, they were asked to complete a short logic test. On average participants spent about 20 minutes under each lighting condition and blood pressure and pulse rate were measured at the end of this period.

Different participants were exposed to red, blue and green light and therefore a direct comparison between the heart rates, for example, under the different lights cannot be carried out. Instead, in this work we consider the change in heart rate (and blood pressure) for each participant when they first adapted to white light and then adapted to a coloured light.

3. RESULTS AND DISCUSSION

Table 1 shows the pulse rate results and shows that, on average, there was an increase in pulse rate under the red light (compared with the white light) and a decrease under the green and blue lights. However, none of the differences were statistically significant ($p > 0.05$).

Table 2 shows the blood pressure results and shows that, on average, there was an increase in blood pressure (both systolic and diastolic) under the red light. However, none of the differences were statistically significant ($p > 0.1$).

PR		
red	green	blue
0	-9	0
2	-7	0
-5	-5	-3
-5	1	5
1	-6	-7
-4	-6	4
-1	-16	-4
7	0	-5
6	5	-3
7	8	2
-1	2	-4
7	2	8
-8	6	1
-1	1	0
0.3571	-1.7143	-0.4286

Table 1: The difference between the pulse rate measured under the test light and the control light is calculated for each participant. The mean differences for each of the three test lights are shown in the bottom row.

BP (Systolic)			BP (Diastolic)		
red	green	blue	red	green	blue
-6	10	1	-1	1	-5
-7	3	0	1	2	-4
7	-10	1	1	-5	-2
-7	0	4	-8	8	4
-5	-5	3	-6	-9	-1
-4	-1	2	-1	-2	-1
8	-12	-3	-1	-5	1
5	0	-5	2	0	-1
3	-16	-1	10	-1	0
-4	-4	9	6	12	8
11	-5	-5	8	3	-3
5	8	3	11	2	-26
2	-5	0	-5	0	2
23	10	-7	17	12	-10
2.2143	-1.9286	0.1429	2.4286	1.2857	-2.7143

Table 2: The difference between the blood pressure measured under the test light and the control light is calculated for each participant. The mean differences for each of the three test lights are shown in the bottom row. Data are shown for systolic and diastolic conditions.

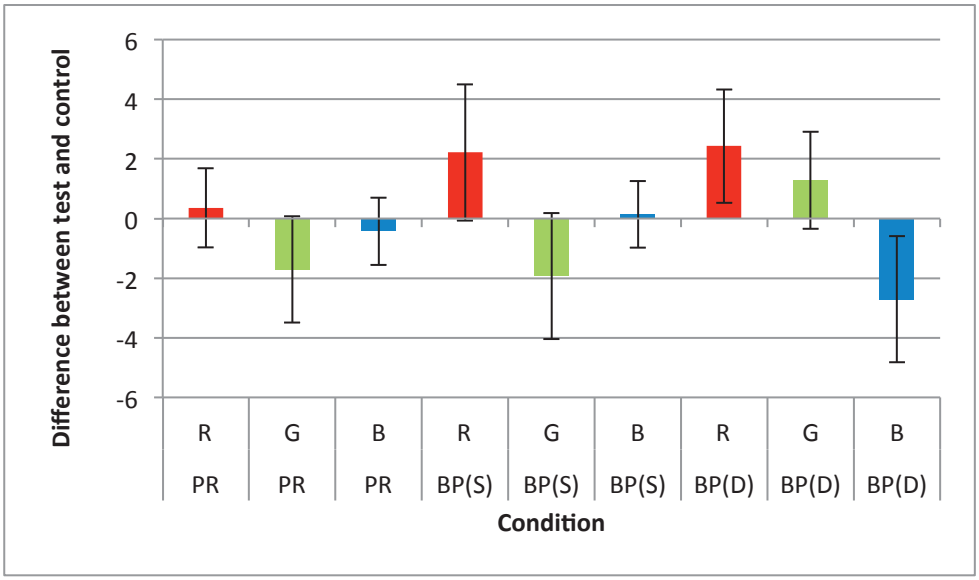

Figure 2: Summary of the physiological measurements. The mean differences in pulse rate PR, systolic blood pressure BP (S) and diastolic blood pressure BP (D) between the test and control light conditions are shown.

4. CONCLUSIONS

In this study, 42 participants took part in an experiment to explore the effect on their physiological response. Measurements were taken of blood pressure and pulse rate. When compared with the control condition (white light), the pulse rate increased under the red-light condition and decreased under the blue- and green-light conditions. The effects were not statistically significant, however; this is consistent with Jacobs and Hustmyer (1974) who found no effect of colour on heart rate.

When compared with the control condition, blood pressure (systolic and diastolic) increased under the red-light condition. However, there was no statistically significant effect of the test colour on blood-pressure change. This is consistent with Kaiser (1984) who noted that he had "unpublished data which show no differences in systolic blood pressure as a function of observers looking at grey, red, blue, green, or pink".

Despite anecdotal evidence that colour affects blood pressure and heart rate, in this study we find no statistically significant effect despite using colour environments that were very intense and likely to be far more colourful than the environment in most practical applications. However, it cannot be ruled out that in this study there were simply too few participants to find a significant effect since although there were 42 participants there were only 14 for each colour condition. The observation that red did increase blood pressure and pulse rate (although not significantly) is intriguing however and further work is probably needed with much greater numbers of participants to be able to make a robust and general conclusion. All that can be said is that, in this study, no effects were found. It seems likely, that even if a further study with more participants finds a significant effect then the effect may not be very meaningful since the magnitudes of the differences (even under the relatively extreme conditions used in this study) were quite small.

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