JOINT DISCUSSION OF

SCREEN BRIGHTNESS AND THE VISUAL FUNCTIONS*

by

E. M. LOWRY

and

AN EXPERIMENTAL INVESTIGATION OF PROJECTION SCREEN BRIGHTNESS**

by

B. O'BRIEN AND C. M. TUTTLE

MR. TUTTLE:† Mr. Lowry, can you tell us, from the acuity data you have gathered, what is the minimal brightness required to see upon the screen all the detail that an optically "good" motion picture image contains? From our experience it appears that a motion picture seems to lack definition if, for some reason, either optical or photographic, the resolution of the positive image falls below 500 lines per inch. Since this value is based upon the judgment of a critical observer who would pass upon the definition by close inspection of the screen, it would seem fair to ask the question of an observer seated rather close to the screen. Assume, then, that a member of the audience sits 30 feet from the screen, and that the picture magnification is 250 diameters. How bright should the screen be to see the image of the detail resolved in the release print when the contrast is of the order of 100 to 1?

MR. LOWRY:† It should first be emphasized that the data available are for the most part those applying to threshold conditions and for rigidly controlled surroundings, the general case being a black test-object against a uniformly illuminated white background. For the specified requirement of a resolving power in the film of 500 lines per inch and a screen magnification of 250, the linear dimension of the smallest detail in the projected picture would be approximately one-half inch. This corresponds to a visual angle of five minutes subtended at the eye of an observer 30 feet from the screen. A visual angle of 5 minutes requires a visual acuity of only 0.2, and for the normal eye the necessary field brightness is something less than 0.1 foot-lambert.

MR. TUTTLE:† What brightness would be necessary if the viewing distance were increased to 60 feet?

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* See p. 490.

** See p. 505.

† Communicated.

MR. LOWRY:† Increasing the viewing distance to 60 feet would reduce the visual angle to 2.5 minutes, or a visual acuity of 0.4, which under the same conditions of contrast would require a screen brightness not greater than 0.1 foot-lambert. Data for a wide range of background brightness are shown in Fig. 1.

MR. SCHLANGER: Mr. Lowry, were the recent tests made by Ellis, Freeman, and Luckiesh on stimulus distance taken into consideration?

MR. LOWRY: Those data were not included in the work reported in this paper. I believe that Luckiesh found that visual acuity increases with distance.

MR. SCHLANGER: That information is important because the viewing distances in the theater vary sufficiently to bring that factor into consideration.

Referring to O'Brien and Tuttle's paper, I assume that the illuminated screen border is to serve as an area of transition between the screen and the audience, in

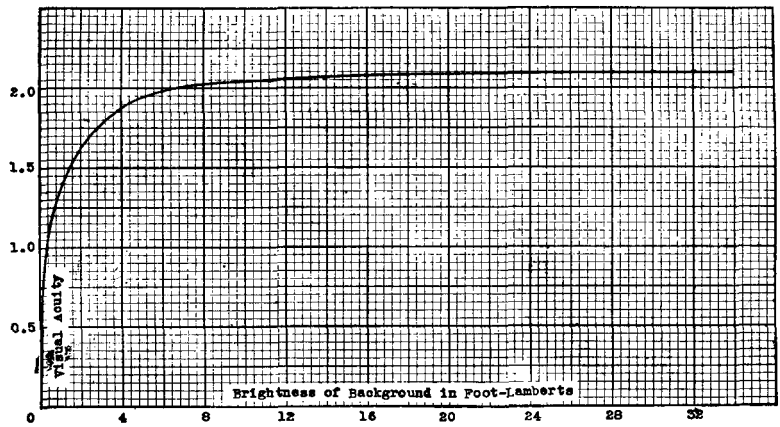

FIG. 1. Relation between visual acuity and brightness of background, according to Luckiesh.

addition to its having some bearing upon the screen brightness problem. Will the intensity of this illuminated border be uniform all around the screen? The brightness of the edges of the screen image varies with the nature of the photographed scene, and the contrast between an edge of the screen and the screen border may vary to a disadvantage.

MR. TUTTLE: We are using a uniform illumination of the border.

MR. SCHLANGER: A very dark area of the screen image adjoining an illuminated border would be as unsatisfactory as a light area of the screen adjoining a dead-black border. Strong contrast at the edges of the screen makes the viewer picture-frame conscious.

Peripheral screen images would automatically take care of the problem, since the image area would extend beyond the limits of the screen into the border area. The brightness of the peripheral area would vary constantly with the scenes that are imaged. There would be a more natural transition between the screen and the audience, and at the same time there would automatically be provided an area of

suitable brightness about the screen without having to create a special artificial border.

In regard to determining the correct size and brightness of the screen, we must take into consideration contrast, viewing distance, stimulus distance, visual acuity, and so forth. One of the difficult problems is that of determining the proper viewing distance. For example, a certain brightness may be satisfactory for extreme viewing distances, but may be too low for the spectators near the screen.

To establish a brightness level that would be most efficient and best for the greatest number of seats in the theater, it would first be necessary to determine the optimal viewing distance in relation to the width of the screen or the screen image size. If we could determine that relation, we should have a definite point from which to start in determining the proper brightness.

It would, of course, be necessary to determine the visual acuity desirable; and in order to determine that, it would first be necessary to establish the amount of detail in the screen image that should be discernible by the viewer. That is an open point and could probably be answered best by the directors who make the pictures. The final visual requirements of the viewer must not be forgotten: the viewer must enjoy the full effect intended by the director of the production. We should seek from directors and cinematographers their ideas as to what detail must be discernible in, let us say, close-ups, medium shots, and long shots.

MR. CARVER: Do I understand Mr. Tuttle correctly, that in his tests the observer began with the minimum level; and sometimes also with the higher levels of brightness? If in both directions, was there a difference?

MR. TUTTLE: The observer can make the wedge go in either direction. He starts with it either too high or too low, and adjusts it to suit himself.

Mr. Schlanger has brought up a very interesting point. The question of the variable brightness of the peripheral area is one that we hope our data will answer. Anything we say now may be jumping at conclusions, but it is my impression, after having gone through this experiment several times, that the peripheral brightness is not very critical; but that a border of given and constant brightness changes the whole aspect of the picture. My feeling when the border illumination is turned on is that a very distinct improvement has taken place. However, the brightness of the border apparently does not affect the brightness of the picture provided that that brightness is high enough.

MR. SCHLANGER: I believe that Helmholtz and others regarded the peripheral area as one of transition from the light in front of the eyes to the black behind the head. The area is variable; sometimes a black might occur in the left peripheral area while in the right area a greater amount of light might be seen, subject to the nature of the objects in the peripheral area. That again brings up the point that we must be careful not to have a dark peripheral image contiguous to an illuminated area of the screen border.

Would it not be better to use in these tests a half-scale or other size model, or some arrangement that would permit making an "auditorium test," which would take into consideration the screen, the areas contiguous to the screen, and the other areas of the auditorium that come within the field of view of the spectator? While we are determining the optimal screen brightness we can at the same time accomplish something else—determine the auditorium illumination that will best

complement the screen brightness. It would be better if more tests could be made, possibly in combination with the smaller-scale tests.

MR. JONES: The program of the Committee is a long one, and can not be accomplished in a few months. I believe the Committee has taken the point of view that it is best to begin with simple things first. The question of screen environment has been placed upon the program, and measurements in theatrical surroundings have been planned. The Committee will gradually build its work up to the more complicated parts of the problem. We must try to be a little patient.

MR. JOY: Will Mr. Tuttle give us more information upon the methods used in this work to determine the correct screen brightness? What is the distance of the observer from the screen, and what is the size of the screen? Do you intend to use test-films in which the major portion of the picture is dark and other test-films in which the major portion is light? Have you standardized the distribution of light upon the screen—that is, the ratio of the light at the center to the light at the sides or corners of the screen without film in the machine? Do you intend to determine the effect of varying this distribution?

MR. TUTTLE: We have attempted to select pictures that are a cross-section of release print quality, both from the point of view of transmission and brightness distribution. We have done this on the basis of a study reported in another paper in this symposium, a study of release print density. Of course, we are limited as to the number of subjects we can use. Actually, we are using only five scenes at present: two exteriors, having quite different distributions of subject matter, light and dark; and three interiors, one of which is a close-up, one a semi-close-up, and the other a long shot.

The choice of subject, we realize, will always be open to criticism. Perhaps we are not using the proper ones; but upon the basis of statistical data presented in another paper, we have chosen the subjects that seemed best to represent actual theater prints.

We are planning to vary the distance of the observer from the screen, thinking that the angle subtended by the screen at the observer's eye may be an influencing factor in the choice of brightness. We are doing the first experiment at a distance of twelve feet from a three-foot screen; and as to the distribution, the screen illumination is very uniform, in fact, it falls off at the edges only by the theoretical unavoidable amount.