VISUAL ACUITY OF LABORATORY WORKERS – A PREREQUISITE TO ACCURACY IN COUNTING[1]

Morris C. Matt

Abbotts Dairies, Inc., Philadelphia, Pennsylvania

Eyes are among the most delicate and important parts of the human body. They are used daily for a thousand and one seeing tasks. With the new concept of "eyes right for the job," the old standard of "good eyes" or "poor eyes" does not apply. Some jobs require exacting vision at close range; in others, color discrimination is important. In many occupations, inadequate depth perception is a hindrance to work. Of all the human skills that the individual brings to his work station, the only skill that can be improved quickly and easily, if it is found to be deficient, is his vision.

The routine of a bacteriological laboratory, especially of those tests relating to colony counts by the standard plate methods, microscopic examinations, etc., requires good vision on the part of laboratory workers. Dr. Albert C. Snell (*1*) described good vision as "that degree of visual functional ability which is adequate to perform the visual task presented."

Standard Methods for the Examination of Dairy Products (*2*) states that laboratory workers assigned to counting bacteria by the standard plate method should avoid inaccurate counting due to carelessness, impaired vision, or failure to recognize colonies. Technicians who cannot duplicate their own counts on the same petri plate within 5%, and those of other technicians within 10%, should discover the cause(s) and correct such disagreements.

The purpose of this paper is twofold. One is to bring to the attention of the personnel director, or that person charged with hiring laboratory workers, the importance of including, in addition to a general evaluation of the applicant's aptitudes, also his visual skills (performance). The other purpose—an equally important one—is to remind the laboratory director to check periodically the visual performance of those workers already employed, and to apply corrective measures whenever indicated.

Very few eyes without correction, either of their inherent defects or of those acquired with advancing years, are able to function at their maximum potential efficiency and with comfort at all epochs of life. In studies made by the United States Public Health Service covering nearly one million persons, it was revealed that up to age 20, 23% of the population had defective vision; up to age 40, the percentage reached 48%; up to age 60, the percentage reached 82%; and over age 60, the percentage reached 95%. Thus, whenever a program is planned for checking visual performance of laboratory workers, it is quite obvious that the director of the laboratory, or that person assigned to the task, should periodically check *his own* visual skills, especially if he sets himself up as the "standard for comparison" in such a program.

Importance of Checking Visual Acuity of Laboratory Workers

Let us return to the first purpose of this paper, namely, the importance of thoroughly checking visual acuity of applicants for laboratory work, whose duties may include bacteria counting. A review of literature relating to industrial vision-testing programs (*3*) reveals that many industries have long recognized that adequate visual requirements are related to job performance. Recognition of the critical role of vision led management to seek some means of determining the adequacy of an employee's vision for the job demands. It became apparent that the traditional wall chart was of but limited value as a measure of the essential skills—limited not only in accuracy but also in comprehensiveness. Accurate recordings of visual acuity are practically impossible because of the difficulty in controlling factors such as lighting, memorizing, clever cheating, etc. At best the wall chart measures only a few of the requisite visual skills, giving no indication of *near acuity*, which is of basic importance in many industrial jobs. (This is certainly true in the bacteriological laboratory, making agar plate counts, microscopic counts, etc.).

Just as modern production accuracies necessitate the use of fine measuring devices, such as micrometers, so the measurement of visual performance requires a scientifically accurate visual testing instrument. The search for more adequate techniques for measuring visual skills has resulted in the adoption of mass testing by instrumentation, which includes other necessary tests, in addition to a more exact visual acuity determination. Actually, twelve tests of visual functions were found to be important in industrial work.

The tests fall under four basic classifications:

[1]Presented before the Laboratory Section of the American Public Health Association, at the 87th Annual Meeting in Atlantic City, Wednesday, October 21, 1959.

1. *Phoria*—Vertical and lateral, at two distances—13 inches and 20 feet—four tests. The phoria or muscle balance tests show the relative posture of the eyes in relation to each other—binocularly—under conditions of controlled accommodation. The importance of the phoria tests is in identifying individuals who are likely to tire easily.

2. *Acuity*—Both eyes, right and left, at both testing distances—six tests. The acuity test measures fineness of visual discrimination, *in terms of true retinal resolution, not ability to read letters.*

3. *Stereopsis*—At distance only—one test. The purpose of this test is twofold: first as a measure of binocular poise, and second as a measure of one of the important factors of *depth perception.* It permits the identification of individuals with superior stereopsis, as well as those who score *average* or *below average.*

4. *Color Test*—At distance only—one test. The color test is a quick, reliable method of identifying persons with color weakness in three general classifications. The test is very effective and easy to administer.

Although not diagnostic, in the clinical sense, these tests do identify employees whose visual skills are inadequate for the job. Once identified, these individuals are referred to local eye specialists for professional examination to determine the causes of the condition and to prescribe correction or treatment, *if possible.* (A definite proportion of eyes cannot be made to function on a standard of high efficiency by any correction, aid, or treatment. Many persons with such eyes are congenitally defective in one or possibly in both eyes. An example is Amblyopia, a dimness of vision without detectable organic lesion of the eye. There is no known cure or correction. There are said to be over half a million persons in this country with this defect.)

A program utilizing a systematic evaluation of an applicant's or an employee's visual skills has proven itself beneficial to both management and employees. It is effective not only in the rehabilitation and conservation of eyesight, but also in revealing unusual visual qualifications. Proper placement of new employees has resulted in reduced training time and better job performance. A valuable by-product has been a generally increased awareness of visual problems. The benefits to employees included reduction in eye fatigue, improved health, better morale, and greater job satisfaction.

The *relatively few* dairy scientists who have made statistical comparisons of methods for determining the bacteria count of milk and milk products were definitely aware of the *personal equation of the operator* and emphasized, in their studies, the importance of laboratory workers to duplicate more closely their own results as well as the results of others, on the same or on duplicate samples under test.

Conversation with a large number of laboratory directors and dairy bacteriologists revealed that while many were aware of the reference in Standard Methods to accuracy in counting, many others did not recall the references, *per se*, or the details thereof; others admitted that while they recalled the reference, they did not treat it perhaps as seriously as they should. Others assumed that an operator who has been engaged in making plate counts over a long period of time (years), does—or should do—a satisfactory job; certainly there should be no need questioning that operator. It was further revealed that many laboratory directors failed to check *their own* efficiency at counting.

In a recent check of the visual performance of a number of technicians in his several laboratories, the author recognized the need for corrective measures for some of the workers under test. Strangely enough several of those with poor visual performance had their glasses corrected only a short time prior to these tests—yet there was no material improvement in counting. It soon became apparent that those workers whose visual performance was not improved, even with glasses or a correction of the latter, would have to be given other assignments, with emphasis on manual rather than on optical duties; or else, some kind of a "crutch," perhaps a change or modification of the counting devices presently in use, might help these "problem" operators. Aware of the importance of maintaining proper morale among our laboratory workers, it was considered more expedient, for the time being, to find that "crutch" rather than give new assignments.

RESULTS FROM TESTING PERSONNEL

Pursuing further the second purpose of this paper, namely checking the visual acuity of laboratory workers and applying corrective measures when indicated, the author undertook a more comprehensive study of visual performance. Taking a cue from other industries and with the assistance of the Bausch and Lomb Optical Company, the group of laboratory workers were again checked for visual skills, this time using the Ortho-rater[2], an instrument of the type referred to earlier in this paper. The workers under test were classified as (*a*) those able to count colonies within the range stipulated in Standard Methods and (*b*) those whose performance was borderline or fell below the satisfactory range. The Ortho-ratings were analyzed and compared with the quality of visual counting performances. All colony counts were made with the Quebec Counter, Dark-field Model (American Optical Company). Fastened to the in-

[2]An instrument of the same general principle, called the Sight Screener, is available from the American Optical Company.

strument was a Veeder tally counter, hand operated.

Eleven persons were given the instrument tests. Six showed satisfactory performance, *viz.* "within the standards set for the job." And yet, for three of the six workers, the Ortho-rater indicated slight muscle weakness in one or both eyes. While these same three workers had been giving satisfactory performance in counting, nevertheless the very indication of muscle weakness should be a warning that (*a*) the operator's efficiency is apt to drop at some time in the future, and (*b*) a visit to the eye doctor is advisable.

Of the other five Ortho-rated, two wore trifocals. At times these two showed borderline counting, and at other times their performance dropped below the desired range. It was concluded that such vacillating could result from a subconscious or deliberate shifting of the eyes above or below the trifocal and/or bifocal segments of the lens during the counting procedure. It is definitely advisable that such operators obtain a pair of reading glasses for counting, and for close work in general. Reading glasses utilize, as a rule, only the prescription of the bifocal segment of the original glasses.

Of the remaining three workers, two gave borderline performance in counting at times, while at other times the performance was well within the desired range. Ortho-rating, however, revealed several weaknesses. In discussing the instrument ratings with these two workers, it was revealed that while both had glasses, they had taken the test without wearing them. Actually, one had left the glasses at home, while the other had them in her purse, remarking that she wore them only when she had headaches. The test was promptly repeated for this worker, with her glasses. This time her performance was markedly improved. Both workers were then told to *always* wear their glasses when making bacteria counts.

The eleventh person is a very able research chemist. However, he is highly Myopic (nearsighted). While his activities very seldom include bacteria counting, he asked to be included in the Ortho-ratings. His rating proved very poor in those visual skills pertinent to the job of bacteria counting.

While these are the author's first experiences at Ortho-rating laboratory workers for bacteriological routine, the value of this type instrument for checking visual skills has been well demonstrated.

CORRECTIVE MEASURES SUGGESTED

As mentioned earlier, it was thought that perhaps some change or changes in the design of the counting device(s) commonly used in the bacteriological laboratory might contribute some measure of correction, in improving or facilitating visual performance of the operator. Glare and fatigue were the common complaints from laboratory workers, usually after 45 to 60 minutes of continual counting. In many instances, accuracy in the counts dropped steadily after that period of time. Experiments with electric bulbs of various wattage and color, as well as with glass plates of different color, were part of a study to determine whether the efficiency of the counting device could be improved upon. Most promising thus far has been the use of a Wolffheugel plate of a special shade of blue, designated as Dr. Simon Gage's "day-light blue." This replaces the plain glass presently standard in the Quebec Colony Counter. Used with the blue plate is a *75-watt white bulb*, replacing the 50-watt bulb in the standard equipment. The changes appear to give greater contrast between colonies and background; also reduces glare and fatigue. These improvements effect greater accuracy in counting.

The author was further encouraged in this study, especially in his choice of the *blue* plate, by the following quotation relative to color therapy (*4*):

> "Color Therapy may become an important and useful addition in treating anxiety states, depression, hypertension, and nervous tension. Results from an 18-month study indicate that blue may act as a relaxant and tranquilizer for anxious, tense persons, while red tends to disturb them. Blood pressure, respiration rate, number of eyeblinks, and muscle tension were significantly lower during blue rather than red illumination. Blue colors also brought significantly less arousal of the brain as measured by electroencephalograms. The studies were conducted on normal persons, and future research is being expanded to patients, including those in mental hospitals, reports Dr. Robert Gerard, Clinical Psychologist, Veterans' Administration Center, Los Angeles."

The special blue glass was obtained by the author, on specification, from a Philadelphia firm and ruled by the American Optical Company and cut to fit their Quebec Colony Counter. The special plates were then installed in several of the counting machines. The laboratory workers were then asked to make colony counts using the modified counter and then read the same plates with the standard instrument. Almost without exception, the operators remarked that the blue plate was much easier on the eyes; and they could count for a longer period of time with less fatigue. But more importantly, it was soon observed in the case of some of the workers, a pattern of higher counts was obtained when readings were made with the blue plate.

Realizing by now the potentials of the new plate and desiring confirmation from other workers in the field, the author had several more of the special plates requisitioned and distributed to other laboratory directors who expressed a willingness to collaborate in the study. The reports thus far are very gratifying in that they confirm the observations made by the author.

In the course of this study with the Quebec Counters, several interesting, and novel, comments and suggestions were made by the collaborators as well as by the author. Following are a few that might have genuine merit:

1. A 75-watt bulb does increase further the benefits of the blue Wolffheugel plate.

2. Rulings on the standard as well as on the special blue plate are too wide, tending to conceal small colonies. Narrower lines are desirable for greater accuracy.

3. Reversing the present plates reveals some of the colonies concealed by the wide rulings referred to in 2.

4. To help synchronize the Veeder tally counter with the visual count, silently count in the cadence "1, 2, 3, 4, 5" and stop momentarily with the eye as well as with the hand. This brief pause prevents one count from running ahead of the other, and thereby reduces the chance for an erroneous count.

5. Of several suggestions offered to facilitate counting, the following is an interesting one and is worth trying. The eye starts scanning at the very top of the petri dish; the reading is from the extreme left to the extreme right, taking one horizontal sector at a time, with the synchronized cadence of eye and hand counter as described in 4. In the trek across the plate, however, the eye moves in an up and down path between the upper and lower boundaries of the horizontal sector. This procedure is said to have the effect of placing a barrier between colonies already counted and those yet to be counted.

6. Beginners in colony counting or those who find it difficult to (*a*) recognize the very small or so-called "pin-point" colonies or (*b*) to distinguish them from debris, are advised to encircle several of the questionable spots with a yellow or red glass-marking crayon and return the covered petri dish for 24 to 48 additional hours of incubation. If the encircled objects are true colonies, the prolonged incubation usually increases their diameter to the extent that they can now be recognized as such. A few such trials are usually sufficient to accomplish the purpose.

7. A very valuable aid for checking the accuracy of colony counts (whether made by the director or the laboratory worker) would be a glass or plastic standard. This could be in the form of a petri dish made entirely of glass or plastic with simulated light amber medium (agar). Embedded in the agar, and distributed at several levels, would be a number of simulated colonies (perhaps 150 to 200) varying in size from pin-point to pin-head. Accompanying each standard dish would be a factory certificate indicating the total number of colonies present.

SUMMARY

Standard Methods for the Examination of Dairy Products establishes a standard for accuracy in making bacteria counts. Visual acuity of the laboratory worker is a prerequisite to such accuracy.

Visual acuity entails good vision—that degree of visual functional ability which is adequate to perform the visual task presented.

All epochs of life being considered, most pairs of eyes, *unaided*, cannot function at their best. While many inherent imperfections of vision can be overcome with proper correction and suitable training, yet a definite proportion of eyes cannot be made to function on a standard of high efficiency by any correction, aid, or treatment.

The desire of some directors to teach workers all the jobs in the laboratory, for the obvious reasoning of making them more useful, could meet with disappointment should any of the workers lack the visual skills required for a particular job.

The personnel director, or that person charged with hiring laboratory workers, should include in addition to a general evaluation of the applicant's aptitudes, also his visual skills. Visual testing programs have already been established in many industries. It is quite evident that a machine test of visual skills can be used to predict clinical factors with a fair degree of accuracy and consistency.

The laboratory director must check *periodically* the visual performance of all workers, as well as his own, and apply corrective measures whenever indicated. Those operators who do not have visual acuity adequate for the task presented, should be given other assignments. Continual counting by those qualified should be limited to definite periods of time, say 45 to 60 minutes, with a rest period between, to reduce the incidence of fatigue and resultant inaccuracies. Periodic rotation from optical to manual routine is also advisable.

A critical study of the design of counting devices presently in use is under way to determine whether proposed changes might contribute some measure of correction and enhance the visual performance of laboratory workers.

Novel, but worthwhile, suggestions for facilitating the counting technique in bacteriological laboratories have been presented—"with an eye toward better performance."

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REPORT OF THE PROCEEDINGS OF THE MASTITIS ACTION CONFERENCE

MORRISON HOTEL, CHICAGO, ILLINOIS, OCTOBER 29, 1960

ORIGIN OF THE CONFERENCE

The Mastitis Action Conference was developed as the result of consideration by the Executive Board of the International Association of Milk and Food Sanitarians. A number of problems have arisen dealing with policy in regulatory, as well as public health aspects of mastitis, that implied necessity of action. The problems may be cited, briefly, as follows:

(*a*) Regulatory definitions provide milk shall be procured from disease free animals; mastitis is a physiologic disorder transmissible from animal to animal, and potentially, to man. The incidence of mastitis is extremely high; strict enforcement of existing regulations would have drastic effect on available acceptable milk supplies. Unlike certain other diseases the causative agent of which is more specifically known and controlled, mastitis has multicharacter and form, and is less readily controlled.

(*b*) In more recent periods, it has become apparent mastitis has potential far reaching hazards of public health significance. It is apparent also that extensive use of antibiotics has not solved, though it may have affected the mastitis picture, and has created problems relative to acceptability of milk. The regulatory sanitarian has had congnizance too of the failure of existing procedures, whatever they may be, over a period of years to satisfactorily correct a problem of long standing.

In the light of these, and other factors, the Executive Board of the Association (IAMFS) after a series of meetings with interested individuals and organizations, decided more effective action on a collective basis was possible. Accordingly, it appointed, through its Committee on Farm Methods, an *ad hoc* Mastitis Action Committee, with representation of various disciplines and organizations, consisting of the following persons:

Dr. Ned Bayley—U. S. Department of Agriculture
Richard Burleson—U. S. Department of Agriculture
M. G. Van Buskirk—Dairy Trade Executives Association
R. H. Dastrup—Livestock Conservation, Inc.
Dr. A. C. Fay—Past President, American Dairy Science Association
Dr. J. C. Flake—Farm Methods Committee (IAMFS)
Donald Hirsch—American Farm Bureau Federation
Dr. R. G. Hodges—New York State Veterinary College
Richard Hoyt—National Milk Producers Federation
W. D. Knox—*Hoard's Dairyman*
Dr. C. A. Manthei—U. S. Department of Agriculture
Dr. Robert Metzger—Farm Methods Committee (IAMFS)
Dr. John Sheuring—University of Georgia
Ed Thom—Olsen Publications
Dr. K. G. Weckel—University of Wisconsin
George Willits—Johnson and Johnson

The Mastitis Action Committee held several meetings, and reached the conclusion that the problem of mastitis could best be evaluated by the meeting of several disciplines, including producers, processors, regulatory officials, extension workers, veterinarians, and research workers. Accordingly, a program was developed to establish the background of knowledge by people engaged in various disciplines within the dairy industry, and which was destined to serve as the basis of discussion for subsequent group task meetings.

The program as eventually developed was as follows:

MORNING SESSION *WHERE DO WE STAND?*

1. ORIGIN, PROCEDURE, OBJECTIVES OF THE CONFERENCE.
   General chairman, Dr. K. G. Weckel, University of Wisconsin.
2. KEYNOTE – MASTITIS – WHERE DO WE STAND – WHAT CAN WE DO?
   W. D. Knox, Editor, *Hoard's Dairyman.*
3. ECONOMIC EFFECTS OF THE DISEASE ON THE DAIRY FARMER.
   Dr. H. G. Hodges, Supervising Veterinarian, New York State Mastitis Control Program, Cornell University.
4. ECONOMIC EFFECTS OF THE DISEASE ON THE DAIRY PROCESSOR.
   Dr. A. C. Fay, North Miami, Florida.