

## COLOR AND AN EYE TO DISCERN IT.

PROF. A. H. MUNSELL.

### OUTLINE OF THE DISCUSSION.

#### *Introduction.*

- 1—Complex nature of our color sense.
- 2—Eye creates color; pigments are its servants.
- 3—Color blindness; its help in the study of normal color vision.
- 4—Retinal response to red, green and violet (purple), blue.
- 5—Yellow is not primary, but retinal union of red and green.
- 6—Peculiarities of pigment absorption and reflection.
- 7—Color education follows a false tradition.
  - Should be based on scientific color measurement.
  - Brewster's false theory based on pigments.
  - Pigments variable, only relatively stable under best conditions.
  - Some other standard necessary.
- 8—Instruments to measure pigment colors.
  - Three scales necessary: Hue, value and chroma.
- 9—An *Atlas of Color*—To define and relate all colors.
  - A Color Tree*—To erect a clear mental image.
  - To name, match, record and memorize colors.
- 10—Tempered color (not extremes), the basis of beauty.
  - Picturesque color, a special field, not for ordinary students.
  - Discipline of the color judgment needed for daily use.

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#### *Mr. President and Fellow Teachers:*

When asked his impressions of a noted forest, a young traveller replied it had been impossible to see the forest because there were too many trees. That is somewhat the difficulty in discussing color. There are so many points of view, such diversity of aim, the very act of perceiving color is so complex, and the terms used to describe the sensation are so loose, that instead of reaching its essence we are lost in a tangle of externals.

Now your President has invited me to present a paper looking toward the standardization of color, so as to concentrate discussion upon something definite. But words are weak expressions for color. William Hunt said he would as soon eat a recipe for mince pie, as to read the description of a painting, while one of my pupils in anatomy defined the lower jaw as the "implement of mystification." But I shall try to avoid such mystification,—although using words,—by placing the colors themselves before your eye.

Here are three colors familiar to every child: Red, yellow and blue. Brewster *assumed* these colors to be primary, and although the error was exposed by Clerk-Maxwell half a century ago, it is still a popular notion among artists and educators. Upon this wrong assumption Brewster reared a vague theory of color beauty—vicious because it misleads the beginner and vain because it leaves the elements of beauty in doubt. A fine colorist soon puts it aside since it is based on the uncertain action of pigments and quite ignores the essential action of the eye. *The eye is master, and paints are but agents to work its will.* Let us first, therefore, inquire how the retina reacts to light, and then consider how pigments satisfy its requirements. To those who have always thought in terms of pigment, that may seem like putting the cart before the horse. Not a few in the audience are now somewhat prepared for this inversion, but when it was disclosed at the joint meeting in Cleveland five years ago, it appeared so strange, so revolutionary, that the discussion filled an entire afternoon. Some misconceptions were natural; some opposition to be expected. An old tradition dies hard even when its error is acknowledged, and since this old pigment theory contained some grains of practical truth, the task of separating them required patient and careful work.

Those misconceptions are fading; even careless readers of the book\* no longer say that the system omits orange, because it is given a more appropriate name. They find that the system includes and arranges all color sensations on a measured foundation, even providing for still stronger colors, should science discover them. *Such measures refute the old blunders as to primary and secondary hues and establish the true complements of color, as created by the eye.*

A psychologic doubt as to whether the child's eye responds to fine degrees of color stimulation has also disappeared. *It is now seen that to begin the study with tempered degrees, rather than with extremes of color, is educational wisdom.* The samples spread before you, prove that a child trained by moderate degrees of color strength and color light will not flounder about in ugly color; but gradually learn to manage even the strongest pigments with skill.

On the scientific side, this measured color system has not been discredited, as would be the case with a narrow personal scheme; but

accepted as logical measure, false tradition, image of all colors.

It is in use at universities, in schools, in industries where color

\* "A Color Notation"  
"Atlas of the Museum of Art"

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accepted as logical, impersonal and accurate. It replaces guesswork by  
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image of all colors with their relations.

It is in use at Harvard, Columbia, Clark and Washington Uni-  
versities, in schools of Art and Technology, in Normal Schools, and in  
industries where color plays an important part.

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\* "A Color Notation." A. H. Munsell, Boston, 1907; G. H. Ellis Co.  
"Atlas of the Munsell Color System." Boston, 1907; Wadsworth, Howland Co.

#### ALL EYES DO NOT SEE COLOR ALIKE.

Even the right and left eye of the same individual may not agree,  
while that which is visible to one person may be invisible to another,—  
or, if visible, convey quite a different sensation of luminosity and hue.  
For instance, a Brooklyn man who lunched at home,—looking at his  
wife with that solicitude which marks the newly wed,—said: "My dear,  
is that a blood spot; have you bitten your lip?" Now, she had been  
eating spinach, and when he carefully touched the supposed blood spot  
with his napkin, she exclaimed: "Why, that's not blood; it's spinach,"  
and so they learned what neither had before suspected, that he was  
partially color blind. I have also met a man who cannot find a red  
polo ball in the grass until its shape is emphasized by sunlight and shadow.

There are many lesser degrees of this deficiency of color perception,  
and one might say that individuals varied as much in color discrimina-  
tion, as they do in discrimination of sounds and odors. There is an  
average or normal sensitiveness to color (a study of abnormal cases  
having been of the utmost value in defining the process)—and beside color  
blindness there is color ignorance.

The loose terms applied to colors cause much misunderstanding;  
what one calls blue, another thinks to be purple-blue or green-blue. Many  
allusions to other objects appear, such as baby-blue, sky-blue, king's blue,  
queen's blue, blue "being born" and blue "dying," as attempts to define  
a particular sensation. Thus, the popularly accepted blue pigment—arti-  
ficial ultramarine,—is not typical, but of a distinctly purplish hue, and  
quite removed from cyan-blue which is typical.

The notion of typical red varies with almost every person examined.  
The common effort to define a "shade of red" by two qualities, ignoring  
the third and most subtle quality,—*chroma*,—makes agreement well nigh  
impossible.

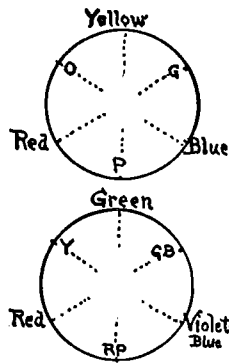
As a student, I was told that three parts of yellow, five parts of red  
and eight parts of blue, made harmony, although the formula failed  
to define what sort of red, yellow and blue would harmonize. Using  
the pigments in my box to illustrate this formula, resulted in a great

excess of hot color (which painters term "foxy") and the eye rebelled at a lack of balancing green-blue. Luckily, Professor Rood's book fell into my hands in 1879, and furnished a true theory of color balance. It is hardly to be wondered at that my respect for those who had taught the old blunder fell near to the zero point.

Now, leaving pigments for the present, let us consider the mechanism of the eye.

The eye is a marvelous instrument. The brain spreads out its optic nerve over the back of the eye in a network lodging millions of sensitive nerve ends, and translates the vibrations of ether into all the endless colors we recognize. It is supposed to be a photo-chemical process, to explore which would lead us far afield in physiology and psychology.

For our purpose it is enough to say that the retina reacts to three simple elements, or color sensations, which are called *fundamental*—not as popularly supposed, the red, yellow and blue—but *red, green and violet blue*. Mixtures of these three elements clothe this otherwise colorless world with ever varying hues. Fatigue one element by an excess, and it falls asleep or dozes, while the remaining two elements unite to make its complement, until recovering from fatigue, the first joins the action of its fellows and a balance of red, green and violet blue is restored. This condition of normal balance is the source of visual contentment. Color combinations, which preserve it, we call "beautiful, harmonious, soft, rich," etc. Annoy the eye by disturbing this balance and we exclaim "how ugly!"



That the eye is determined upon approximate balance of these red, green and purple-blue elements is easily proven by staring for half a minute at the setting sun or a red Bengal light. Then suddenly close the lids and there comes in the darkness a *vivid blue-green image*, for the red element is fatigued to the point of exhaustion, and the two remaining elements, green and purple-blue, are free to create this complementary after-image. \*Dr. Ayers tells of a mother who was sewing on a scarlet gown held in the sunlight. Glancing up at her baby, she shrieked, believing it was dying, for its face looked corpse-like to eyes unable to see any red. Had the gown been of vivid green she might have thought her baby strangling, since fatigue of the green nerves leaves red and purple-blue free, and they unite to give purple-red until the green nerves recover. Fatigue of the purple-blue element leaves red and green free to act, and their union—strange as it seems—is *yellow*. That the sensation of yellow results when the eye receives both red

and green sensations every degree of to certain proportions.

\*Color blindness

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and green sensations is easily shown with a controlled spectrum; indeed, every degree of red-yellow (orange), yellow and green-yellow, is due to certain proportions of red and green.

\*Color blindness, *Century Magazine*, April, 1907.

You may find it hard to believe that a little green added to red gives the sense of yellow-red (orange), while more green produces full yellow. But this is a well established fact of healthy vision, and were there time I could give some interesting cases of color blinds to whose abnormal eyes our brilliant yellows are colorless white since they perceive neither red nor green. \*Later we shall learn why palette mixture of colors does not imitate visual action because of irregular absorptions and reflections.

Now, perhaps you reject the verdict of science. You say a colorist is born, not educated, and that any reference to science is a waste of time. But let me ask "how many children are born colorists?" Have you found one among thirty, or even in a hundred? Science is but an extraordinary degree of common sense—a clear understanding of limitations—and in musical education it establishes the measured basis of success. We do not give the child an untuned piano, and we should not give him untuned colors. Just as the established musical scale is fixed in the memory, so an accurately tuned color sequence should be kept before the eye until it becomes a subconscious basis for comparisons. The present unrelated pigments fail to do this .

Whatever pigments or other stimuli we use, the eye demands approximate balance and resents unbalance in proportion to the effort it makes to regain equilibrium. This explains our aversion to the gaudy billboard, which assaults the retina with a chromatic shriek. Its only excuse is that of the circus, the auctioneer and the crying baby—to disturb our equanimity and attract attention.

Nature presents us with brief and brilliant sunsets, but also with long, gray days, with blazing noons, but also with soft twilights; contrasts brilliant flowers in small masses with great expanses of atmospheric hue, and while playing endless variations in spring, summer, autumn and winter, she carefully preserves a balance of light and color.

*Education seems unable to take this hint* of color balance. Froebel balls and the three-color box usually given at the outset are unbalanced, both in strength and luminosity: they start the child at his most impressionable age with false notions and a crude disregard of balance. We carefully protect the body from extremes of heat and cold, the ear from extremes of sound, and although avoiding extreme colors ourselves, except for danger signals or advertising yells, we fling these extremes of red, yellow and blue at the young eye. Strong colors should

\*See Rood's "Modern Chromatics" and Abney's "Color Vision."

only be used as strong condiments or strong sounds, by those who have learned how to employ such excessive stimulations and yet preserve a balance.

Froebel's mistake may be excused because at his time the pigment color theory of Sir David Brewster was generally accepted, but if Froebel were living to-day he would welcome the truth. How then can disciples claim to honor his memory by perpetuating an error?

THE HARM DONE BY THIS FUNDAMENTAL ERROR IS FAR REACHING.

\* \* \* \* \*

The pigment (red, yellow and blue) theory assumed that primary colors, and that their complements, green, purple and orange, are their opposites in a circle. The trustful child is thus led to believe that

RED is the complement of GREEN, which it is not;

YELLOW is the complement of PURPLE, which it is not;

BLUE is the complement of ORANGE, which it is not;

And this starts false ideas of color balance, which can only fail of proof to a normal eye and mislead every effort to arrange colors properly.

Ignorance of the difference between the action of the eye and the behavior of pigment gives a semblance of truth to this persistent error. If a red pigment, such as vermilion, reflected only red light, and a green pigment only green light, *then their mixture would make yellow*. The spectroscope shows us that each pigment reflects nearly the entire spectrum, but with one part so much in excess that the eye recognizes only this dominant hue. The unrecognized elements are active, however, in any mixture of the two, and neutralize into a weakened yellow, far too poor to serve when we try to imitate nature's yellows. So we are forced to seek an independent yellow pigment, such as cadmium, aureolin or chrome. These substances seem yellow because they reflect both red and green to the eye, as is readily observed in the spectroscope, but the eye failing to analyze these hues (as the ear analyses sounds) records the sum as yellow.

In the same way, if a blue pigment reflected only blue light, then its mixture with a yellow pigment would make neutral gray, *not green*—the green we see being what is left of the light after each pigment has absorbed a certain part. Such pigment absorptions also make red and blue mixtures unsatisfactory as competitors with nature's purples, and we seek independent purple pigments, such as the madders, carmines and artificial purples. *Thus the expert colorist cannot get on with red, yellow and blue alone, but must also have green and purple—making five colors indispensable.*

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If the expert must use five colors, is it sane to limit a beginner or the teacher who has taken a course of ten lessons in a summer school, to only three?

Cheap color printing uses red, yellow and blue, and we suffer the result of the billboard and tomato can. For illustration: I came down this beautiful Chesapeake shore yesterday morning, enveloped in a sunny spring atmosphere. The car window framed a succession of color poems, nature at this season singing in tune. But, like the crash of a brass band, there sprang up great billboards in red, yellow and blue, with their chromatic shrieks for Harvard Beer, Hunter's Rye and Gorton's Codfish!

They shut out the vistas of misty blue, and delicate green, which might have taught their makers the value of color balance and proclaimed the failure of Brewster's theory. Color photography also fails to succeed with red, yellow and blue. The best work by Lumière plates is due to imitation of the eye process by mixtures of red, green and purple-blue.

The very nature of the eye demands approximate balance of these three sensations, and because our pigments do not follow retinal action, it becomes absolutely necessary to supply the palette with purple and yellow, as well as red, green and blue. It behooves us, both from the standpoint of practice and of theory, to discard a misleading tradition. It is an abuse of opportunity to burden a child with such false ideas. When he unlearns them later with difficulty his respect for us must wane.

Now, perhaps some painter has told you he can and does work by the red-yellow-blue method. But study the result: If he succeeds in producing beautiful combinations of color it is because of this unrecognized fact that the overruling verdict of his eye has saved the error of his thought. His case is like that of the cook who depended on her clock, saying that when the long hand was near two and the hour hand at six, if it struck one she knew it was about lunch time. Such devious reasoning may be thought artistic, but it is hardly educational.

An educator who is not blind to the mischief of present color methods asked: "May not the old theory be an easy door?"

My answer was, "Shall we take the wrong door because it opens easily?" Shall the pedagogue lead a child away from the right door?

SHALL FALSE THEORY CONTINUE TO DISTORT COLOR  
TEACHING?

\* \* \* \* \*

Consider for a moment the training of other senses—taste, touch, hearing and muscular expression. In no case does it begin with extremes of sensation. We do not shout in an infant's ear, or give it strong food,

or handle it with violence. And, in later education, loud sounds are not the basis of musical training nor savage feats the door to graceful demeanor.

The lesson of experience is to *avoid extremes, not to invite them*. Why, then, should the extremes of color be made the basis of a child's color thought? It would be promptly rejected as illogical and of distinct harm, did it not come as an old tradition unthinkingly accepted.

Moderate degrees of sound and motion—not extremes—constitute the beauty of music and the dance. Moderate degrees of color—not extremes—characterize the masterpiece both in decorative and in picturesque work, and every consideration points to moderate and tempered expression as a threshold for the study of color.

Now how shall moderate degrees of color be selected and defined? The selection cannot rest on the dictum or fluctuating whim of an individual. It must be the average sensation, established by scientific means, with measured records obtained from many individuals, and it should be defined in measured terms of the three color qualities—hue, value and chroma.

It has already been stated that all the pleasure-giving arts are based upon measure. What measures underlie the art of pleasing color?

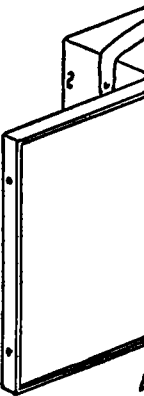
This question is sometimes met with a blank look of incredulity. Nevertheless, it is true that all successful color work is the outcome of measure, *conscious or unconscious*. Balance is itself a form of measure, whether the balanced elements are similar and symmetrical or unsimilar and compensating. As an equilibrist balances unequal weights at compensating distances from a center, so the skilful colorist balances unequal degrees of pigment by compensations of area and position. But to do this *it is first necessary to know what constitutes equality, and that is a problem in measure*.

Color scales are needed to train the visual estimate of color, in the same way that musical scales train the ear, and such scales cannot be left to personal whim or guesswork. They should be standardized by scientific methods or they will fluctuate with each inspection and even vary from day to day, according to the mental and physical poise of the individual. The eye is the easiest "fooled" of all our senses. Color impressions are so fleeting, unstable and dependent on the degree of contrast and time interval that one must have a fixed point of departure by which to determine his bearings in the sea of color.

As the tuning fork and its measured pitch determines the middle octave of the piano, so color must have its chromatic tuning fork established by measure, and this is done by measuring devices such as the spectroscope, the photometer and Maxwell discs.\*

\* See new volume Century Dictionary, for Daylight Photometer, by A. H. Munsell.

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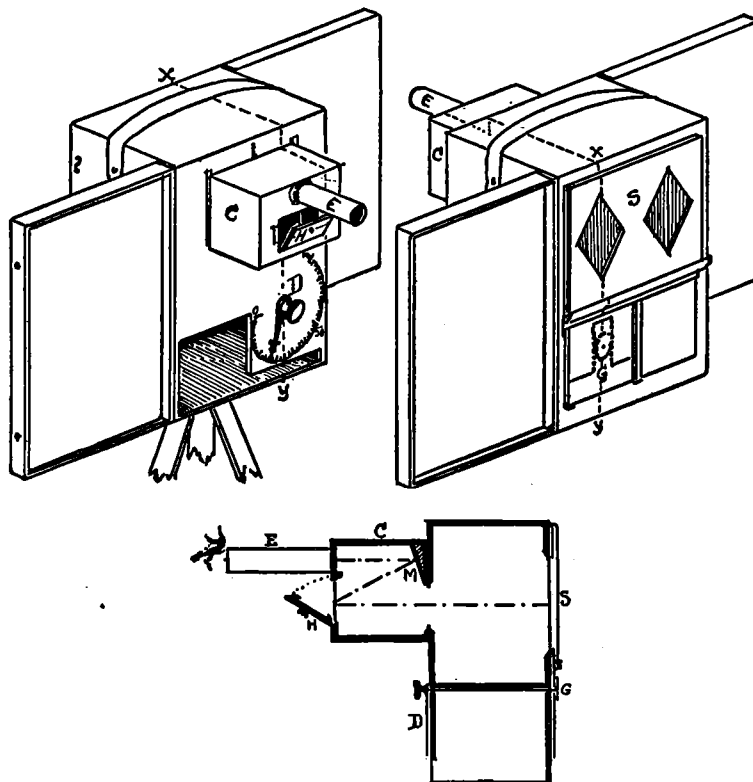
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Perhaps these names are as unfamiliar to you as was the polariscope to a western farmer. At the end of a political harangue in which it had been mentioned as determining the tariff on sugar, he approached the speaker and asked, "What is this polariscope, anyhow?" and the politician covered his own ignorance by saying in a very confidential way: "See here, I haven't the time to describe it now, but I'll tell you this—if it once got among your pigs there would be the devil to pay."

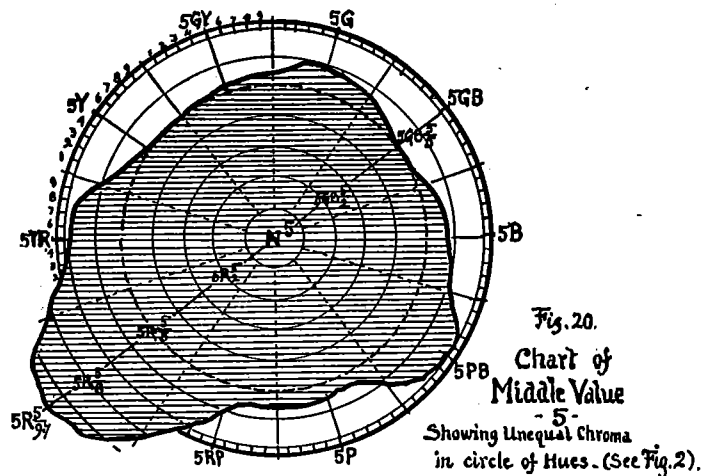


Proper instruments will measure color, and the results of such measure are spread before you in the charts of this color atlas.

To understand how the atlas is made and used, let us imagine we have a great collection of various colors in silks or cottons or papers, which we wish to classify, and have at hand a convenient filing cabinet. Its ten drawers are numbered from one at the bottom to ten at the top. Such samples as are found by the photometer to reflect one-tenth of the

light shall go in the bottom drawers. Those that reflect half of the light shall be placed in the middle or fifth drawer, and so on, until all the colored samples are arranged in their proper levels.

The middle drawer contains many hues; all are of middle value, and when measured by the spectroscope we may place these hues in a circuit ranging from red, through its gradations to yellow, then to green, to blue, to purple, and back to the starting point in red. The samples of each hue are then graded in a radial line toward the center, with the strongest degrees at the outer end. Each hue will thus become grayer as it passes into neutral gray at the center, which is the balancing center for all hues.



Such is the MIDDLE CHART of this Color Atlas. Lighter charts represent the contents of the upper drawers of the filing cabinet, and darker charts those of the lower drawers down to black. If a vertical rod is pushed down through the center of this cabinet it traces a scale of neutral gray from black in the bottom drawer to white at the top. This neutral scale is established by the photometer, and not as in most published scales, by the fluctuating whim of an individual.

This neutral scale may be called the trunk of a Color Tree, whose branches push out at various levels to the strongest pigment examples of red, yellow, green, blue and purple. Such branches are not all of equal length, nor at regular intervals of the trunk, as some have assumed.

In describing these colors you will note that we use three measures—a measure of HUE, another of light or VALUE, and a third of strength or CHROMA. Two measures do not define a color. Now these three measures or dimensions imply a solid, and when the color tree puts out

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The Color Tree is not the product of the qualities of mixtures. It enables the score permits the each color in the



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all its leaves we have an interesting and very irregular solid, with white as its topmost point and black at the root, while the strongest colors are projecting branch-ends at various points.

The Color Tree supplies a visible type of all color relations. It is not the product of guesswork or personal whim, but an exact statement of the qualities of the pigments we must employ, with all their possible mixtures. It enables the mind to grasp color combinations as the musical score permits the musician to realize combinations of sound, and defines each color in the combination with accuracy.

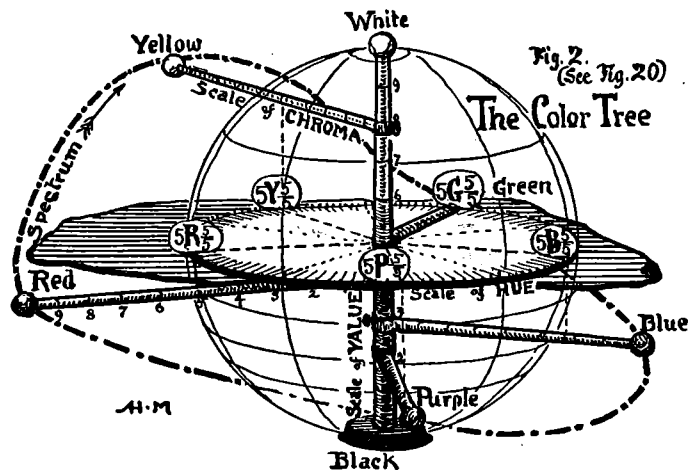


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A horizontal slice through the center of the trunk discloses our middle chart with its irregular contour. The five colors already named, with their intermediate hues, make a regular gradation of ten steps\*—red, yellow-red (popularly known as orange), yellow, green-yellow, green, blue-green, blue, purple-blue, purple and red-purple. Each diameter traces a hue and its opposite hue or complement. This blue-green is the complement of red, while green is the complement of red-purple. The irregular contour is caused by the unequal radii, each proportioned to the strength of its hue. Thus blue-green is only half as strong as red, which argues that to obtain balance we must double the area of the weaker or use only half the area of the stronger.

Does not this chart expose the fallacy of saying that red and green are complements which balance in neutral gray!

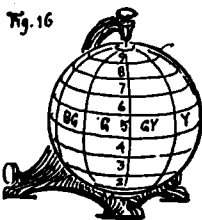
A higher slice at the level of the yellow branch discloses a very different shape, for its opposite purple-blue is here extremely weak, while

another slice as far below middle reverses these relations, for there yellow is very weak and, its opposite purple-blue is nearly the equal of our strongest red.

Nor need we confine these charts to horizontal slices. Suppose we cut obliquely downward from the strongest yellow to the strongest purple-blue. This discloses a fascinating sequence which is the pigment echo of a prismatic spectrum, plus the purples which are wanting in the prism series. Let us study the values and chromas of this beautiful circuit. It varies in chroma from the powerful red to the weak blue-green; in value it ranges from the lightest yellow to the darkest purple; it is of changing hue value and chroma at every step; so complicated are these interrelations that they are difficult of comprehension by an adult without the help of this Color Tree and the charts of the Atlas.

How can we expect a child to understand so subtle and complicated a sequence!

The teacher's skill is shown in searching out the simplest and most easily grasped facts; in finding not only an "easy door," but the *right door*; in leading the child through the maze of color by steps so clearly understood and remembered that he will safely find his way alone and not become confused. The simplest approach is by means of a regular sphere of color carved out of the irregular color tree. This sphere can be no larger than its weakest pigment—blue-green (viridian)—and with its center at middle gray, the radius of the sphere excludes all the irregular maxima of red, yellow, green, blue and purple, as well as extreme white and black, which lie outside its regularly curving surface.



The EQUATOR of this COLOR SPHERE is a circuit of ten hues, all midway in value between white and black, and like the blue-green, half way in chroma between middle gray and the strongest red. This is proved when the sphere spins rapidly, for the equator becomes a neutral gray as each opposite pair of balanced complements unite on the retina to balance the elements of red, green and violet-blue. And here let us remark the great advantage of *five color pairs* in place of three, since it avoids trying to explain to a child the differences of pigment mix-

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ture and retinal mixture, and still sets him right as to the colors which enrich each the other. This avoids the old red-yellow-blue blunder, which teaches false complements and inevitably leads to raw and inharmonious results.

A study of school programs shows that the aim of color study ranges from a simple discipline of the judgment and memory, through exercises of a decorative character, to attempts at picturesque composition, and even an analysis of the masterpieces of color. This last is a very ambitious aim. What is artistic color? The coloration of Raphael, or of Holbein; of Manet, or of Corôt—of the pre-Raphaelites or of the Futurists? Artists themselves do not agree as to what is "artistic color," and teachers can only confuse their pupils by assuming to explain matters about which they are themselves in doubt.

Let us leave these superstitions to private academies and concentrate public education upon a simple and definite training of the eye, so that it may be quick to recognize, define, imitate and memorize the colors in daily use.

Vocational color work includes much more than the atmospheric values by which an artist imitates natural effects, and the broad field of industrial color work is largely so conventional that it retains no hint of representation. A training in definite scales and color sequences, where the pupil clearly understands his problem and may recognize just the degree by which his effort falls short of success, will develop finer and finer discriminations. It is not complicated with the question which Kipling puts in the mouth of Satan: "It's pretty, but is it art?"

We do not train the ear to discriminate musical sounds with the idea that each child will produce artistic results. That is only for a few chosen natures in special advanced schools. But a simple discipline in tone discrimination is good for all, and a simple training in color qualities is equally the right of every child.

Let us turn back to our *chromatic tuning fork*, so simple that it may be grasped by a child, both by his hand and in his memory.

FIVE MIDDLE COLORS, equal in chroma and equal in value, so that they differ only in HUE, may be aptly called a tuning fork of color, for they are the starting point in judging equal departures to the extremes of white and black, and to the extremes of no color (i. e., neutrality) and strong color (i. e., maximum chroma). What makes it still more valuable is that these "middle colors" largely predominate in successful work, so that if these five are placed in a child's hand when he visits the Art Museum he will find them and their near neighbors used in beautiful rugs, tapestries, enamels and paintings, while the maxima of red, yellow and blue will be conspicuous by their absence. If any traces appear they will be as small accents of strong color opposed to a large field of quiet and balancing chroma.

So that for both theoretic and practical reasons, these tempered colors should be the first recognized, imitated and impressed upon the memory, as a means for rightly estimating the unequal chromas of the maxima.

Perhaps you think this too exact and formal as an approach to color study, but is it not the logical counterpart of what is done in music and all the arts of expression? The strongest sensations are never chosen as an introduction! If psychologists are to assert that the young eye demands the strongest contrasts, and does not react to moderate color, they must explain such an inversion of the general law of sensation. No mother shouts in her baby's ear, stimulates its stomach with strong drink, or exposes its nerves to shocks of any sort. Indeed, Nature safeguards the child even from a stupid mother by her mild "first aid." Since the whole teaching of life, not only physical but aesthetic, is to avoid extremes, it seems the simplest educational wisdom to train the color sense by temperate degrees.

Does not this measured and definite presentation of color by means of the Color Sphere, the Color Tree and the Color Atlas appeal to your experience? The teachers under whom these studies in measured color were worked out by children in kindergarten, primary and grammar grades, have no wish to return to the old hit-and-miss methods. And in higher education it is accepted by scientists. The system and its illustrative models are in use by Prof. Dow at Columbia, Prof. Cross at the Massachusetts Institute of Technology, Dr. Baird of Clark, and Dr. Langfeld of Harvard; also in schools of Art and Normal Training, and industries where color is an important factor.

Does the thought arise that this scientific structure unfits it for a child? That it may cramp his freedom or chill his enthusiasm, at a period when he should be allowed to run wild in color? It is true that he dearly loves to play Indian in the back yard, to scalp his sister, shoot the cat, paint horrid hieroglyphs upon the stable door and make the cook shudder with his yells, but I have yet to visit a school where such exercises form the introduction to singing or dancing. Only in color does such savagery exist. Education aims at control of the body and the mind, and it is high time to apply logical methods in training the eye.

We must remember, also, that artists form a very small fraction of the community. The majority of children are destined, not to make pictures, but to use their color sense in other ways. Therefore the training should be brought to bear upon practical uses of color in the home, in personal dress, and in industries where color is of distinct value. Especially in such industrial applications, it is necessary to have definite tests and measures, because guesswork is wasteful of material and time. It would seem to be our duty to outline the fundamental steps of color education which are necessary for all children; which can be definitely stated

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without ambiguity or florid Ruskinian phrase, and which so far as they go and at whatever point interrupted by change of domicile or leaving school for some occupation, shall be a real foundation and help in the study of color.

#### TO SUM UP THIS PROBLEM FOR DISCUSSION:

Shall we teach false notions, which ignore the action of the eye and make color balance impossible?

Shall color practice be guesswork, and a blind groping for lucky accident—or shall such guesswork be replaced by measured color relations?

Finally, may we not come to some agreement as to aim and method—some clear statement of principles involved in the training of the color sense, so that a child shall not waste his time or befog his thought in quasi-artistic efforts, but learn to estimate and memorize colors by reference to a measured standard? I believe the suggestion of your President is most opportune, and that this Society may do a real service to the cause of color education by concentrating attention on the essential discipline of the color sense.

## DISCUSSION OF MR. MUNSELL'S PAPER ON "COLOR AND AN EYE TO DISCERN IT."

Chairman Buchner: After this sound and remarkably clear presentation of a very intricate subject, I am sure we are anxious to go on with the discussion which the program provides under the title, "The Possibility and Practicability of a Standarization in Color Teaching," which is the third of the three questions to which we have been led. The discussion is to be opened by Mr. Farnum, of Albany, N. Y.

Royal Bailey Farnum: I hesitate to lead this discussion for the simple reason that I know that religious meetings are alike in Boston and down in the cape towns of Massachusetts; and I know from past experience that when color is presented before such a body of teachers as this, we get just as hot under the collar as we do at such religious meetings.

I feel very strongly on the subject of color—for two reasons. First, I know Mr. Munsell pretty well; I studied with him, and he "bossed" me for nearly three years. The second reason is that I am fascinated with the subject itself. I am so optimistic about this so-called Munsell color theory that I feel like the man who went into the restaurant without a cent in his pocket and ordered a dozen blue points and a pint of ale, knowing that he would find a pearl to pay for it at the end. The thing has got to go, you know. I know how you are all feeling, because I have heard some whispering together. What is it all about? Why does he leave out orange? You insist upon that, although he really doesn't leave it out. You know those questions that pop into your heads.

Now, these three topics are for discussion. I want to read, first, a letter that I received in New York from a representative of the Mercury Novelty Advertising Specialties from New York City. It is full of advertising matter; it is a sure letter, you can all see it; it isn't cooked up for this occasion. (Reads): "Gentlemen," addressed to the Education Department and therefore sent over to me, because it contained matter concerning color. "To avoid a suit to recover \$640 we would like to know what is acknowledged by the trade here to be royal purple, and we would be much obliged to you if you would answer the following questions: Is royal purple just one distinct color, or has it different shades? How much bluish and how much reddish do these shades run, if there are any? Of what proportions of blue and red does this color consist? What differences are there in the United States stand-

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I wrote to the man and told him that if he wanted that question answered he could go to two people—one was Mr. Munsell and the other was Dr. Ross, of Harvard University. I don't know whether Mr. Munsell received word from that gentleman or not, but undoubtedly we have got to standardize color; there is no doubt about that.

Color is not wholly a question of feeling. Last night after Miss Ball gave that most interesting talk, one of the manual training men who doesn't pretend to know a thing about art or color, said: "Well, I did understand it." I said, "Why?" "Well," he said, "she pointed out certain things for me to look at in those colored prints. I looked; I followed up those points. I began to feel what she was driving at." Now, I believe that in order to feel things, to really feel things, we have got to have something to stand on first. I never appreciated the etchings of Haydon, for instance, until I really knew the processes underlying that work. I could not go and see those things and understand them and feel them. I don't believe children are going to feel color until we have a proper foundation for the true appreciation of scales of color, etc.

The first question is, "Shall false theory distort our color teaching?" Frankly, I believe we have not taught color, for the simple reason we have not known it. We have taught at it, but we have not taught it. I know I never have. I have attempted it until I studied with Mr. Munsell. We have not taught it as I feel sure that with this theory we can teach it. A great many teachers I know are feeling that we should not give the children those gray colors. Yesterday when I was going through an exhibit with a teacher who sent me a number of those rural school drawings from real rural schools, she said to me: "The children love those gray colors that Mr. Munsell gets out." Now those were rural school children. Some other teachers say: "Well, my children don't like those colors." I don't know what to say about that. Maybe they don't. Maybe they do. I know my youngster, three years old, just at present likes gray color just as much as she does bright color; there is no choice. Maybe when she gets outdoors she will play Indian, or be the tomahawked Indian maiden for a boy. She may then appreciate the stronger colors or want to use them, because when in the house I don't allow her to make a nuisance of herself through her

noise and that sort of thing. We get down to a very refined attitude, and I believe firmly that is what we should do in the schools. There is no doubt but that a false color theory should give way to a true color theory, and then I feel we will be able to teach it.

Shall historical color be replaced by measured relations? The "royal purple" discussed by that letter was pure historic color. The question as to what constituted royal purple could be answered by very few people at present.

Shall color be standardized? Of course it is going to be standardized, there is no question about it.

Now, I hope that other people will get up and ask questions. Mr. Munsell has told me repeatedly that he will be the first one to accept any error to be found in his theory. Nobody has been able to down it yet, and he is simply looking for people to do that.

I don't know whether this is in order, but I would like to present a motion to the effect that this problem of color standardization shall be taken up in a most definite way by this Executive Committee, or by some other committee, for consideration during the next year, to be developed at the next meeting. That committee could consult with the Western organization on this very problem; teachers who are teaching this sort of work (and there are some thirty-five, I believe, who are teaching it) could present to us at that time, at the next meeting, examples of the work and tell how they presented it, how much time was given to it and the grade in which the work was presented. We should have discussions on the floor, not formal talks, but a talkfest among everybody on this one topic of color. It is vital to the manual training man just as much as to the art man, and vital to the vocational school. People recognize the fact that design in color is going to play a great work in their line of education; just so long as they recognize that they are going to come in and discuss this problem with us. I would like to put that, Mr. President, in the form of a motion—that we turn this thing over to the Executive Committee, to be one of the topics for discussion at the next meeting of this association. I don't mean that this should stop this discussion; we ought to go on. We must talk about this; get it out of our minds. There is someone over back here, I know, who doesn't believe the Munsell color theory. I wish he would get up. I would like to hear what Miss Church would say about it. I would like to hear what Dr. Piez would say about it. I am not going to look at them or point. I don't know that I have authority to do that, but can't they say just a few words about it?

Chairman Buchner: I am informed that the next two speakers on this discussion are unfortunately absent, and the discussion is now open to the floor, and I am going to take the opportunity, in view of the fact that color is closely related to form (it always has had and

always will have years and years aspects of this in

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Dr. Piez: Mr. Chairman and Ladies and Gentlemen: I didn't come here expecting to take part. I really came here to learn about this Munsell system of which I have been for the first time thoroughly informed this morning. I must confess myself within limits a convert to this system this morning. From certain points of view I should think that the standardization of color, and of paints for the industries particularly, is desirable and necessary, and it seems to me, from what I have heard here, that perhaps this system will offer what we need in the industries. I have, however, certain reservations about any system of teaching of any theory to young children. My work is with children and not with colors. I teach children, and I teach teachers to teach children.

I find, as Mr. Farnum told us, that children are just as fond of gray colors as they are of strong colors. They are just as much interested in even the daintiest color impressions as they are in the violent colors. But I don't find that they reject the violent colors, or are in any way tainted by them; I don't find that they are in any way injured by them. Furthermore, and I don't want to take the unfavorable position, perhaps, of being in the opposition, for I am not, I find nature doesn't guard children so carefully against color impressions. Nature presents children with all kinds of color impressions, of all degrees of strength, without in any way injuring the children. I was very glad to hear and to learn that after all Mr. Munsell lays the stress on the development of color discriminating power rather than upon the development of the eye.

Now, the eye is nothing more than an optical instrument, and we might as well talk about developing the lenses from the microscope as developing the eye. Children's color discriminating power needs developing, and in the last analysis I find that discriminating power in color develops simply and solely because they deal with colors and with many colors. Just by way of analogy, we have taught reading in the past by the alphabet method and by the synthetic method and by Mrs. Pollard's method and by the rational method and by fifteen or twenty other methods, but one fact stands out conspicuously, that children learn to read by all of these methods and they learn to read because in the process of learning they are made to read. Method has a certain advantage, of course. It saves time. If this system will lead the children a little bit more quickly to appreciate real color relations, why then it is valuable and it ought to be supported.

Children don't start out with theories and don't start out with systems. Children pass from vague, indefinite, indistinct conceptions

to more and more distinct ideas, and, personally, in my experience at least, I am not inclined to foist upon young children in the primary grades and even in the intermediate grades any particular system; but what I would advocate, rather, is to give them a great, vast, extensive experience with colors and develop their color discriminating sense. Possibly in the high school and in industrial lines I should be inclined to support this system unreservedly. It certainly furnishes a standard to work by, but for young children I still have reservations, and I express them.

Now, one other point and I am through. I have been for a long time opposed to teaching the three-color scheme. I have been a believer for a long time in the large palette, for when we come to look into the history of the development of color industry we find that the real colorist never has been concerned with theory. Theory is something which the scientist has "put over" the colorist. The colorist, whether he was a drawer or a painter, or whatever he was, was concerned, as I see it, at least, with finding substances with which he could produce certain colors. He was looking for substances, and he is looking for them now; and I have an idea that we will live long enough to see a great many new—shall I call them paints?—which are mixtures of some other things, or pigments, or whatever we choose to call them.

In the arts as applied to the industries I find that the manufacturers—those people that make the paints for us—supply us with certain well-known paints. A child in daily life, for instance, goes into a paint-shop; he may find there yellow ochre, or he may find there gamboge, or vermilion, or Prussian blue, and fifty or sixty other substances which are known in the art world by these particular names. I have looked over a number of paint-shops, but I have never found anything that is standard red—have you?—or standard yellow, or standard blue, and I have not yet found any of these standard colors in the industrial world at large.

Now, the authorities that direct us say, "You must begin your teaching with life, and you must lead the children back to life." Therefore, I have always tried to make my pupils familiar with the common paints of the industries. Instead of dealing with the palette of just five, we use a palette of fifteen or sixteen colors, selected simply with the view of making young people familiar with the common paints and common pigments of the industries so that they could learn what would actually happen if the paints were mixed. When all is said and done perhaps Mr. Munsell will agree with me: we will never learn color by mixing paints alone. Color is a quality and paint is a substance. And we have talked for years about the result of mixing paints when in reality we were thinking about the result that comes from mixing alone by means of the color disc. It comes right back to my starting point;

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children are empiricists, they are not scientists. From a broad, empirical basis we gather up a lot of information, and if we can guide them to acquire a system, a theory, then our work is well done. The theory is the apex, and the empiricism extends not only to the study of color as color, but certainly it ought to extend to the study of paints. With a broad, empirical basis—experience with colors, experience with paints—I think this system will be an excellent climax to a system of secondary teaching.

Chairman Buchner: In the matter of the resolution that Mr. Farnum has suggested, which will officially be referred to the association under charge of the President, I will offer one suggestion. It will be highly desirable to have the spirit of that resolution carried out in your future actions by having a conference at which manufacturers and tradespeople and the middlemen and the buyers of the country will become gladly interested. We have to reach—at least we ought to recognize—the “vested interests,” to which reference has been made, and while we might go along certain pedagogical lines according to our own judgment it would be futile unless we can get the huge army of tradesmen and sellers and buyers to agree with us. It seems to me that it would be extremely appropriate for this organization to stand in conjunction with other organizations, not merely of an educational character, but of a commercial character as well, to concentrate for a few years on this particular problem. You know, the changing of a milometer on a screw will cost millions of dollars in discarding the lathes of the country and upsetting all of the standardizations in implements and tools and houses and cars and ships and one thing and another which we are making from day to day, and in this matter of the universal rivalry in color we should recognize that objective situation which we as teachers can not control. If we can get an interest of that sort on the basis of this resolution, I think we will be doing good, not only for ourselves in the schoolroom, but will be doing a great deal for the generation which is to come.

Langdon S. Thompson: I have a few words with regard to the questions on the blackboard. I don't think that there is any room for discussion, and I cannot see why anybody should say no to any one of those questions. We will leave Mr. Munsell entirely out of the question in this case, and anyone will say a false theory should not be introduced into our teaching; anyone will say that it would be a great advantage if we could standardize color and that the historical colors should not be relied upon solely. The thing, then, that seems to me of interest with regard to these questions is not whether they are true or false—we believe them true—but the question is whether this theory that has been presented is the true theory.

Now as to that I am not quite ready to say yes or no. The first

serious study that I ever gave to color was twenty-five to thirty years ago when Dr. Rood's work, referred to, first came out. I got a copy of it and also got a copy of Chevreul in France. Chevreul, of course, teaches from the practical side. He was a dyer. Rood teaches from the theoretical side, although he was practical, too, I think. Since I studied Rood's book I have never taught in a general way that green and red were complementary. I have said that a certain red and a certain green were complementary, but not, perhaps, the so-called standard red or the so-called standard green.

Now, with regard to the practice and theory: Of course, the work of any mind must be practical. We have to do something before we can theorize about it. But we must begin to form some sort of order and arrangement (which is nothing more than theory) just as soon as we begin to practice. We find that we have done a little better here than what we did some other way the week before. There are people who say, "I have no theory." Yes, they have a theory; we can't get away from it, that is all. We must have it. But I do not think that there is any sort of opposition between theory and practice. I say that no practice is good if it contradicts theory, but I say that no theory is good if it cannot be put into practice. And when we understand what theory really is—the best practice—we will find that they agree. As I said before, the first step is the practice. We must do something, and then we may begin to theorize about it. Now, it reacts again on our practice; then we change our practice. We change our practice before we begin to theorize again, and therefore they work backward and forward, one helping the other, and they must always agree in the end if they are both true.

Miss Church: Mr. President and friends of the Eastern Association: You will probably discover soon that I am not a good speaker, and you have called upon me very suddenly. I have a furore of emotions and thoughts on this subject of color, and I am afraid that I shall find it difficult to be very definite. However, I will try to dip into this maze and pick out something definite to present to you.

As scientifically color true, I accept Mr. Munsell's system. I believe it is the scientific truth. The only question in regard to it that I have is as to its place in education. In the artist's, in the child's education—I think to-day in all education—we might accept what Buddha stood for among his people, and that is, approach to the law. We have this law of color, which is the truth; we have our people who know nothing of the truth. Now, we must take the truth down to our people, meet our people where they are and bring them up to the truth; and I believe that this is endeavoring to teach "how" by the scientific method, which I feel sure will always avail. I believe that we have art as an essence, which is not material or intellectual truth, but it is spiritual truth. It is in essence what religion is. It is spiritualized human emotion, and it is not thought.

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I believe that we should begin, in all art training, to train that inner feeling of the individual and allow him free expression of that through all that he has of the intellectual and the material. Now, don't misunderstand me. I believe that science has its place in the training of the artist; but I believe it is not the initial step. It comes later, and I would place Mr. Munsell's color science late in an artist's training. I would allow an artist to express his feelings freely first. I would do that also in the case of the child. I don't believe that we would take a systematized science of language, such as we had in the grammar and rhetoric, and hand it to the public and say, "Don't babble or talk until you can speak correctly—speak correct grammar and speak in the correct rhetorical forms." I don't believe that we would teach the science of astronomy to a first-grade child. I think we would allow him to enjoy the stars first. So that my feeling is that this system of color—scientific color truth—should be placed late in a system of art education, and that it should be placed late in the child's education.

Mr. Munsell has referred to the fact that we did not give the child an untuned piano. True, we do not; but what about the violin? Do we not love the violin because it responds more beautifully to the emotion of the artist, because he colors his tone with his feeling? He produces tone; he varies the tone as he produces it, and I believe we love the instrument that is not too accurate more than we love the accurate instrument, the piano. I think that is all that I can summon at the present time.

Mr. Munsell: We remember last night that "father had no last words because mother was with him to the end." I appreciate fully the thought of what Miss Church has said, and I also welcome all the instruction that can be made logically and practically on this. No one wants the truth more than I, and working alone as I have had to do a good deal of the time, I may have made a little corner in the truth and think it is the whole of it.

As to the tuned instrument, I meant by the piano all instruments. I didn't mean to specialize it; I took it merely as the type. When we give the child the untuned violin it raises the very old Harry with our nerves. If there ever was the original spirit of the wailing cat it is in the catgut, and the instructor tunes that instrument by the piano, puts it into the hand of the child and he gradually remembers those four strings until he can handle them within a very small fraction of accuracy, and if he goes to play with a piano and varies the least bit in the tuning or in the fingering it makes trouble, even to the student; so that I agree with Miss Church that there should be no science with the child until he is fifteen at least. Don't give him science; on the contrary, it is to avoid the necessity of explaining anything by science that I suggest a color holder which includes all degrees of color; that is, by the selection

of five easily understood scale points as a threshold—a threshold from which we judge in all directions truthfully. In a short time the child can learn to tune his piano. It only took four grades for the child to take the watercolors red, yellow, blue—which, as they have been used, have been misleading, but need not be misleading—and to tune those watercolors by the diagram. I have done it here, and the only aim of this is to furnish a basis of equal intervals of light and strength.

Mr. Hopkins: Just a word of appreciation concerning what we have had this morning, and I want to say it because I fancy there are some of the good manual training men who perhaps in previous congresses and conventions have not heard this particular arrangement—all of this methodical work, all of this research—developed and presented.

I know Mr. Munsell pretty well; I have had the opportunity of seeing this good work going forward; I know how earnestly he strives under every condition to boil things down. Our people in Massachusetts know that he has carried his scheme out successfully with little people, but he is presenting it to you in terms so that you, as mature investigating critics, can get right down to whether it does rest on a clear-cut foundation or not; and I don't want to tell tales of Dr. Sykes, but there have been times when we have told him that his machinery, his scientific presentations, his desire to boil down the question so that we, as mature people, could get at it and grasp it, cheapens things very frequently—bring in misunderstandings as to what the work stands for.

I don't want to say that because I think perhaps those who have not caught the thing before have never had the opportunity of recognizing it; they feel that it represents formulas from beginning to end, when in reality it doesn't. And why do I say these things? Because we have seen it grow from the beginning. We remember how those things were started—how in his classroom, for instance, this little device was being experimented upon. You can go back, for instance, to the second meeting of this association in Boston when he presented the devices as they stood then and saw the disturbance forthcoming of all these talks.

I am reminded along this line that there are phonographs, graphophones and victrolas that play popular airs and ragtime music. There is a family in which the ragtime things have been eliminated, where the old, standard classics have been offered to the youngest member. The two older girls, who have reached maturity, demand Sousa and ragtime—interesting and beautiful things, by the way—but nevertheless not the subtle, refined, classic things. The little tot, because she has been brought up on the things that count and that stand for so much, begs the neighbors at the house where she visits for the classic things and refuses to listen to the others.

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It is not a question wholly, it seems to me, as to just when and where we present it. That is another matter. We are bound to present it in time. We may doubt it for some time, but it will come, just as it has been coming in all of these schools and schemes—it will come, and on this basis: that here is a man, of our own people, in our own time, who, gathering hold of this idea and believing in it, has come definitely forward so that practically every last word has been answered.

The direction of it, it seems to me, is first in the schoolroom. We will not have in our living rooms and in our music rooms untuned pianos—we would be ashamed to do it. We have them tuned every once in so often, because we want to bring back to our little people the opportunity to play on an instrument. That is what color does in our schoolrooms and in our work; so we want to have the opportunity to play on cards of color, and here is a man who sees color. Wouldn't you like to study in his studio and say, "By Jove! I have done that thing?" Wouldn't you like to be able to say to the world that you have left that record right here, that instrument—something that the scientists have accepted all the way through? When you ask the tuner of your piano to come into your home and get it ready, he doesn't necessarily tell you the steps in his mental process by which he brought that thing about. It is a rare man who is willing to imitate Mr. Munsell's courtesy and show you those things, but he turns to you and says (as the Frenchman says): "Voila! there is the piano; play on it"; and I think we ought to feel at this time—and I speak feelingly on this subject, because I have seen the whole of the development of this work—I believe that we should say that we appreciate the great work that has been placed in our hands. I think, Mr. President, that this color instrument has largely been brought forward by our good friend, who has said. "Voila! here is the opportunity."