Adaptation of humans to colored split-field glasses[1]

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Abstract

"Split-field" glasses, consisting of a red filter before the left half-field of each eye and a green filter before the right half-field, were worn by three observers. The colors in the glasses did not seem to diminish in saturation as Kohler (1951) has reported, even after as long as 146 days. A very small change in perceived color could be noticed as the gaze was moved back and forth from right to left without the glasses on, but this may have an explanation at the ocular level.

Problem

Kohler (1951) has reported that prolonged wearing of "split-field" glasses (tinted red to the left of the center of each lens and green to the right) results in conditional adaptation, such that the same retinal illumination may produce different sensations of hue, depending upon direction of gaze. We attempted to replicate the Kohler study in its essential aspects.

Method

"Split-field" glasses made from filters obtained from Kohler were worn almost continuously by three observers for 38, 103 and 146 days respectively. As the experiment progressed, tests were made without the glasses to determine whether perceived hue was becoming contingent upon eye position. Testing was done by having the observers vary the proportions of two lights, a red and a complementary green, until the resulting mixture looked white. A "situational" adaptation such as Kohler has reported would have required observers to become biased in their color mixing without the glasses, dependent upon whether the eyes were gazing left or right. For a white-appearing mixture, as time passed, more red should have been required when gazing left and more green when gazing right.

In the actual apparatus used, mixture was accomplished by passing white light through two filters in a movable mask. These were identical with the filters of the glasses. The resulting red and green lights entered the side of a lucite bar in which they mixed before illuminating a 1-in square of ground glass imbedded in black flock. The ground glass target served as stimulus to the observer. The arrangement was such that the color of the ground glass target could be continuously changed from red, through white, to green with no change in brightness.

The observer's task was to move the mask with a remotely controlled motor until the target appeared achromatic. Testing was carried out both in the light and in the dark for each of five different eye-head positions, at first daily or semi-weekly. As it became evident that no substantial changes of color perception were taking place, these tests were discontinued and the observers simply continued wearing the glasses.

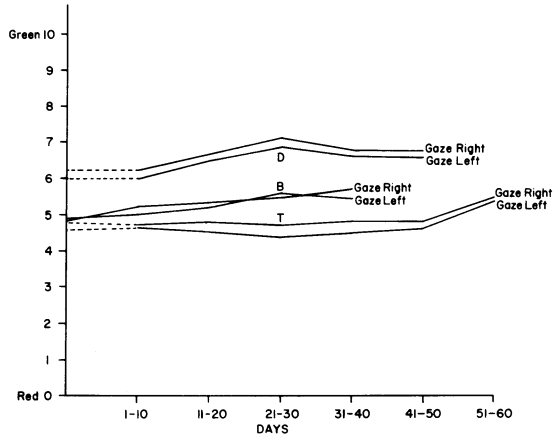

Fig. 1a. Color mixer settings judged neutral, averaged over blocks of ten sessions.

At the end of the experiment, before the glasses were removed permanently, an extensive battery of special tests was carried out on the 103- and the 146-day observers. One group of these tests was similar to the day-to-day measurements previously described, but included measurements made on each eye separately. The other group of tests was concerned with the observer's abilities to pair variously saturated red or green chips of paper viewed to one side of center with matching chips on the opposite side. Each step in the series of chips was about one tenth of a Munsell step.

Results and Discussion

The early color mixer data showed a tendency for observers to set the machine more and more toward the green extreme when asked to choose the setting that appeared achromatic (Fig. 1a). This was the only striking effect attributable to the glasses. The figure shows that as the days passed there was no increase in the difference between observers' achromatic points on the left and right sides. It may be seen that the testing situation itself contained a small bias (less than one j. n. d.). It is equally evident at the beginning and at the end; hence it did not result from wearing of the glasses.

Results of the final tests with the color mixer are shown in Fig. 1b. Again, aside from the small bias previously noted, no difference dependent on direction of gaze appears. Monocular mixing performance on

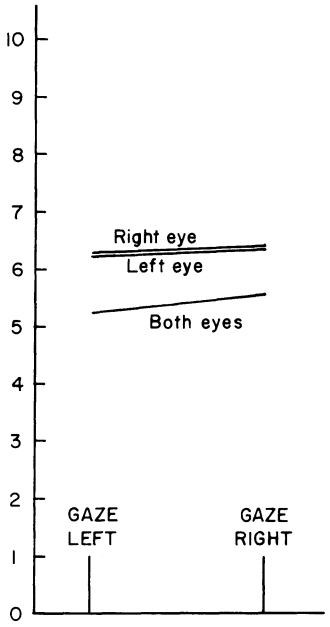

Fig. 1b. Final tests on the color mixer. Thirty two observations per point. Averaged over 103- and 146-day observers.

these tests proved to be independent of the eye used, although observers were relatively more sensitive to red when using either eye singly. The latter result is probably an artifact of the testing procedure.

Tests with the chips were similarly negative (Fig. 1c). Again, a very small bias was apparently present in the testing situation, but since it intrudes itself into data collected 90 days after the glasses had been removed and also shows up in data from a normal observer, it

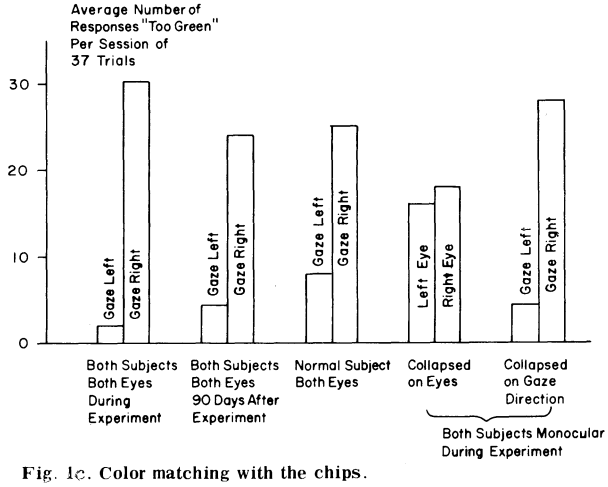

Fig. 1c. Color matching with the chips.

probably pertains to some asymmetry of the lighting in the room.

Subjective reports were almost equally negative. However, sometimes a small hue-like difference was reported when certain objects were viewed to one side of center vs. the other with the glasses removed. These objects, upon extremely close inspection, did seem somewhat more "reddish" when viewed to the observer's right. In general, neutrally colored, well-textured objects were best for viewing this effect. Even under good conditions, the after-effect was so small that an observer not looking for it would be unlikely to notice it.

Viewing with either eye singly, the 146-day observer was unable to detect any gaze-direction effect. The 103-day observer reported an effect that was about half as strong monocularly as it was binocularly.

The two long-term observers reported that a difference, similar in quality to the gaze-direction difference, could be observed by simply closing one eye, then the other. Vision through the right eye was slightly tinged with red, through the left eye with green. This effect extended over the entire field, however, and was independent of the direction of gaze. The 146-day observer's interocular difference was reported to be as strong as his gaze-direction difference. The 103-day observer thought the eye difference about half as strong.

In contrast with Kohler's observers, the observers here were not able to report that the colors of the glasses became less imposing as the months went by. The world remained red on one side and green on the other when the glasses were being worn.

So small was the gaze-dependent after-effect from the glasses that we are strongly inclined toward a non-psychological explanation for it. In view of the comparatively large changes in retinal stimulation caused by eye movements, e.g., changes of entopic light due to shadows and reflections from the nose, changes in light passing through the sclera, and ocular pressure changes, an effect as small as the gaze-direction difference discussed here is virtually uninterpretable psychologically.

Reference

Kohler, Ivo. Ueber Aufbau und Wandlungen der Wahrnehmungswelt. *Wien:* Rudolph Rohrer, 1951.

Notes

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