

## SOME PSYCHOLOGICAL ASPECTS OF NATURAL COLOR MOTION PICTURES

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PSYCHOLOGY is not ordinarily considered to be an engineering subject. This is due, however, not to any lack of technical and practical problems of a psychological nature but rather to the relatively undeveloped condition of psychological science. Nevertheless, we are beginning to see signs of a psychological technology in many fields of human endeavor, not the least of which is the production and manufacture of motion pictures.

If we regard the motion picture art from the standpoint of the director, its basis is obviously almost wholly psychological. The function of motion pictures appears to be to stimulate the emotions of an audience, and the director is successful in so far as he accomplishes this result in a not too disagreeable manner. In his efforts the director is endeavoring to control the emotional reactions of the average motion picture patron, who is said to have a mental age of approximately twelve years. He is also compelled to manipulate the motions and emotions of his actors, a task which is also not free from psychological problems.

From the standpoint of the producer the big problem is always that of the psychology of the common people as expressed in the familiar phrase, "What does the public want?" Undoubtedly the producers would pay millions to any psychologist who could answer this question infallibly. It is evident that producers have only a vague idea of what the public wants at any given time, the most reliable principle being that the public will like something which is very different from anything which it has ever seen before.

When we turn our attention to the action of the photographic and optical media through which the producers and directors must express their ideas we find a very complex array of psychological problems. The stroboscopic phenomenon upon which the motion picture is founded is a purely psychological effect. Thousands of pages have been written in psychological publications concerning the conditions

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and explanation of this phenomenon. If we dig a little deeper still, we find that the gradations of brilliance or apparent light and shade which are presented to the motion picture audience are psychological reactions. As Mr. Jones has recognized with his characteristic thoroughness, the complete theory of photographic tone reproduction necessarily involves the sensibility curve of the eye as a final phase.

Now the perfection with which the screen image reproduces the original scene is evidently very incomplete in current motion picture work. There are a series of very interesting psychological questions which may be asked as to the *desirability* of true perfection in this regard.

Is it desirable that the movies should become audible, as in Movietone, Vitaphone, or Phonofilm?

Is it desirable that they should present three-dimensional plasticity, as in recent experiments?

Is it desirable that they should show the natural colors or hue and saturation aspects of the scene, permit me to say, as in Technicolor?

In a word, is it desirable that they should lose their peculiar movie characteristics and become identical in effect with reality or the best in drama?

I shall not attempt in the present paper to answer all of these questions, although it seems likely that the failure of motion pictures to *recreate reality* is at no point an actual advantage except from the economic standpoint. However, the technique of motion picture reproduction *does* permit many effects, such as rapid changes of scene and viewpoint, which cannot be duplicated on the stage. A glorified motion picture having no limitations would be far less limited than is theatrical production at its highest point. I must confine myself in the present paper primarily to the last of the specific questions which I have enumerated; namely, that of the desirability and other psychological aspects of natural colors on the motion picture screen.

Financiers and engineers who have spent money and time in the attempt to make possible motion pictures in natural colors have done so on the assumption that there would be a strong demand for such a product. When it was impossible to manufacture such pictures, very few people seemed to doubt their desirability. However, now that it has become possible to produce motion pictures in substantially natural colors there seems to be an expression of skepticism on this particular point. I may refer to comments to this effect in a paper<sup>1</sup>

<sup>1</sup> "An Exhibitors Problems in 1926," Trans. S.M.P.E., Vol X., No. 27, p. 47-48, (1926).

presented before this society by Mr. Eric T. Clarke. He considers that the number of persons in the average motion picture audience who are interested in color as such is too small to be considered." He says, "To the exhibitor, color at present is no talking point," and thinks that the shorter a color insert, the better it is. Among producers and directors we find a wide range of opinions—from those who see no advantage in color to others who are highly enthusiastic about it. One of the commonest propositions is that color interferes with the appreciation of dramatic action.

I am far from believing that it is possible to arrive at a conclusive opinion regarding the value of color, upon a wholly theoretical basis. To be *sure* of this question we must work it out in practice. Nevertheless, the arguments against color are just about as academic as those in favor of it, so that something should be said on the latter side and there is a great deal to be said, the foundations for which seem rather secure.

Of course, we must recognize that there is an *economic* as well as a psychological problem. We must first show that natural color in motion pictures has *utility* in the economic sense. Such utility rests upon the psychological effect in the minds of motion picture audiences, in the enhancement of the entertainment value of the pictures. In endeavoring to demonstrate the existence of such a utility we may appeal to practical evidence or to fundamental psychological principles, the latter, of course, being based upon empirical observations in related fields. However, as a second point, it is of course necessary that the *increased cost* of natural color should not exceed the added utility, and it is obviously a technical and business problem to reduce the cost to the point where these two factors are in equilibrium. Assuming that the cost can be reduced so as to be less than the utility, then the success of the project is inevitable in time, although it will meet with temporary resistance due to prejudice and habit. However, we may simplify our present discussion by assuming that motion pictures in natural colors ultimately can be produced at the same cost as in black and white. We might then ask whether they would be used and to what extent; and even whether there would be any reason why they should not entirely replace black and white. If we believe what some critics say, we might still doubt whether they would be universally or even partially adopted. It is my purpose to examine the probable truth of such ideas.

We may consider first a proposition which seems to be enter-

tained to some degree by certain motion picture directors and which I will formulate in extreme form. Let us assume that the function of the motion picture is identical with that of literature, as represented for example, in the *novel*. In this respect the motion picture is not intended to be a *representation* or *reproduction* of anything, but is simply a medium for arousing certain ideas or meanings in the mind of the witness. The print in a novel has no resemblance to the thing referred to, but when we peruse the novel, images or meanings are aroused which form a connected story and result in pleasure. In accordance with this theory the sole advantage of a motion picture over a written story lies in its *greater efficiency*. It suggests the story or sequence of ideas far more *rapidly* and with *less effort* and fatigue on the part of the audience than does the printed volume. "The Three Musketeers" can be conveyed on the screen in three hours, whereas it might take three full days to get the story from the text of Dumas. Moreover, the chances are that the screen presentation gives more detail than does the written one.

If we think in harmony with this assumption, a screen story might consist entirely of titles which tell the whole tale provided it were possible to cram all of the ideas required into the same length of film which is used in the form of pictures. The only defect of the printed symbolism would lie in its slowness and general inefficiency. However, we may note in passing that the pictorial method is evidently inadequate at some points, since it is usually necessary to supplement it with titles, which represent the literary method.

Now let us suppose that the function of the motion picture actually *is* limited to story-telling in the manner above suggested although at the same time the medium is one of pictures rather than of words. *To what extent is the story-telling capacity of the picture impoverished by the absence of natural color?* One way of attacking this problem would be to examine a large number of novels and determine to what extent either direct or indirect references are made to color. It is evident that without the use of titles, black and white motion pictures can convey no color impression whatsoever, although the novelist has as great a freedom with color as he has with any other ideas. Thus, if the story writer is describing a landscape or the appearance of one of his characters he is entirely free to introduce chromatic ideas, but in black and white motion pictures this is wholly impossible. The greenness of vegetation, the blueness of skies, the red of a rose, or the bloom on the heroine's cheeks are entirely debarred from the

black and white story. Of course, we can introduce a title which says that the heroine's cheeks are rosy and her lips ruby, but in practice this does not seem to be done.

Now there is no doubt whatsoever that we should be compelled to delete a considerable portion of descriptive matter in a story if we were to limit its power of suggestion in the manner above indicated, so that it would be, so to speak, a strictly *black and white story*. We should be required to expunge not only direct color references but also all indirect references; for example, we could not even say that the woodland scene or the heroine is "*beautiful*," since a very large fraction of the beauty in such cases consists in the nature and distribution of colors. Instead of saying that the heroine is beautiful, we should be compelled to say that she exhibits a pleasing contour and distribution of lights and shades. I do not know whether I can get some student of psychology to make a statistical study of 100 novels in order to arrive at a solution of the above problem, but it is evidently a possible subject for a thesis.

It is my personal conviction that the story-telling power of a film is distinctly and unpleasantly curtailed by the absence of color, so that even on the basis of the most reduced conception of what the motion picture is for, we can claim that natural colors should bring a very definite enhancement of utility.

Let us, however, go back to our assumption of a superscreen story made up entirely of titles and yet conveying with equal efficiency all of the ideas which would be conveyed by a pictured presentation. I believe we can recognize immediately that such a presentation would not have the entertainment value of the picture film. If this is so it means that there are some other features about the picture films which, compared with a written account, *do* add to their entertainment value. One aspect of this sort might be formulated in terms of increased *realism*. The picture is far more convincing than the written story because it approximates more closely the actual objects and events to which the story refers. The associative processes by which we pass from symbolism to meanings are greatly reduced. Now I believe that it is a psychological truth that the arousal of interest and emotion depends always upon some degree of *conviction*. A mere idea is not sufficient; it must be "*believed in*." The actual experiences of every day life are usually entirely convincing because they are direct appeals to sense, whereas the majority of the things which we read or hear about are unimpressive because we always doubt their existence to

some extent. The same reaction applies, of course, to pictures but to a less degree according as the pictures become more and more faithful to our conception of the reality. Thus a photograph is much more convincing than an artist's drawing.

Once we are embarked on this line of thought it is impossible to avoid accepting natural color. Mere black and white reproduction is radically lacking in faithfulness of representation. It reduces all observers to the level of absolute color blindness, which is a very rare condition. A motion picture audience is arbitrarily afflicted with this ocular disease and is subject to a corresponding impoverishment of perception. When we divorce ourselves from our habitual familiarity with this defect of the motion picture we realize at once how imperfect and symbolic the black and white motion picture representation is. How would we feel in real life if all objects were presented in colorless shades or grays? How peculiar familiar scenes and faces would appear!

This theoretical consideration is certainly substantiated by an *appeal to the facts* regarding color motion pictures as compared with those in black and white. After viewing a sequence of scenes in color, the black and white pictures give an impression of unnaturalness and weirdness which is highly disagreeable. The loss of reality constitutes a very definite step-down of interest and emotional appeal. I should maintain that this reaction is not an artificial one but merely results from a removal of the defence which is ordinarily made against the artificiality of the black and white representation.

Now, it is evident that realism and story-telling are closely related, so that the dramatic effect of the picture should be greatly enhanced by natural color. In spite of this evident truth, we find, as noted above, that many producers and directors feel that the use of color interferes with the appreciation of dramatic action. They imagine that the audience will look at the color and have its attention distracted from the story or ideas which the picture is supposed to suggest. It is possible that some effect of this sort really may be experienced when we make a sudden change from black and white to color, as in the case of a natural color insert in a black and white subject because of the habituation of the motion picture patron to *chiaroscuro*. However, even under these circumstances it can be presumed safely that the distraction of attention results from the pleasantness or entertainment value of color *per se*, and hence we might argue that temporarily the dramatic action might be suspended

without any net loss of interest. Directors are accustomed to think about the subtleties of their work and they should be careful not to confuse effects. If a picture is shown of a woman in a gorgeous costume or with beautiful jewels, the audience should be given some time to appreciate this display before the story proceeds. This is what would be done in a theatrical presentation, and theatrical producers evidently do not feel that gorgeous costumes are detrimental to box office receipts. In other words, the use of color *does* change the requirements made upon the director, although it would seem that in general it makes it easier for him to produce a pleasing film. We have seen a number of short subjects in color succeed where the same subjects in black and white would certainly have had little appeal.

I believe that the alleged disturbances of attention due to color are greater in the minds of experts, such as motion picture directors and producers, than they are in those of the average motion picture audience. We have met several laymen who witnessed "The Black Pirate" or other color productions without explicitly recognizing the existence of the color. This does not necessarily mean that they did not enjoy the picture more because the color was there, but its presence certainly did not distract them. The novelty effect, when it is present, quickly wears off. If natural color as such interferes on general principles with dramatic appreciation, then the legitimate theater should produce its plays in black and white, not even permitting flesh tints to appear on the faces of the actors. Instead of doing this the colors used on the stage are of a supersaturated variety, evidently because the glare or yellowness of the foot-lights desaturates the normal colors and these have to be restored to prevent the audience from getting an unnatural reaction. It has even been stated<sup>2</sup> that motion picture *actors* cannot perform satisfactorily in a black and white set, so that it has been found necessary to go to the expense and inconvenience of using normal colors in the studio. But incidentally the black and white camera rejects all of this beauty except in so far as it affects the pantomime.

Now the added realism which is attainable with natural color film as compared with black and white is no mere logical deduction. The effect, of course, varies with the character of the scene, but certain types of scenes are enhanced in a startling manner by the

<sup>2</sup> "Panchromatic Negative Film for Motion Pictures," by Lloyd A. Jones and J. I. Crabtree, Trans, S.M.P.E., Vol. X., 27, p. 163, (1926).

use of natural color. An element of *atmosphere* may be introduced which is unobtainable in any other way. A very striking example of this is in the case of water scenes, particularly where there are waves or surf, when one frequently gets such a vivid impression that he can almost feel the coolness and freshness of the sea air. Color and the impression of *depth* or distance in pictures are well known to be closely associated, and seascapes or landscapes in color are very appreciably more stereoscopic than in black and white. Of course we cannot expect to get a full stereoscopic effect without making use of the binocular principle, but in many cases the so-called secondary criteria of distance exert a very powerful influence. Among these are to be found the effect of atmospheric haze upon colors. This haze in itself usually has a light bluish tint, and it reduces the saturations of colors in proportion to their distance. This effect is lost in a black and white reproduction.

Another important case in which color adds realism is one which is practically universal in motion pictures. This consists in showing *flesh tints* in their normal hues and saturations. It is needless to say that proper rendering of flesh tints is a primary requisite of any color process, whether it uses the two or three-color principle. In practice it is not difficult to get theoretically perfect flesh values on a two-color basis; in fact, it is much easier technically than in the case of a three-color system. Of course, there are many different flesh tints, ranging from the darkest negroid to the palest Caucasian, and this variation of flesh color is by no means without bearing upon the story-telling aspect of the pictures. The black and white picture is powerless to show the significant difference between the deep bronze tan of a rough outdoor character and the delicate bloom of the ideal heroine's cheeks. It cannot show a man either as red-faced or as "getting red in the face." The fact that we can witness a motion picture presentation without being positively annoyed by the imperfection and unnaturalness of black and white flesh values bears witness to the extent to which mental adaptation is possible. Undoubtedly our familiarity with black and white photography, in general, helps in this adaptation, but only a brief experience with a good color rendition is required to break it down.

Undoubtedly the greatest "kick" of color, at least for the male members of an audience, consists in the value which it adds to the delineation of feminine beauty. All pretty girls in black and white are pale and consumptive. In the color film they look as we like to see



them in every day life or, even better, on the stage. I do not know to what extent it is moral to advocate the cause of colored motion pictures on the ground that color adds to "sex appeal." However, there is a considerable use of this sort of appeal in motion pictures; to such an extent that I believe the appeal in question has been designated as "it" in this domain. Miss Clara Bow, as the great exemplar of "it," loses entirely her famous auburn colored locks when delineated by the black and white camera, in spite of which the press agents continue to include this feature among her many other pleasing attributes. One well known director hails the advent of commercial colored motion pictures by saying that they "bring sex into the movies," which seems to imply that this factor was absent hitherto. I cannot vouch for the truth of this implication, but at any rate it is evident that natural flesh values are of tremendous assistance in this particular matter. Of course, the censors might frown upon the advocacy of color on this basis, but as a psychologist I feel quite sure that the point is a very important one, because all experts admit that the basic appeal of motion pictures must be through primitive emotions, among which eroticism is not the least.

This leads us to consider another fundamental question, namely to what extent the motion picture should be supposed to constitute "a thing of beauty" in itself or to entertain because it is inherently pleasing to look at. Now there is no doubt that a great deal of pleasure can be derived from the mere looking at *pictures* even when there is no particular continuity or story involved. It is much more entertaining to go through a pile of photographs, no matter what their subject matter, than to sit and do nothing; and I think that no one will disagree with the proposition that pictures are much more interesting in themselves if they are in natural colors. If we study the history and practice of the graphic arts, we find that artists have almost universally preferred color to black and white in spite of the much greater difficulty and cost of the chromatic medium. Of course, there are some domains of art which are hardly amenable to color, such as sculpture and, apparently, up to recent times, photography.

I have found that almost every ordinary person prefers a color still photograph to a black and white one even when the colors are quite crude. The objection to color photography, whether for the amateur or the professional, lies in its difficulty and expense rather than any aversion to the product. Apparently no really commercial method of producing natural color photographs on paper

has yet appeared, but wealthy patrons frequently pay exorbitant sums to experts to obtain color portraits of themselves or their friends.

Now the same situation has apparently obtained in the motion picture field up to recent times. There has been no color process which has been capable of yielding reasonably good reproduction of natural colors and at the same time did not have insuperable defects of a practical or economic nature. However, the Technicolor process in its present form overcomes all of these objections with the possible exception of a reasonable increase in cost. Technicolor cameras are now able to work under exactly the same lighting conditions with exactly the same lens apertures as do black and white cameras, and Technicolor I. B. film has the same mechanical characteristics as black and white film. It is single-coated, runs through any standard projector, and shows greater resistance to mechanical breakdown than does standard black and white positive. Since it contains no silver it is much less liable than black and white to catch fire in the projector when any accident happens. We are therefore confronted primarily only with the questions of the desirability of color in general and of the perfection with which Technicolor film reproduces natural color values.

When we compare modern motion picture photography in black and white with the technique of early pictures, we see that a great deal of progress has been made in the perfection of the purely *pictorial* side of the work. We have better definition and more freedom from lens distortions than in the early days. Much greater care is taken in the composition of the pictures from an artistic standpoint. The reproduction of tone values, as Mr. Jones calls it, is more faithful; although in the majority of cases there is a radical departure from naturalness in the case of colored objects, which could be remedied by the general use of panchromatic film. Thus the motion picture industry has shown a pronounced interest in improving its product not merely as a story-teller but as a work of art. I might even say that it has made more progress in the latter direction than in the story-telling direction. This is the more surprising because in my experience the motion picture producers are not large employers of technical or scientific talent, having left most of the scientific problems to the manufacturers of photographic and optical materials. It is somewhat paradoxical that the most intensive scientific studies of photographic problems are not being made by the

producers, and I sometimes wonder whether the latter have read or are capable of understanding what the research experts of the manufacturers have to say.

Now it would seem in view of this evident interest of the producers in a more perfect pictorial result, that they should embrace natural colors as the most important single step forward in their photographic art which has yet been made possible. They have evidenced great interest in the improvement of the motion picture as a pleasing representation as well as a story-telling medium. I can only feel that their slowness in adopting the new medium is due to the bigness of the step, combined with a certain amount of fear which goes with any important innovation. These fears are practical and economic rather than theoretical in their foundations.

I believe that there can be no argument as to the truth that the popular appeal of the motion picture depends fundamentally upon story-telling. Nevertheless, there is some place in a motion picture program for presentations which are purely matters of beauty and which do not tell any significant story. It is quite clear that presentations of this sort are effective on the stage; for example, in musical productions or revues. Here we find numerous acts, the significance of which is entirely lost on the average witness, but which are given entertainment value by movement and color. Color is a very important factor in such presentations and consequently they are ineffective and impossible on the black and white screen. It follows that the introduction of natural colors makes possible the use of ideas and types of presentation which have hitherto been unavailable to the screen. Imagine, for example, putting the Ziegfeld Follies on the screen in black and white. It would certainly be a complete failure no matter how good the stage production might be. But in full color the result would be quite a different one. Motion picture exhibitors still find it possible to "get away" with a certain amount of *scenic* material in their shows, and the proportion of this which would be acceptable to the average audience would undoubtedly be increased by a very large percentage if the scenics were done in color.

The beauties of nature are largely lost in a simple black and white representation. A similar proposition applies to the use of color in *news reels*, which has recently been inaugurated by Fox. The speed of manufacture which is possible by the Technicolor I. B. process greatly facilitates the application of color to this field. Still

another type of picture to which color obviously makes a tremendous contribution is that of delineating the latest *fashions*. In this field a black and white representation sacrifices about three-quarters of the effect. The same situation holds for the majority of advertising, educational, and scientific films, wherein color should have a value proportionate to that which it possesses on the billboard, in the advertising pages of a magazine, or in an educational text.

There is another aspect of the use of color to produce purely aesthetic effects. I note that Mr. Clark says that there are very few persons in the average motion picture audience who are interested in color "as such." I do not know exactly what he intends to imply by this latter phrase. The most radical interpretation would be a reference to something like the so-called color music or color harmony schemes which have interested certain persons. It is undoubtedly true that mere colors in a meaningless pattern have an aesthetic effect, although the grip of color permutations on our pleasure-producing nerve mechanisms is much less than that of the permutations of musical tone. Such meaningless color patterns and changes will certainly not suffice to entertain an audience over any very protracted period. The principal value of color must lie in its use as an accessory to perception and association rather than as a pleasurable sensory material by itself. Nevertheless, there is no reason for denying that it has an appeal of the latter sort. I note that a good many exhibitors are indulging nowadays in the use of color slides which throw a light color haze or color pattern on the screen as an introduction to a picture, or are sometimes superimposed upon the picture to obtain a novel effect.

When we reflect upon the proposition which we have heard from some exhibitors and producers that natural colors make no important contribution to their business, we are led to ask some questions such as the following: Why, then, are all billposters advertising motion picture productions uniformly printed in full color? Why do the distributors go to the expense of getting out lobby posters in color? Why does the national advertising of certain producers in the trade magazines utilize so much color? If it is true that color interferes with the appreciation of comedy, why do all Sunday papers insist on the use of elaborate colors in their comic strips? I might even ask why the press agents insist on describing certain black and white motion pictures as "colorful." I may also point out the continued use of stenciling, although it introduces colors of an

unnatural hue and distribution. Moreover, it is well known that a large percentage of positive film is tinted or toned to introduce more or less uniform colors. The layman sometimes confuses such "colored film" with a description of natural color pictures, although there is little likelihood of his failing to discriminate between them on the screen.

One of the most practical questions regarding color-results is as to how faithful the chromatic reproduction must be in order to be superior to black and white. My own impression is that any color whatsoever is preferable to black and white provided it is in the *direction* of the natural hue. By this I mean that we might introduce a slight amount of color of the same hue (red, orange, yellow, etc.) as the natural objects but of a reduced saturation and that this would be preferable to an untinted black and white. Technicolor has experimented with this idea, which we call "color modulation," and it is possible for us to supply film having any desired degree of color saturation from plain black and white to saturations exceeding normal. It is our impression that normal saturation gives the best average result, but that *super-saturated* colors are not to be desired except possibly in producing weird effects for special purposes. However, observers who have become emotionally attached to black and white pictures find the shock somewhat reduced when they pass to a color picture of reduced saturation. It is also possible to depart to some extent from the natural *hues* of objects without producing an unpleasant effect. In the two-color process, some degree of departure of this sort is necessary, and it is only essential that the departure should not apply to objects whose color is very familiar to the observer. The most important of these is, of course, the group of flesh tints, including the hair. Next to these in importance probably come the greens and browns of vegetation and the blue of skies. It is difficult to get both skies and flesh values satisfactorily at the same time, although if the scene is not too exacting it is surprising how good the result can be made. It is usually not essential that colors of woods, fabrics, and other furnishings should be exactly reproduced, since the observer does not know what the actual colors were.

The psychology of the *two-color process* has many interesting aspects. We know that theoretically three colors are required for complete chromatic reproduction except for partially color-blind observers, most of whom would be completely satisfied with the two-color system. In a two-color process we virtually drop out one of

the colors in the three-color system, and there seems to be no doubt whatsoever that the blue or violet component is the one which is most readily dispensed with. There seem to be a number of reasons which support this choice, the most important of which is that the rendering of flesh tints is not appreciably affected. A close second lies in our familiarity with the appearance of objects under yellow artificial illumination. Ordinarily we do not appreciate that there is any loss of color under such a light. It is only when we are endeavoring to make accurate color matches that we get into trouble in distinguishing fine shades of blue and green or the like. The two-color system is supported to an astonishing degree by the capacity of the brain to reconstruct color perceptions on the basis of memory, provided it has a sufficient clue. The naturalness of a two-color result is often indistinguishable from perfection even to a trained eye. This is not saying that eventually we shall not pass to three colors, but for the present the greater simplicity and lower cost of a two-color system justifies its use as a first step towards the ultimate goal of complete color rendering.

A question which has been considerably discussed has to do with the amount of *fatigue* produced by motion pictures and particularly by natural color as opposed to the black and white picture. Very careful studies by Irvine and Weymann with about one hundred observers showed that ocular fatigue is less after viewing a Technicolor film than after a black and white showing of the same length. The conclusion is also reached that there is less fatigue due to viewing motion pictures than to reading and that those who suffer eye strain in the movie theater usually have defective vision. I do not know how conclusive these studies are, but *a priori* I should expect ocular fatigue to be less the more natural the representation, since any degree of unnaturalness requires compensation on the part of the nervous system. It is therefore not to be expected that natural colors will be any more responsible for ocular discomfort on the motion picture screen than in every-day life; in fact, we should anticipate a *reduction of the discomforts* with the introduction of the natural color film. This anticipation has been born out by the practical comments of many everyday people. On the other hand we must acknowledge that the unnatural color fringing and the super-saturated colors of the first cruder attempts in the color motion picture field led to distressing results.

Now, although I believe that I have shown in the above discus-

sion that the fundamental arguments are all in favor of the natural color motion pictures, nevertheless it would be foolish not to recognize that there are some temporary disturbances in passing from black and white to color, particularly *vice versa*. However, the really important question is not what temporary difficulties may be encountered in the transition from black and white to color but what we may expect when such transitional stages have been passed. Every improvement naturally meets with inertia because of habituation to a more primitive state of affairs.

### DISCUSSION

DR. HICKMAN: The claim underlying Dr. Troland's excellent arguments is that full, natural colors are preferable to monochrome, and his query is why have they not been adopted in spite of their slight extra cost. I suggest that the reason lies in what one accepts as "full, natural color." Two-color processes, beautiful as they are, do not give full, natural color; it is a question how far the departure affects average persons—whether they would rather see the picture in black and white or pay extra and see the color.

It is well recognized that though a trained eye is required to appreciate true tone rendering, the most inexpert can detect false color. In this respect all color processes are at a disadvantage. However, by representing true colors in terms of some conventionally accepted scale, very beautiful and acceptable results can be obtained. Some few years ago the underground railway in London published a series of scenic advertisements in complementary colors, with green skies, red trees, and purple fields. The color combinations were chosen by artists and the results were pleasing. Now with your two-color process you cannot leave your choice to an artist; you must choose your two primaries so that in appropriate mixture they pass through the flesh tint range. This leaves your other colors dominated by two hues—brick red and blue green. Any psychologist will tell you that these are not favorite colors, favored neither for modern dress nor to be found in nature.

I do not wish Dr. Troland to interpret these remarks as inimical to his process; I greatly admire its beauty. I merely suggest that the limitations imposed by a two-color combination will make such films delightful to see occasionally but tiresome for a steady diet, and that, that is the reason why they have not been patronized to a larger extent.

DR. TROLAND: It is certainly a question of great interest what the relative utilities of the two-color, three-color and black and white results actually are. The only way to get an answer is by collecting the introspective statements of different individuals regarding their preferences. On this basis we find that by far the greater number of people prefer the two-color result to black and white, although there are some exceptions. My own impression has been constantly that the two-color process at its best gives results which are astonishingly close to perfection, if one bases his judgment on memory rather than on simultaneous comparison.

Of course, two-color reproduction can not be theoretically perfect, but examples of it have frequently impressed even professional artists as being so, a reaction which has been somewhat surprising to us. A great deal depends in the two-color process upon the exact selection of primary colors, and if the best choice is made, it is usually difficult for an inexperienced eye to detect any departure from naturalness of colors. In some two-color pictures which have appeared in the past, the selection of primary colors was ill-advised, causing even the flesh tints, which are the most important colors, to be rendered very poorly. If the flesh tints are properly reproduced, other colors can take care of themselves. I am not advocating the two-color process as the ultimate standard of perfection and look forward to the use of three colors when they become economically feasible, as I believe they may.

DR. MEES: This question as to how far a two-color process is satisfactory is one on which one can argue all night. Personally, I am on the side of Dr. Troland.

There is one field of motion picture photography for which I think the two-color methods unsuitable, and that is landscapes.

One thing Dr. Troland said, which is a source of criticism of pictures in colors, is that subjects which have been a failure in black and white have been a success in color. That is one trouble; too many color pictures have been made with the belief that the color would save a picture which didn't have any story.

DR. TROLAND: I am very glad to have the support of Dr. Mees, because I have a high esteem for his judgment in such matters. I am inclined to agree with him concerning the desirability of not doing any more scenic work by the two-color process than is necessary. However, we are under the orders of the producers and directors and have to photograph the subjects which they set before us. This



applies also to the tendency to use color to strengthen a weak story; a principle which is also concerned in the use of "stars." If a story is strong enough to get across without a star, the producers usually dispense with the latter, so that the stars commonly find themselves associated with a poor story.

However, I believe that it is significant as to the box office value of colors that such a production as "The Black Pirate," which was not strong as to dramatic action, can show good financial returns. Nevertheless, if the producers were wholly wise in their use of color, they would combine it with features which are good in other respects, thus raising the general quality of the production to a level which could not otherwise be attained at all. This has been done in such pictures as "Ben Hur" and "The King of Kings."

MR. RICHARDSON: I have long been convinced that projection methods as applied to color are in urgent need of attention. Hundreds of projectionists have realized that something was not right and have written me in an endeavor to locate the cause of the trouble. I am convinced that the sponsors of color will not be entirely successful until they not only further their process of making but also find some means of insuring that the color values will not be distorted on projection. The blue, for example, must not appear as a dirty bluish gray.

Some time ago I witnessed the projection of a color subject in a small theater. The colors appeared very beautiful on the screen. I went up to congratulate the projectionist, whom I found to be using a 900-watt Mazda light source and projecting a rather small picture. The week following I was in a large theater while the same production was projected, and it most emphatically was not beautiful. The light source was a high power intensity arc, which tended to "wash out" the colors until what remained was not pleasing. I spoke to the projectionist, asking why he did not reduce the light power as much as he could. He was astonished at the suggestion. His view was that color was relatively dense, hence needed all the light it was possible to use.

I believe color advocates must adopt some method of educating theater managers and projectionists to the fact that the projection light source must be carefully matched in both its power and tone to the requirements of color work. I shall personally be very willing to give them any possible aid to that end. I am of the opinion that the harsh, bluish light of the high intensity arc is not well adapted to the projection of color films.

DR. TROLAND: I quite sympathize with Mr. Richardson's remarks on the outrageous projection conditions which exist in many theaters, since we have made extensive studies of this matter ourselves. It is true that the projection of natural color pictures requires more expert handling than in the case of black and white. It is desirable to have at least 10 foot-candles of illumination on the screen, and the color of the light source is of the utmost importance. It is unfortunate, from our standpoint, that the majority of theaters use the high intensity arc, because two-color pictures are best seen under Mazda lamp illumination, which is practically non-existent even in the smaller theaters. Our present single-coated film has a rather strong tint which is designed to color-match the high intensity arc to a high efficiency mazda lamp. Some degree of compromise is necessary, however, but it is fortunate that the effect of the tint on Mazda lamp projection is relatively unimportant, while with the high intensity arc there is a marked improvement regarding the "washing out" of the colors. I believe that it is impracticable to try to coerce the exhibitors or projectionists into adopting any particular kind of equipment for the showing of color film.

MR. KELLOGG: I guess we all recognize what a tremendous factor education is and how we can become accustomed to anything which is not quite a perfect reproduction of nature. In accepting black and white photography we have a long process of education behind us not only in attending the movies, but from babies we have become accustomed to looking at black and white pictures. On a moonlight night, for example, we admire everything about us, but there is almost a total absence of color. All that means that we can accept the colorless motion picture with the usual amount of satisfaction.

When viewing the talking movies I have been struck at once by the fact that when a person begins to talk, his ghostly appearance becomes more impressive. Education may overcome this little barrier, so that I cannot say whether the advent of talking pictures will increase the demand for color or not; it will stimulate it, if anything.

DR. TROLAND: It is certainly true that night vision is colorless, or at any rate is a bluish monochrome if not strictly neutral. We have had amusing experiences with producers who want to do night scenes in color, whereas in my opinion these are the only kind of scenes which should be done in black and white or monochrome.

The relation of color to talking pictures is interesting. We have frequently heard the comment which has been offered by Mr. Kellogg concerning the unnaturalness of the black and white image when it begins to speak; and I believe the combination of color with sound will strengthen the total effect by producing a more harmonious relationship between the screen and the sound reproducer. We have already made numerous tests on the combination of color with a number of talking movie systems.

MR. GREENE: In regard to illumination, Dr. Troland recommended an illumination of at least 10 foot-candles; does that include shutter loss and does it assume a plain white screen? If I heard correctly, I understand that there is less danger of fire with Technicolor than with other film. Could Dr. Troland elaborate on that point?

DR. TROLAND: There is no absolutely prerequisite intensity, but we favor one of about 10 millilamberts, which is about equivalent to a 10 foot-candle illumination on the average screen. The measurement is made with the shutter running and is the apparent brightness of the screen under these conditions. Regarding the relative non-inflammability of Technicolor positive, this is due to the fact that the film contains no metallic silver to absorb the heat rays and raise its temperature to the ignition point. The coloring materials which are used are almost wholly transparent to infra-red radiation, and they have about the same absorption as gelatin or film base. Of course, the nitrocellulose base is just as inflammable as ever, but the heat passes through instead of being taken up by the film. We have found it possible with a Mazda lamp source to stop the film in the gate indefinitely without its being ignited. However, this is not recommended with a high intensity or other arc lamp.

MR. IZAACS: What screen is recommended for the best reproduction?

DR. TROLAND: I am not the expert in this matter, but I think a matte white screen as nearly as possible neutral. I should not recommend aluminum or a semi-direct reflecting type of screen.

MR. STEWART: A little while ago I was with Dr. DeForest, and I told him I thought it would be splendid to combine color and talking pictures, and he said: "Not on your life, Stewart. I don't want anything to detract away from our talking film. Give me a third dimension, and I won't ask for anything else."