A reference to my own work on the prolonged occlusion test in Dr. Maddox's opening paper on heterophoria* in the 1929 Transactions of the Ophthalmological Society of the United Kingdom is my excuse for restating some conclusions on this subject, based on the observation of about 1,400 cases examined by myself and my son, Dr. S. B. Marlow, and for adding some criticisms suggested by the paper and the discussion which followed it.

These conclusions stated categorically with the main reasons for their adoption are as follows:

1. When the ordinary short tests (screen and parallax, diplopia, or Maddox rod) show orthophoria they reveal only the manifest or functional balance. Latent errors of various degrees and kinds may be present. In other words the ordinary short tests are of very low value, when negative. For instance, among the

* Exception must be taken to Maddox's definition of orthophoria, "A tendency for both eyes to set themselves truly for the object of fixation."—This surely is a definition of binocular fixation, a condition present not only in orthophoria but in every form of heterophoria.

If to it were added the words, "when the extrinsic muscles are in a state of minimum innervation," it would approximate Stevens's original definition and the term "heterophoria" would be a little more comprehensive as it would cover cyclophoria in addition to the lateral and vertical deviations.
first 700 cases examined by the prolonged occlusion test there were 154 cases showing orthophoria by the ordinary short tests. At the end of the occlusion period only 13, or 9 per cent, remained orthophoric. The remainder showed various kinds and degrees of heterophoria. Exophoria 1°—16°, esophoria 1°—8°, hyperphoria 0°-5°—3°.

2. When a heterophoria is shown by these short tests their value is doubtful. They may reveal the whole truth, or only a part of it, or may be misleading. To be specific, a subsequent prolonged occlusion test (1) may make no difference in the kind or amount of error. (2) It may bring out a higher, often a much higher, degree of the same kind of error, or (3) may add a vertical to a lateral error, or (4) it may reverse the findings: an esophoria may change into an exophoria, or a right into a left hyperphoria.

Thus in 104 cases of pure exophoria at the pre-occlusion test there was an increase in the exophoria of from 1°—16° in 95 cases, and a hyperphoria of from 0°-5° to 4° developed in 85 of them. In 55 cases of pure esophoria before occlusion there was an increase in the esophoria of from 1° to 12° in 7 cases (12 per cent.), a diminution of from 1° to 6° in 21 cases (38 per cent.), a change to exophoria in 21 (38 per cent.) and hyperphoria of from 1° to 4° developed in 42 cases (76 per cent.)

3. Low degrees of esophoria are always open to suspicion and often change to hyper-exophoria. This is borne out by the statistics just quoted. If to those be added 78 cases in which hyperphoria in addition to esophoria was present at the preliminary test, the reason for suspicion is emphasized. Of these 78 cases 33 (42 per cent.) became exophoric at the end of the occlusion period.

4. That lateral deviations of low or moderate degree should not be ignored as is sometimes recommended.

5. That prisms are of high value for lateral deviations as well as for vertical, though not degree for degree. These statements are based on the experience of a large number of cases in which nothing could be found to account for the symptoms except a lateral deviation, usually exophoria, a correction of which by prisms or operation, has given relief.

The following case is an example.

Mrs. H., aged 33 years, the subject of severe asthenopia and persistent indigestion, frontal and occipital headache, nervousness and photophobia, for which she had been under treatment by various doctors for four or five years. The symptoms pointed clearly to some kind of eyestrain.

Examination showed the right eye to be emmetropic, the left eye accepting +0·25 D. cyl. axis 110°, and tests of muscle balance
showed orthophoria. It was clearly useless to prescribe on that basis. She readily accepted an occlusion test when it was explained to her. Her muscle balance was tested from day to day and remained orthophoric until the fourth day when an exophoria began to develop, reaching 8° at the end of 10 days (Chart 1). During the same period hyperphoria of low degree could be demonstrated, but as it varied from day to day and at the final test was nil, it was ignored. She was given a 2:5° prism base in, over each eye for constant wear. At the end of 3½ years she reported that the glasses had given complete relief from all symptoms and that she had gained 30 lbs. in weight.

6. That the constant wearing of prisms does not tend to increase the total deviation. The apparent tendency to do this is due to the fact that only the manifest, and not the total error is measured by the usual tests. While it occasionally happens that a second or third occlusion test may bring out more error than the first, presumably due to the first not having been long enough, it is usually true that the ordinary short tests made at periods subsequent to the prolonged occlusion test fail to show as much error as was shown by that test. Sometimes in fact the whole error again becomes latent when the glasses are left off.

7. That prism abduction bears no constant relation to the amount of exophoria. Post occlusion exophoria may greatly exceed the pre-occlusion abduction.

This observation has been made so frequently that only in exceptional cases is attention now paid to prism abduction.

The relation has been recorded in 299 cases. In 195 cases the post occlusion exophoria measured less than the pre-occlusion abduction. In 28 cases the two were equal, while in 76 (25 per cent.) the post-occlusion exophoria exceeded the pre-occlusion abduction, sometimes greatly. The most extreme case showed prism abduction 13° before and exophoria 30° after the prolonged occlusion test, the abduction then becoming 31°.

8. That the results of treatment on the post-occlusion basis are greatly superior to those on the pre-occlusion basis, in many cases converting complete failure into complete success, and in a very large majority bringing about a great improvement.

Cases supporting this statement could be cited in large numbers. As a sample I cite one only.

A man (A.H.M.) aged 33 years, the subject of severe asthenopia, in 1910 showed exophoria of 4° and right hyperphoria 0:5° and a low degree of hypermetropic astigmatism. Glasses prescribed on this basis gave no relief. He was seen again 10 years later when tests showed the same amount of exophoria but no hyperphoria.
CHART 1.
O = Hyperphoria: Right H above the zero line. Left H below the zero line.
X = Exophoria.
CHART 2.

X = Exophoria. O = Hyperphoria. Right H. above the zero line. Left H. below the zero line.
seven-day occlusion brought out exophoria 9° and left hyperphoria 1·5° (Chart 2). Prescribed for on this basis he was completely relieved of all symptoms for seven years, at the end of which period there was a slight recurrence of asthenopia.

9. That the phorias (excepting perhaps some cases of eso-phoria) prism abduction—presumably the expression of an active divergence centre—sursumduction and deorsumduction, now in man non-purposive, can be best explained on the theory that they are persistent vestiges of functions originally useful when panora-mic or circumferential vision was important. This is dealt with in more detail but briefly in a monograph published some years ago.*

10. That hyperphoria often varies in degree and even in kind in different parts of the field of fixation, showing insufficiency of one or more muscles. This is much more obvious after occlusion than before, the determination of the particular muscle involved being then much easier.

11. That it is important to measure not only the deviation but also the sursumduction and deorsumduction before and after occlusion. These usually, but not invariably, undergo changes harmonious with the changes in hyperphoria found.

For example Mrs. J. H. T. (6,824) showed left hyperphoria of 3°, right sursumduction 0·5°—1°, left sursumduction 2°—3° at the pre-occlusion test. A seven-day occlusion raised the left hyperphoria to 4°, the left sursumduction to 5°—6° and reduced the right sursumduction to a minus quantity, - 3°—4°.

In another case a 1·25° left hyperphoria rose to 7°, the left sursumduction rising from 4°—5° to 8°—10° and the right falling simultaneously from 0·25°—1° to - 2°—1°.

12. The occlusion test usually makes no material difference to the near point of convergence. Of 82 cases in which the near point of convergence was taken before and after occlusion 2 only showed more than 2 cm. increase. In 30 cases there was no change and in 22 the distance was shorter.

13. That the majority of patients are greatly benefited by a partial prismatic correction based on the post-occlusion findings. It is essential that such glasses should be worn constantly. Their immediate effect is often discouraging. It may take several days or even weeks to accomplish the readjustment of innervation and relative muscle action.

14. The blurring in the distance by which a full correction of hypermetropia is sometimes accompanied is often due to

* "The Relative Position of Rest and The Prolonged Occlusion Test." F. A. Davis Co.
Prolonged Occlusion Test

accommodative spasm secondary to the convergence efforts necessary to overcome a deviating tendency (exophoria and hyperphoria) which may be quite latent.

15. Similarly a diminution in the degree of myopia occasionally follows the correction of a muscle imbalance, the necessary corollary of which is that a determination of the muscle imbalance is an important factor in the prophylaxis of myopia.

16. That exercise has probably no influence on the relative (anatomical) position of rest.

For instance Mrs. W. was examined in New York at the age of twenty and underwent a prolonged course of treatment by exercise for a divergence said to be 20°. What benefit she received was temporary only. Seen by the writer 20 years later she showed 7° of divergence at the pre-occlusion test and 19° afterwards. The effect of exercise was to obscure the error and not to cure it.

17. That hyperphoria, usually associated with a lateral deviation, is the commonest form of heterophoria, exophoria being a close second, esophoria being comparatively rare.

In Maddox's paper the following significant, and from the point of view of the prolonged occlusion test, crucially important, sentence occurs.

"The screen and parallax test are well known. The only hint is to let the eye be covered long enough for the deviation to develop." It is upon the principle contained in this hint that the occlusion test is based and upon this alone.

A question which Maddox does not specifically answer is, "How long shall the eye be covered?" The natural answer, based upon the hint just referred to, would seem to be "as long as the deviation continues to develop," or "until it becomes stable from day to day." This is usually quite practicable. At any rate a test lasting from 7 to 14 days commonly gives data upon which rational treatment can be based.

Maddox, however, seems to hesitate to carry out the principle he has enunciated to its logical conclusion. Rather he compares eyes under occlusion for a week or two to a "derelict machine," as being not so informative as a functioning one. Why eyes showing a deviation after an ordinary short test should be regarded as functioning normally, and the same eyes showing more or less, or possibly the same error after a longer test of precisely the same kind should be classed as derelict does not appear.

At what point should the line be drawn between normality and the derelict condition?

The validity of this analogy seems open to question. If we use a machine for the sake of analogy, should we not rather admit that
while the way the machine works may give information as to something being wrong, taking it to pieces, dis-assembling it, will give still more information and usually show what is wrong?

Now the occlusion test takes the binocular fusion faculty mechanism to pieces, completely dissociates the two eyes, and permits each to take a position independent of the other, its position of rest, and frequently reveals an error very different in degree and often in kind from that which an active binocular function indicated.

Also Maddox's comparison of the effect of prolonged occlusion with the fortnight's leave of absence, given by the drill sergeant, seems still more irrelevant. The men are exposed to all kinds of physical, psychical, moral and emotional influences. Whereas the occlusion test introduces no new factor but changes only the length of time for which the test is used. It is quite within the bounds of possibility that the behaviour of the men on parade at the end of their leave may or may not differ materially from that previous to it and this may or may not be true of the occlusion test. But the fact is that on one side of this analogy you have a very complex set of influences and on the other a very simple single and unchanged one except in point of time.

Dr. Maddox thinks that the high and various degrees of imbalance revealed by the occlusion test are due to subsidence of "that muscle tone which normally makes up for the anatomical inequalities due to the irregular attachments of the tendons."

It is hard to understand how muscle tone can offset irregular attachment of the tendons. If this is true the prolonged occlusion test shows that irregular attachments occur in great variety and also that subsidence of tone, and consequently the actual amount of tone must vary much in different muscles and in different cases.

The admission of irregular tendon insertions, that is, of an anatomical basis for heterophoria would seem to negative the classification of the latter condition as a symptom. Yet this Maddox asserts to be the case. It is easy to understand how occlusion can eliminate the fusion impulse and therefore any active contraction due to it, but its influence on muscle tone is less obvious. If occlusion causes subsidence of tone and therefore permits complete relaxation, it must result in the eyes assuming their anatomical position of rest. Moreover is it really of vital importance whether the manifestation of latent imbalance is due simply to the relaxation of the active contraction depending on the fusion impulse, or to the subsidence of tone?

Whether it is due entirely to the former, or to some extent to the latter as well, the fact is that after prolonged occlusion a latent muscle error becomes manifest and that a correction of it commonly produces a great amelioration in the symptoms.
In the analogous cases of hypermetropia why should we pay so much attention to the latent error, going even to the point of paralysing the ciliary muscle to determine it, if at the same time we ignore the latent muscle imbalance? There can remain no doubt of the intimate relationship between accommodation and convergence, and cases of asthenopia cannot be completely understood without the fullest possible knowledge of each.

As a matter of fact failure to measure muscle imbalance adequately is the commonest cause of failure, in the experience of the writer, to relieve asthenopia.

FACTORS DETERMINING THE ADVISABILITY OF SELECTIVE OPHTHALMIC SURGERY

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The field of ophthalmic surgery, while very comprehensive, may for the purpose of this discussion be narrowed down to those procedures indicated for the relief of the troublesome affections of declining years, especially cataract and glaucoma. A great tendency exists to regard these conditions as individual as well as independent affections, only partially related to the complex whole of the human organism. In fact the preparation of the patient and the field of operation are very often considered only as regards the possibility of infection of the field, or of the blood through the field of operation.

Ocular, or in fact any disease in the declining decades of life may be influenced by the same factors that have influenced the patient's reactions to the vicissitudes of life in general. The man who never acknowledges defeat, nearly always shows a physical resistance out of all proportion to his obvious physical equipment. The laboratory men working along the line of microscopic organisms never seem to have adequately explained, from a biological standpoint, the phenomena of individual resistance to disease, but have complicated our possible understanding of it, from a clinical point of view, by references to speculations involving the use of new and complicated expressions. Thus for our own understanding we are compelled to fall back upon the homely expression "individual resistance to disease," something every practitioner can readily appreciate.
THE PROLONGED OCCLUSION TEST

F. W. Marlow

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