

COLOR CONTRAST.

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At the recent meeting of the National Academy of Sciences, Professor Rood gave some account of the experiments on color contrast now in progress at Columbia College. Previous experiments have been altogether qualitative; the present ones are the first quantitative experiments ever undertaken.

Colors of all objects are altered by their surroundings. An instance cited was that of a house which the Professor supposed to be of an orange yellow brown color, until he saw it in winter, when it was evident that there was not a particle of red in the color. The apparent red was caused by contrast with the green grass.

There are two kinds of contrast, simultaneous and successive. These investigations were of simultaneous contrast, which is very difficult. Successive contrast would be still more so, on account of the inability of the memory to recall slight shades of color.

The investigation was conducted by causing colored disks to revolve in such a way as to blend the colors.

The simplest case is that of uniform color all around the circle, as in the case of a disk of green surrounded with a gray ring, and that again with another green ring, Fig. 1.

The interposed gray appears rosy by contrast with the green.

In order to measure the intensity of the apparent redness of the gray ring, two methods were adopted—first by comparing it with a revolving disk of the color complementary of the green, but partly covered with black and white, and varying the amount of the disk thus covered till the color appeared to be of the same intensity as that of the gray ring, Fig. 2.

The second method of measuring was by extinguishing the induced red by partly covering with green, Fig. 3.

Still another method resorted to was copying.

The degree of lightness of the gray disk is not material unless it is made very dark indeed.

It is found that the induced sensation produced by a red disk is extinguished by 8 per cent of the complementary green; that of a green disk, however, requires 33 per cent of the complementary red; and that of a blue disk, 50 per cent of the complementary yellow. No reason is known for this physiological effect.

It is found also that in passing from the red to the violet end of the spectrum, the induced colors vary more and more from the true complementary.

With a green disk, the induced color appears more pink than the complementary; and with a blue disk, the induced color differs widely from the true complementary.

If the coefficient of a red disk be taken as 1, that of the emerald green disk which just balances it and produces white light is 1.7, Fig. 4.

Green when darkened looks bluish; but if you diminish the brightness more than one-half, you only diminish the subjective effect one-third.

With blue, one-third the brightness produces fully one-half the subjective effect. Bluish colors are more effective than others subjectively.

A more difficult problem is to find the most neutral point in comparing colors not strictly complementary, as in the case of emerald green and vermilion. In this combination the most neutral tint is not gray, but yellow. To illustrate this combination of colors, an inner disk of black and white may be introduced, Fig. 5.

In order to aid the memory, an inner disk may be used of the same colors as the outer ring, which is set at the point of the previous experiments, while the outer ring is slid a little one way or the other till the vertical point is reached, Fig. 6.

It should be understood that in all these experiments, the disks are compounded of two capable of sliding one above the other, so as to expose a greater or a less proportion of each color, the individual colored disks having each a slit, which enables them to be adjusted; each color covering a disk of this construction, Fig. 7.

The second part of the investigation was to ascertain the quality of colors that are not true complementaries.

Two colors, A and B, were taken, nearly, but not absolutely, complementary, A being used as the standard.

The value of B having been determined, as in the first experiments, it was combined with a third color, C, which was a little further up the spectrum than A. C would be combined with D, which was still a little further from the starting point. Thus all the colors of the spectrum were compared through a gradation of fifty colors. This is an entirely new process.

As a result of these and other experiments, he claims that Newton's diagram of colors should be arranged in



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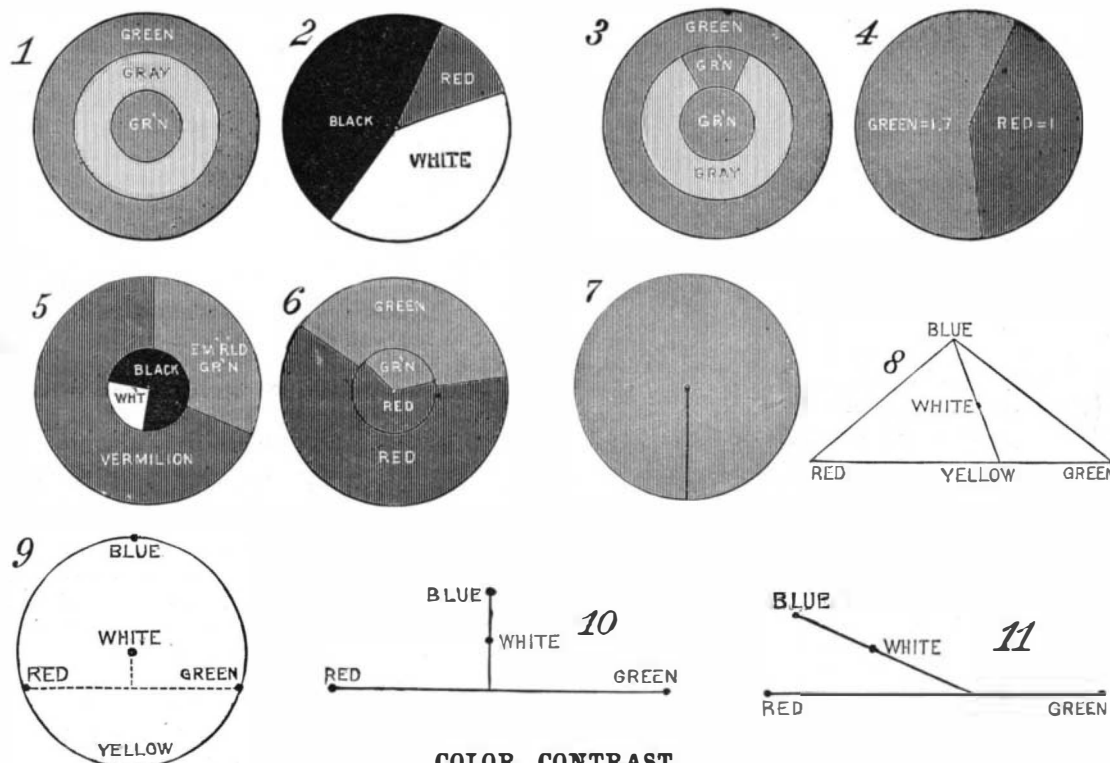
a circle, not in straight lines, as Newton had it. Instead of Fig. 8, we have Fig. 9.

White occupies the center of the circle, and lies on a line drawn at right angles to the palest tint. Some of the experiments in corroboration of this are of the following nature:

Let the three fundamental colors be supposed to represent weights at the end of a system of bars, Fig. 10.

Then white represents the center of gravity. If the system were arranged as follows, with the blue off at one side, white would still represent the center of gravity; but the amount of blue necessary to counterpoise the system would be much greater, Fig. 11.

Experiment shows, however, that the amount of blue



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required to neutralize the others is a minimum, which proves that the blue is on a line at right angles to the line forming red and green.

GERMANY has eight schools of forestry, where five years' training is required of those who seek positions under the Government, although a course of study half as long may be taken by amateurs. France supports a single school at Nancy.

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T. O'CONNOR SLOANE, PH.D.

Many of our readers have tried the old time classic experiments with solutions of different metallic salts, in which tin trees, lead trees, or silver trees were produced. A bar of zinc suspended in a dilute solution of acetate of lead precipitates metallic lead very beautifully, producing the effect of an inverted tree. This was the *Arbor Saturni*, or Saturn's tree of the old school. A silver tree is produced by an analogous method, and was called *Arbor Diana*, or Diana's tree. By the battery, aborescent growths of metal may be produced on an electrode, which, exhibited in the magic lantern especially, produce very striking effects.

By the use of silicate of soda, chemical precipitations can be brought about that still more closely resemble vegetation, in some cases corresponding in color with their model. Crystals of metallic salts immersed in a moderately dilute solution of this silicate, or water glass, as it is often called, send out shoots of precipitates varying from stalagmitic formations to the finest threads. Each of the available salts produces a highly characteristic appearance. In some cases the resemblance to the lower forms of plant life is remarkable.

Silicate of soda is made by combining silica with soda. Some form of silica is heated under pressure in a solution of caustic soda, when combination takes place, and a thick solution is obtained.

It is thus prepared in large quantities for commercial use, and can be purchased by the experimenter cheaper than he can make it. In composition it is precisely analogous to glass, but is soluble to almost any extent in water. Notwithstanding this, when once in the solid condition, its solution is only effected with difficulty. This gives it a certain value as a cement. Broken glass and china can be mended by it quite satisfactorily.

As sold, it is a very thick fluid, resembling strong starch solution. For the experiment in question, it must be diluted. A clear glass bottle or any suitable vessel may be used. It is about one-third filled with silicate of soda solution, and the remainder is filled with water. By shaking and stirring, the two must be mixed perfectly. In doing this, a good opportunity is afforded for observing the action of a liquid of low diffusive power. The silicate solution mixes with much difficulty with the water, gathering into a lump or drawing out into threads. It gives a good illustration of the difficulty we should be placed in, were there no power of diffusion in liquids. Without this power to help us, it would require a long time and prolonged stirring to mix a cup of tea or coffee containing sugar and milk.

When the silicate solution has been thus diluted and mixed, a layer of sand, half or a quarter of an inch thick, is introduced into the bottle. It is best to pour it through a wide tube, reaching nearly to the bottom to avoid discoloration of the fluid. Then crystals of different salts are embedded in the sand. The object of the sand is to hold the crystals in place. It plays no active part in the experiment. The crystals must not be covered with it. Sulphate of alumina, potash alum, protosulphate of iron, or "copperas," sulphate of copper, or "blue vitriol," are good salts to start with. Clear crystals, the size of a pea, should be selected, dropped into the bottle, and by a rod pressed down into the sand until half embedded.

The bottle is then put aside in a quiet place, where it will not be shaken. In a few hours the crystals will begin to sprout to a perceptible extent. The finest possible green filaments, resembling seaweed, will start up from the iron crystals in a nearly vertical direction. More slowly, similar filaments appear with the copper crystals as nuclei, while the alum sends up a most characteristic growth of pure white stalagmites. These three forms are represented in the cut. They can be identified by the description. The iron growth is greenish; the copper, light blue.

A curious difference in rapidity of growth will next be observed. The iron in the course of a few hours will have sent up its filaments several inches, while the copper and alum will be much more gradual in their progress. After a while the iron filaments reach the surface, and another phenomenon shows itself. Where each filament touches the surface, it spreads out, and, as the iron oxidizes, loses its green color. After a while, it becomes too large for the floatative powers of the solution, and sinks until