Effects of combining color and speed on observer's impression formation in viewing motion pictures

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We investigated how combining color and speed of visual stimuli influence observer's impression formation. Our stimuli were motion pictures consisted of 20 circles presented on a CRT display at 50 cm from the observer. In each trial, circles (diameter 3 cm) moved from left to right for 3 seconds with a constant velocity of 0 (fixed), 10, or 100 mm/s. The color of the moving circles was white, red, blue, green, or yellow, and the background was black. We investigated 20 observers' impressions by the use of semantic differential technique. A factor analysis on the results of the experiment extracted three factors: evaluation, eye-catching, and activity. For the activity factor, the observers' impression changed from inactive to active as the speed increased. Furthermore, we found that the colors influenced observer's impression related to activity.

***Key words**: Motion picture, color, Speed, Impression, Activity*

Introduction

We investigated how combining color and speed for visual stimuli influence observer's impression formation. In designing a motion picture, designers have tried to transmit some intended messages to observers. For this purpose, designers have applied various techniques. For example, in television commercials, a luxury sedan often cruises from right to the left. Observers receive impressions of orthodoxy and profundity from such an image (Tokunaga, 1993). However, a lot of those techniques are derived from each designer's personal experience. There have been few studies about those personal techniques with scientific procedures of the motion (Kinoshita, Ichikawa, & Mizukami, 2002). In order to establish the valid and reliable techniques for motion pictures to give intended impressions to viewers, scientific examination would be effective. In this study, we aimed to obtain experimental data that would be a basis for such a scientific examination to establish the techniques to effectively manipulate the impressions from viewing motion pictures. In the first experiment (Experiment 1.), we investigate how the impression as to the motion picture varies with color and speed of the moving objects by the use of SD (semantic differential) method. The second experiment (Experiment 2.) picked up the impression concerning activity, and investigated velocity dependence of the activity impression. Especially, difference of colors brought different impression on activity depending on the speed of the moving circle.

Experiment 1

Stimulus and apparatus

Stimuli were presented by the use of a CRT display (17 inch, NANAO, T566). The vertical scan frequency was 85Hz. The viewing distance was about 50 cm. The resolution was 1024× 768 pixels.

In each trial, circles (diameter 3 cm) moved from left to right for 3 seconds with a constant velocity of 0 mm/s (fixed), 10 mm/s (visual angle: 1.2 deg/s), or 100 mm/s (11.6 deg/s). The color of the moving circles was white (128 cd/m²), red (24.8 cd/m²), blue (15.9 cd/m²), green (97.5 cd/m²), or yellow (122 cd/m²), and the background was black (0.33 cd/m²).

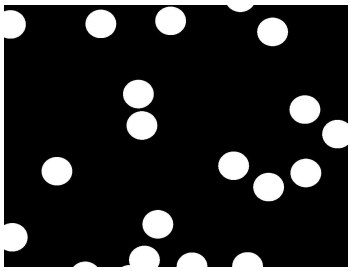

Fig. 1. Example of the stimuli used in each experiment. 20 circles are put on a black background at random.

Observer

Twenty observers (10 males and 10 females) ranging in age from 20 to 35 years participated in this experiment. The average age was 23.4 years old. All of them had normal or corrected to normal visual acuity.

Procedure

Observers evaluated impressions of the motion picture about 11 adjectives to seven grades. 11 adjectives were chosen from adjectives usually used at the SD method.

Result

A factor analysis (principal factor analysis, varimax rotation) on the results of the experiment extracted three factors: evaluation (eigenvalue was 3.4, and contribution was 27.0 %), eye-catching (eigenvalue was 2.6, and contribution was 20.0 %), and activity (eigenvalue was 1.3, and contribution was 8.3 %).

For the evaluation (Fig. 2) and eye-catching factors (Fig. 3), we found no significant differences in factor scores in accordance with the speed conditions, while we found that the colors influenced observer's impression related to these factors. That is, the factor scores of evaluation and eye-catching for the red color condition were respectively lower, and higher than those for the other color conditions.

For the activity factor, we found a significant difference in factor scores between the speed conditions of 10 and 100 mm/s in terms of Analysis of Variance and HSD test. That is, the observers' impression changed from inactive to active as the speed increased. Furthermore, we found that the colors influenced observer's impression related to activity (Fig. 4): the factor scores for red and yellow were significantly higher than those for the other colors, and the score for blue was the lowest among the five color conditions.

These results suggested that the color, which would give observers active impression by itself, might change

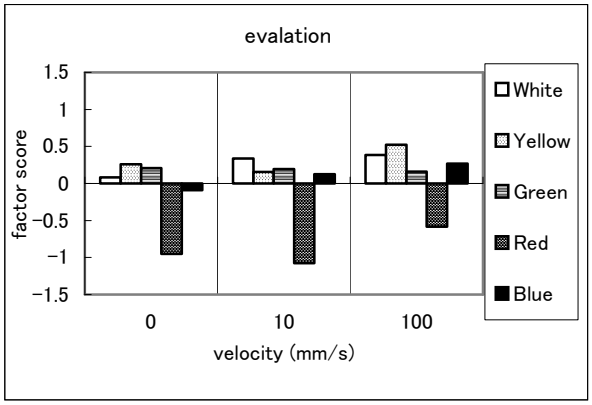

Fig. 2. Result of the factor analysis. No systematic change is found in factor scores of "evaluation".

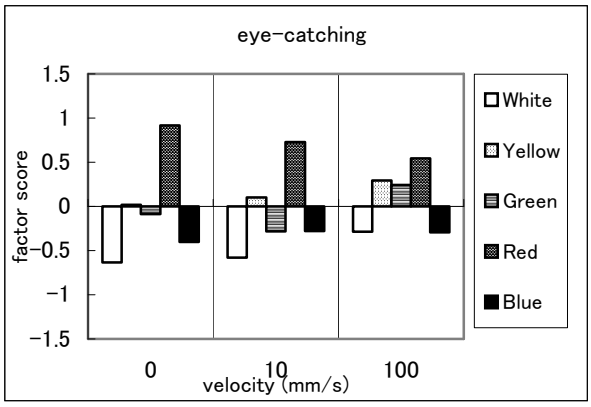

Fig. 3. Result of the factor analysis. No systematic change is found in factor scores of "eye-catching".

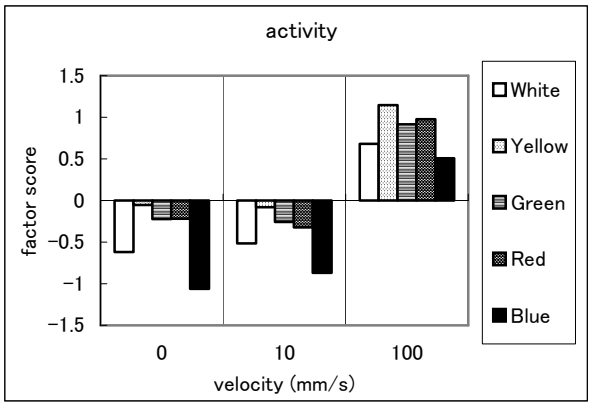

Fig. 4. Result of the factor analysis. Factor scores of "activity" change from minus to plus at a higher velocity region.

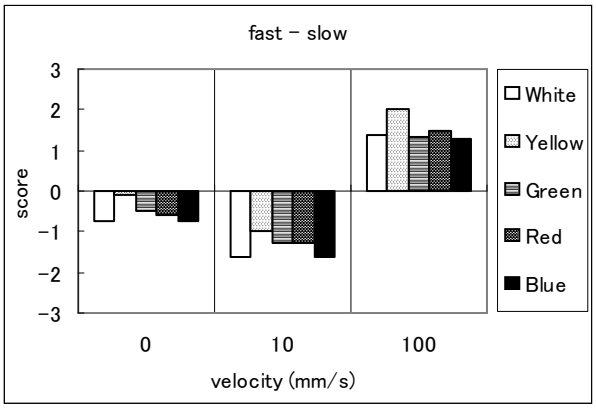

Fig. 5. Scores evaluated for the adjective of "fast–slow" in experiment 1.

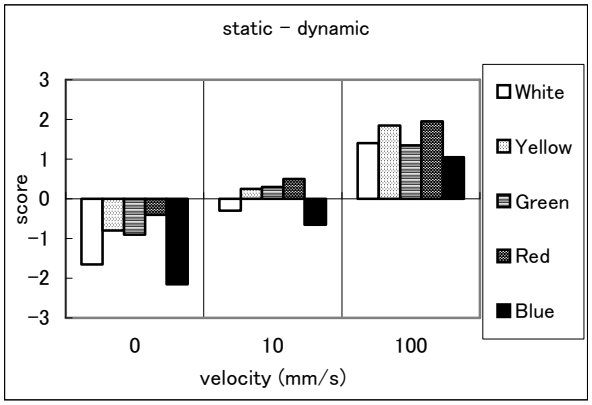

Fig. 6. Scores evaluated for the adjective of "static–dynamic" in experiment 1.

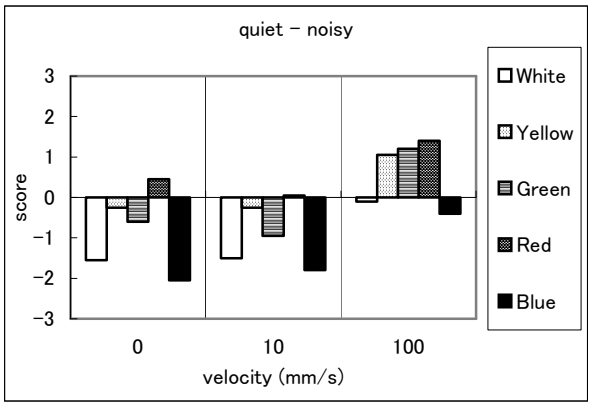

Fig. 7. Scores evaluated for the adjective of "quiet-noisy" in experiment 1.

the impression of the slowly moving objects from inactive to active without changing the impressions related to evaluation and eye-catching. However, because the setting of the speed condition was rough in experiment 1, it is not possible to conclude it.

Figures 5-7 show scores in respective adjectives-pairs representing activity impression with seven grades evaluations in Experiments 1.

Experiment 2

The second experiment was carried out according to the following questions.

1. At which speed the impression changes from inactive to active.
2. How is it different according to the color

Stimulus and apparatus

A display the same as experiment 1 was used. The viewing distance was 57.9 cm. The head position was stabilized by a chin rest.

In each trial, circles (diameter 3 cm) moved from left to right for 3 seconds with a constant velocity of 0 mm/s (fixed), 20 mm/s (visual angle: 2 deg/s), 40 mm/s (4deg/s), 80 mm/s (8 deg/s) or 160 mm/s (16 deg/s). The color was the same as those used in Experiment 1.

Observer

Twenty observers (10 males and 10 females) ranging in age from 19 to 27 years participated in this experiment. The average age was 23.0 years old. All of them had normal or corrected to normal visual acuity. It was nine people that participated in both experiments.

Procedure

Observers evaluated the impression of motion pictures about 11 adjectives to seven grades.

Result

Compared to blue and white, the other colors became active impressions from a slow speed (see Fig.8-10).

In "fast-slow" impression, all color's impression changed "slow" to "fast" when the speed was between 40 and 80 mm/s (Fig.8). An observer felt a little slowness even at 160 mm/s. In "dynamic–static" impression, yellow's impression changed static to dynamic when the speed was. Green and red's impression changed between 20 and 40 mm/s. Blue and white's impression changed between 40 and 80mm/s (Fig.9). In "noisy-quiet" impression, when the stimulus was fixed (0 mm/s), red's impression was a little noisy. When fixed, the other

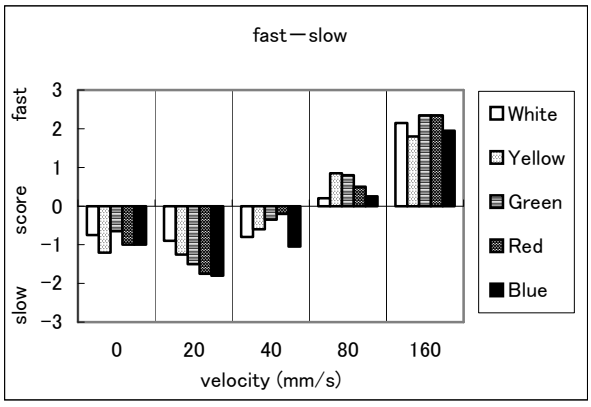

Fig. 8. Scores evaluated for the adjective-pairs of "fast–slow" in experiment 2.

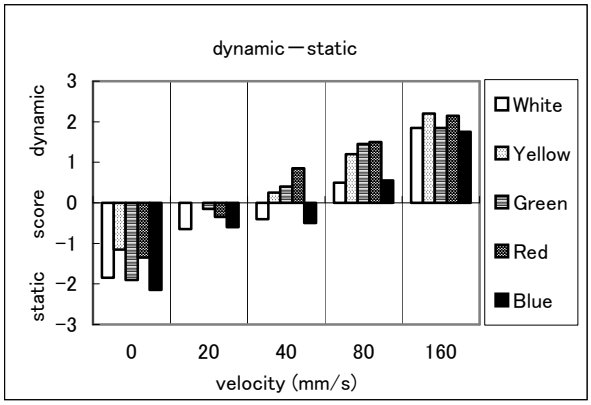

Fig. 9. Scores evaluated for the adjective-pairs of "dynamic–static" in experiment 2.

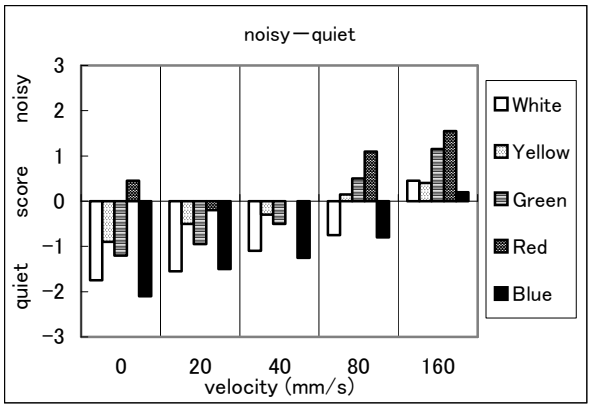

Fig. 10. Scores evaluated for the adjective-pairs of "noisy–quiet" in experiment 2.

colors yielded quiet impression, and when it moved fast, those impressions became noisy (Fig.10).

Discussion

The effects of stimulus brightness on the apparent speed has been investigated several psychophysical studies. For example, there is **the Pulfrich effect** (Anzai, Ohzawa & Freeman, 2001). The apparent speed for the bright objects tends to be faster than that for the dark object. However, this tendency depending on the brightness was not found in the results of present study. For example, white object shows inactive impression compared to the other colors. Since white has the highest brightness and the lowest saturation, not only brightness but also saturation may influence on the activity impression.

This research made clear the following points.

1. When a red object moves at the speed of 80 mm/s or more, everyone feel active impression.
2. When blue or white object moves fast, observers don't feel active impression compared to the other colors.

Consequently, designers may control active impression according to the above results. For more practical use, we have to clarify the change of observer's impressions caused by interaction between object color and background one. In this research, we restricted our experiment within two-dimensional motions of objects. It is interesting to carry out experiments with three-dimensional motions of objects.

References

Anzai, A., Ohzawa, I., Freeman, RD. (2001). Joint-encoding of motion and depth by visual cortical neurons: neural basis of the Pulfrich effect. *Nature Neurosci.* 4**:** 513-518.

Kinoshita, T., Ichikawa, M., & Mizukami, Y. (2002). How does the direction of stimulus movement affect observer in viewing 3D graphics? *VISION*, Vol.14, No.4, 143-149.

Tokunaga, Y. (1993). Visual communication (in Japanese), Structure of communication. NTT Publishing, 227.