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INFLUENCE OF COLOUR ON VISUAL CONSPICUITY: TAKING SUBWAY ROUTE MAPS AS AN EXAMPLE

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Abstract

To investigate the influence of colour on visual conspicuity on subway route maps, two experiments were conducted in this study. Experiment 1 was the main experiment, aiming to develop a visual conspicuity model based on the experimental results. The experiment used coloured subway route maps as the stimuli, generated from a 15-route map designed by the research team, with the route colours varied for each test. During the experiment, each observer was asked to identify as fast as possible whether a target coloured route was present on that map, and the observer's reaction time was recorded for each test. The experimental results show that the larger colour difference between the target route and the other routes, the better visual conspicuity for the target. Experiment 2 was a verification test of this finding, showing a good predictive performance of the developed model in this study.

Keywords: visual search, conspicuity, reaction time, colour attributes, conspicuity model

1 Introduction

In a world of overloaded information, how to get the right one and make a right decision in a timely manner is an important issue in information tasks. If we can make the target stand out of the distractors, we can enhance the efficiency during such a task. Making the target information or a sign appear conspicuous can also help promote the information by attracting attention. But how do we make an object stand out? What are the underlying factors affecting visual conspicuity? To answer these questions, this study took subway route maps as an example to investigate the influence of colour on visual conspicuity.

2 Methods

Two experiments were conducted in this study. Experiment 1 was the main experiment, based on which a visual conspicuity model was developed as a function of colour difference. Experiment 2 was a verification test of this model.

Both experiments used coloured subway route maps as the stimuli, generated from a 15-route map designed by the research team, with the route colours varied for each test. During the experiment, each observer was asked to remember the target route (as shown in Figure1) and to identify as fast as possible whether a target coloured route was present on that map (as shown in Figure 2), and the observer's reaction time was recorded for each test. The reciprocal of the reaction time was used in this study as a measure of visual conspicuity as shown in Equation 1.

$$C = 1/t \tag{1}$$

where

C is the visual conspicuity;
t is the reaction time of the observers.

Figure 1 – Example of a target route for both experiments.

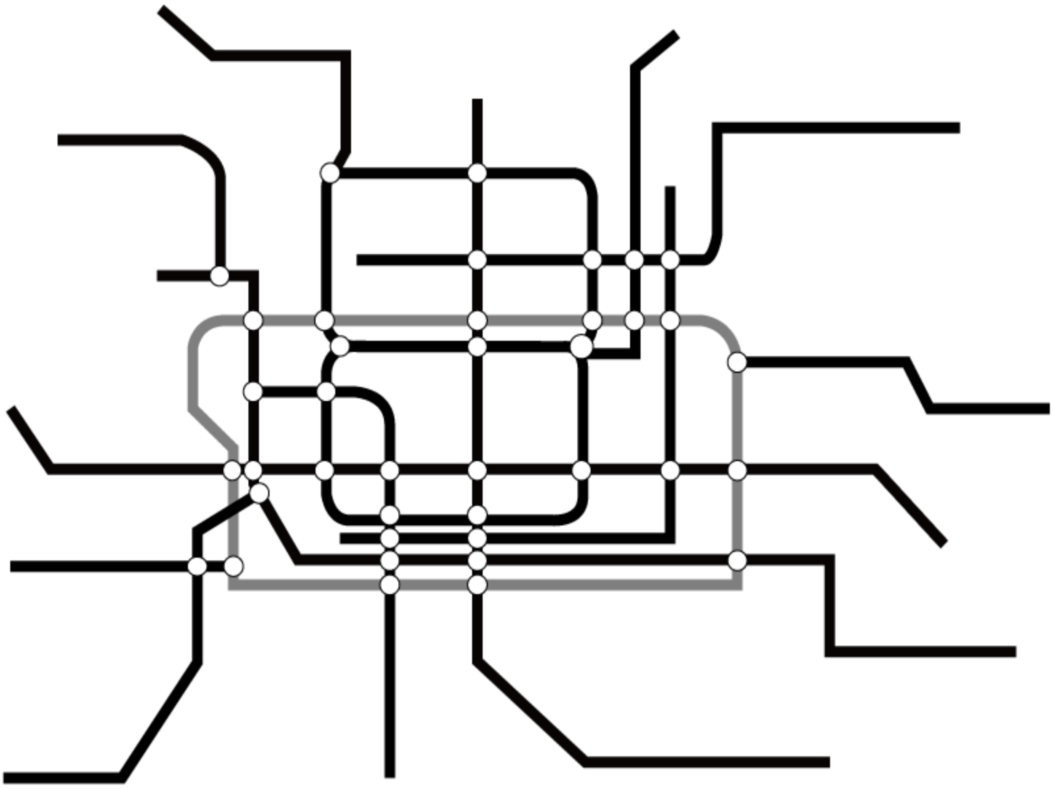

Figure 2 – Example of a subway route for both experiments.

Experiment 1 was divided into three parts. The first part used only achromatic colours, consisting of 5 levels of CIELAB lightness (including 10, 25, 40, 55 and 70), for the target route and the other 14 routes. This resulted in 100 test maps for the first part. The second part used 6 levels of chroma (including 15, 30, 45, 60, 75 and 85) for the 15 route colours, all having the same lightness value 50 and the same hue angle 20 degrees. All test maps had a white background. This resulted in 100 test maps for the second part of the experiment. The third part used 6 hue regions (including 165, 175, 185, 195, 205 and 215 degrees) for the 15 route colours, all having the same lightness value 50 and the same chroma value 60. This resulted in 100 test maps for the third part. In total, there were 300 test maps for Experiment 1. Note that half of the test maps contained the target coloured route, located randomly on each map, with the other 14 routes in various colours. The test maps were presented individually on a calibrated EIZO ColorEdge CX270 liquid-crystal display, 27 inches in size, situated in a darkened room, as shown in Figure 3. A total of 30 observers, including 15 males and 15 females, participated in this experiment.

Figure 3 – The indoor experimental site for Experiment 1 and Experiment 2.

From results of Experiment 1, a visual conspicuity model was developed. To test this model, Experiment 2 was conducted using a different set of colours for routes on the same subway map. Unlike Experiment 1, the 3 colour appearance attributes, lightness, chroma and hue angle, all varied for the routes of each map. The colour samples included 11 levels of lightness (including 10, 15, 20, 30, 40, 50, 60, 70, 75, 80 and 85), 9 levels of chroma (including 10, 15, 20, 40, 60, 70, 75, 80 and 85) and 17 hue regions (including 0, 40, 80, 85, 105, 125, 130, 140, 145, 165, 180, 195, 225, 230, 255, 280, and 285 degrees). An example of the test subway routes is shown in Figure 4. A total of 157 test maps were used for each observer in Experiment 2. The visual conditions of Experiment 2 were the same as those in Experiment 1. A panel of 30 observers, including 15 males and 15 females, participated in Experiment 2.

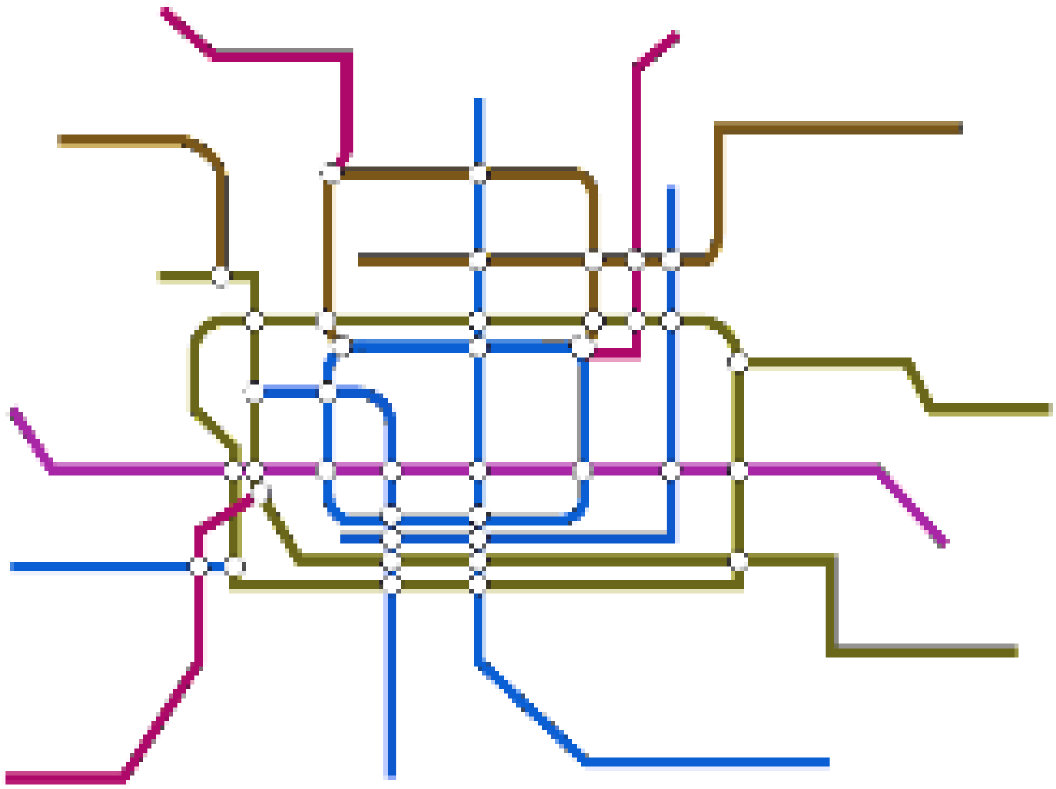

Figure 4 – The subway route for Experiment 2.

3 Results

Results of Experiment 1 show that the visual conspicuity was a function of colour difference between the colour of the target route and the colours of the other routes, i.e. the larger colour difference between the target route and the other routes, the more visually conspicuous it is for the target route. Figure 7 is under 95 confidence interval, the differences in brightness and observers reaction time between target route and interferer. Figure 8 is under 95 confidence interval, the differences in chroma and observers reaction time between target route and interferer. Figure 9 is under 95 confidence interval, the differences in hue angle and observers reaction time between target route and interferer. The black point in the figure 7(a)、8(a)、9(a) is the average reaction time of 30 observers and error bars is the 95% confidence interval of the observer’s reaction time. The black point in the figure 7(b)、8(b)、9(b) is the average visual conspicuity of 30 observers and error bars is the 95% confidence interval of the observer’s visual conspicuity. The horizontal axis is the colour difference between the target route and the distractors.

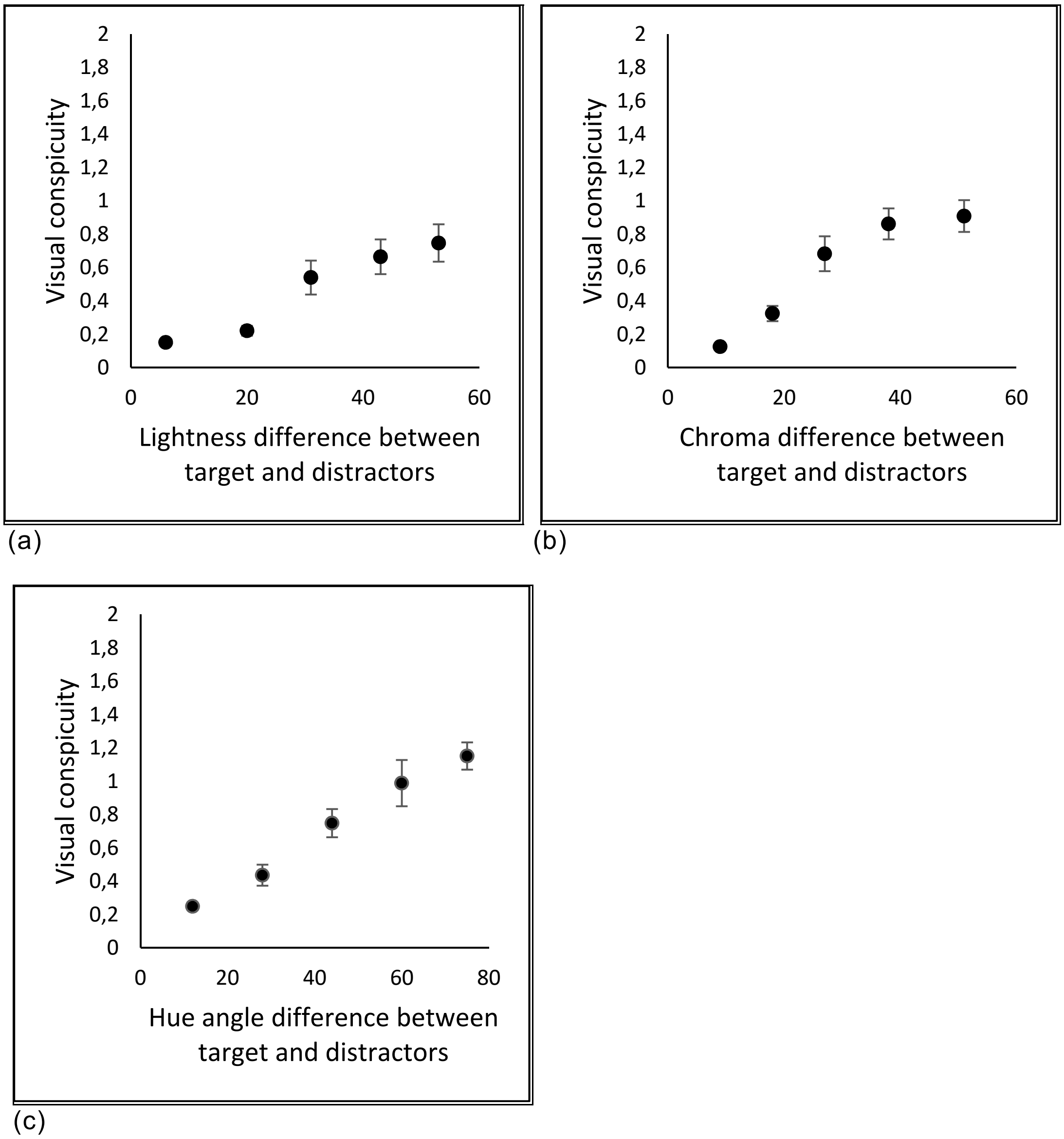

Figure 7 – Experiment 1: the visual conspicuity plotted against (a) lightness difference, (b) chroma difference and (c) hue angle difference between target route and distractors. The error bars indicate 95% confidence interval.

Experiment 2 aimed to verify the visual conspicuity model developed from Experiment 1, and the results show high predictive performance of the model, with a correlation coefficient of 0.87, as shown in Figure 8. The conspicuity model of Experiment 2 shown in equation 2. Note that in Experiment 1, the route colours varying only in one colour appearance attribute for each test map, i.e. either lightness, chroma or hue angle was varied for each test. In Experiment 2, however, the route colours varied in all of the three colour appearance attributes for each test. Thus, the good test result of Experiment 2 shows real robustness of the model.

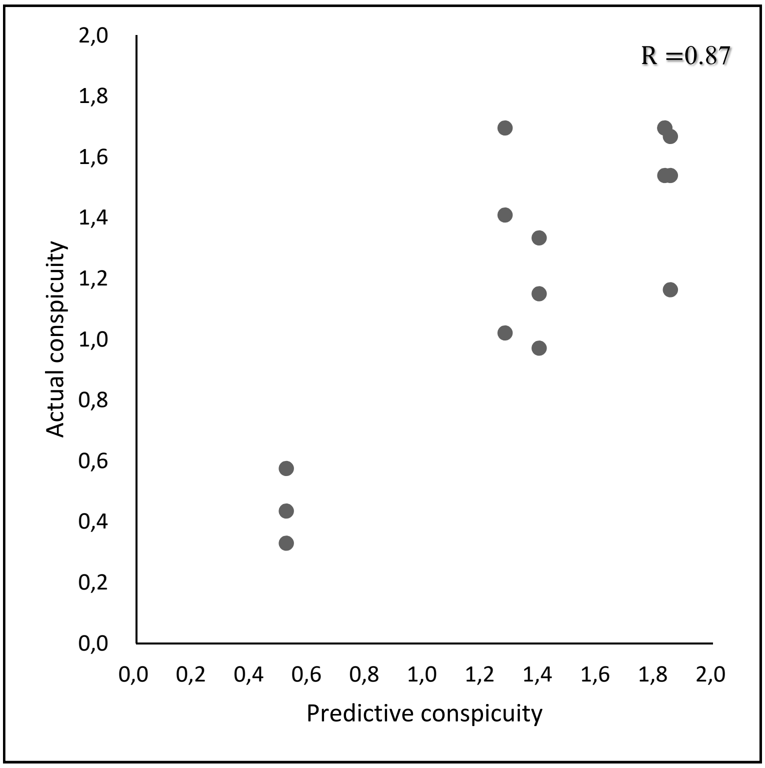

Figure 8 – Experiment 2: test result of the predictive model developed in Experiment 1.

4 Conclusion

Two psychophysical experiments were conducted to investigate the influence of colour on visual conspicuity on subway route maps. The experimental results show that the larger colour difference between the target route and the other routes, the better visual conspicuity for the target. Findings of this study can help develop design guidelines for colour usage to improve visual conspicuity.

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