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A System of Terms relating to the Conditions of the Ocular Muscles known as "Insufficiencies."

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REPRINTED FROM
The New York Medical Journal
for December 4, 1886.

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A SYSTEM OF TERMS RELATING TO THE CONDITIONS OF THE OCULAR MUSCLES KNOWN AS "INSUFFICIENCIES."

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The relations of the eyes to each other, in the act of vision, exercise important influences, not only in occasioning the condition known as asthenopia, but in the causation of many other important nervous disturbances.

If this statement is admitted, it will be evident that the subject of irregularities in the actions of the ocular muscles must assume a greater importance than when disturbances of equilibrium were regarded as only occasional factors of asthenopia, and when these disturbances were looked for mainly in a single direction, in case they were not entirely disregarded. It is true, even at the present time, that "insufficiency of the interni" is the only disturbance of the ocular muscles, excluding strabismus or some of the results of paralysis, mentioned in the majority of the text-books upon the eye. Indeed, the importance of even this defect is hardly dwelt upon at any considerable length in many of these works, and it is not at all uncommon for the oculist to overlook the condition in his practical work.

Defects which result in lasting difficulties and perplexities in the performance of binocular vision are not to be

ignored; and the *rôle* of the ocular muscles in the causation of many nervous disturbances is undoubtedly of very considerable importance.

As the investigator in this department of ophthalmology proceeds in his researches, or attempts to record his observations, he is met by the fact that the terms now in use are not only frequently inaccurate and misleading, but wholly inadequate to describe many of the states observed.

To illustrate the two factors of the proposition just made, a few ordinary conditions may be adduced:

1. The expressions employed to designate the deviations from the state of physiological equilibrium are often incorrect and misleading.

The term "insufficiency of the interni" is used to express a state of the muscles of the eyes which is shown by the equilibrium test of Graefe at reading distance. In this test the images seen by the two eyes are separated by a prism held vertically, with its base exactly up or down before one of the eyes. If, under these circumstances, the images deviate laterally in directions opposite to the two eyes—that is, if the image of the right eye deviates to the left, and of the left eye to the right—there is said to be "insufficiency of the interni" of as many degrees as equals the strength of a prism which, with its base toward the nose, will bring the two images in a vertical line. The expression "insufficiency of the interni" in this relation is used to indicate the fact that the internal recti muscles are "insufficient" to counterbalance the external recti; and it also carries the idea that the externi are, in proportion to their physiological state, stronger than the interni, or that the interni are, proportionally to the others, abnormally weak; tending thereby to balance the eyes outward, so as to cause an unusual and excessive demand upon the internal recti in close work.

The fact that a great many cases, in which the equilibrium test of Graefe shows the conditions described, are really "insufficiency of the externi" and not of the interni, must occur to any careful observer. Such a one will often find that, if he makes his test of equilibrium while the ocular muscles are in a comparative state of repose, as when looking at an object at a distance of six metres or more, he may find very marked "insufficiency of the externi." He may even observe that, if a screen is passed before one of the eyes while the other continues its gaze at the distant object, the covered eye will deviate in a marked manner inward. If the screen is quickly changed to the opposite eye, he will see the lately covered eye move outward in order to fix the object. He may make various other tests which will demonstrate beyond a doubt that the real balance of the eyes is inward, and yet, when he makes the test of the dot and line of Graefe, or any similar test, at near point, he has marked "insufficiency of the interni."

It is manifestly incorrect to say of such a muscular arrangement that the interni are "insufficient," and especially when by such a term it is generally understood that the outer are the stronger of the two opposing sets of muscles.

Again, in certain cases of what is known as "insufficiency of the interni," one of the eyes actually deviates inward while the other deviates outward, while in a still greater number an apparent "insufficiency of the interni" results from irregularities in the superior or inferior recti.

Many other illustrations of the truth that this term as employed is misleading might be cited, but, without further expenditure of time or space, we may pass to the other factor of the proposition.

2. The term "insufficiency" is quite inadequate to ex-

press the conditions of deviation from the equilibrium as they may be observed.

Graefe, as one of the great pioneers in modern ophthalmology, and as the greatest authority on the subject of muscular asthenopia, recognized some of these deviations, and not only regarded "insufficiency of the interni" as a condition of notable importance, but wrote also of "insufficiency of the externi."

Notwithstanding his remarkable observations, much remained to be learned in this department of ophthalmology. While Graefe's great authority is to be fully recognized, the knowledge of these important conditions may yet be greatly extended.

A class of deviations not at all uncommon, and one which induces great nervous perplexity, is that in which the tendency is for the visual line of one eye to deviate above that of the other.

In examining some thousands of cases of "insufficiencies" I have found a very important proportion of such tendencies. There is no term now in use which definitely expresses this condition. We can not say that it is insufficiency of one or other superior or inferior rectus, for it is, in the great majority of cases, impossible to determine through what special influence the equilibrium is lost. We have not here, as in paralysis of the muscles, the definite guides of restricted motions by which we may determine the exact location of the trouble. Indeed, the defect may include an inclination on the part of the one eye to deviate upward, and on the part of the other to deviate downward. We might, perhaps, call such a condition "insufficiency in a vertical direction," with the right (or left) line of vision inclined to deviate upward.

This would be a descriptive and somewhat extended expression. It would still be inaccurate, for it implies a weak-

ness of some muscle, when the actual state may be an excess of tension on the part of some other muscle.

Again, there may and often does exist a combination of faulty tendencies in more than one direction. The eyes may incline to deviate in both the vertical and the horizontal planes, the result of which will be a tending of the visual lines to deviate in an oblique manner. It must be apparent that the term "insufficiency" is inadequate to express all these tendencies.

There may be some propriety in using the expression "insufficiency of the interni" in many cases, but in these just cited it would be impossible for us to speak of insufficiency of this or that oblique muscle without more accurate information than we are likely to possess. Indeed, in the majority of cases these muscles may not be influential factors in the condition described.

Some term better adapted to express just what is intended, and nothing more, is needed. It is after much hesitation and doubt whether a suggestion involving the use of new terms in connection with a subject which has already engaged the attention of many able investigators might not be regarded as needless and presumptuous, that I have ventured to propose such an innovation. If, however, a change is to be made at any time in the classification and nomenclature of these defects, such change should be made before the literature becomes still more extended.

The first need in a scientific classification of these muscular defects is the possession of such terms as, with proper modifications, shall justly express the conditions described.

The terms which have already been employed are all unsatisfactory, and are not uniformly employed by different writers to describe precisely similar conditions. No terms now in common use occur to me as being in all respects desirable,

We may, therefore, select some word which shall convey the general idea and which, with its proper modifications, will express our meaning with specific variations. Such a term should not, like the word "insufficiency," attempt to describe the exact nature of the muscular conditions, for this is often, if not generally, a subject of uncertainty. It should rather indicate the resultant facts as shown by the tendency of the visual lines to deviate from the physiological equilibrium. Nor should the term convey the idea of an actual turning, or deviation of one of the visual lines from what should be the common point of fixation. It should express a *tendency* to such deviation of such character that, should the force of the will be removed, this actual turning would result.

The visual lines, in the conditions under consideration, are held in such relations to each other as to permit of more or less perfect binocular vision, but at an expense of a certain excess of nervous effort. In this we have the distinction between these conditions and those known as strabismus; for, while in these there is habitual binocular vision, in strabismus there is habitual diplopia, either conscious or unconscious. It is true that a fusion of images is possible in many cases of strabismus, and that slight diplopia may become to a certain degree a habit, in the conditions under consideration. Nevertheless, a condition of habitual diplopia should in general be regarded as distinguishing strabismus from these conditions.

The Greek word φόρος (*a tending*) seems to fulfill the conditions required, and accurately expresses our meaning in regard to this class of defects. With this for our central idea we may easily express every variety of tendency to deviation, as well as the absence of such tendency. Thus the two generic terms *orthophoria* (ὀρθός, right, φόρος, a tending) and *heterophoria* (ἕτερος, different) would express re-

spectively a tendency straight forward and a tendency in some other direction.

In order that these terms should possess precise signification, the relation of the visual lines to which they are applied should be determined under the uniform conditions which are here given.

The eyes should be directed toward an object situated at a given distance from them, and the head should be in the position known as the "natural" or "primary" position. The most convenient distance for the object is that at which tests for refraction are commonly made; that is, twenty feet, or six metres. This distance is, therefore, chosen as the standard for the determination of orthophoria and heterophoria. The best object for use in these determinations is a lighted candle against a dark background. It should be on a level with the eyes and at a distance of twenty feet. If ametropia exists, the eyes should be supplied with suitable correcting glasses. In the "natural position" the body and head are erect, the eyes are in the same horizontal plane, and the median line (a horizontal line at right angles with the line connecting the two eyes) is directed exactly toward the object. Under these circumstances there should be in orthophoria the minimum of muscular innervation.

These conditions being observed, we may ascertain the existence of muscular equilibrium or its absence by means of prisms in the manner familiar to all oculists.

The determination of the muscular conditions at near points will occupy our attention as we proceed. It is to be remembered that the results in such examinations are by no means absolute. Heterophoria may, like hypermetropia, be partly or entirely latent. Indeed, as in actual hypermetropia we sometimes have apparent myopia, so with an actual inward tendency an apparent outward tendency may be observed.

The different relations of the visual lines which may be now found may be defined and arranged as follows, a state of the most complete relaxation of muscular effort attainable being always supposed:

I. *Generic Terms.—Orthophoria:* A tending of the visual lines in parallelism. *Heterophoria:* A tending of these lines in some other way.

II. *Specific Terms.* — Heterophoria may be divided into:

1. *Esophoria:* A tending of the visual lines inward.

2. *Exophoria:* A tending of the lines outward.

3. *Hyperphoria* (right or left): A tending of the right or left visual line in a direction above its fellow.

This term does not imply that the line to which it is referred is too high, but that it is higher than the other, without indicating which may be at fault.

III. *Compound Terms.*—Tendencies in oblique directions may be expressed as *hyperesophoria*, a tending upward and inward; or *hyperexophoria*, a tending upward and outward. The designation "right" or "left" must be applied to these terms.

In recording the respective elements of such compound expressions I have employed the sign ⌙. For example, if it is desired to indicate that the right visual line tends above its fellow 3°, and that there is a tending inward of 4°, the facts are noted thus: *Right hyperesophoria*, 3° ⌙ 4°.

In the absence of any means of producing a uniform state of relaxation of the long ocular muscles, such as we possess in atropine for the ciliary muscles, we must resort to every known device to ascertain as nearly as possible the true relations of the muscles. Methods other than that of measuring the deviation when diplopia is produced should, however, be regarded as auxiliary, and the record

of ortho- or heterophoria should be made from the diplopia test.

The powers of the different pairs of muscles to overcome prisms should next be determined. Some confusion has existed in the use of terms to express this power. Thus, the words *adduction* and *abduction* have been employed by Graefe and succeeding writers to express the power of the eyes to overcome respectively a prism with its base out or in. They have, however, been employed to express this power both when the object of fixation has been at a considerable distance and when at the ordinary reading distance.

The same words are also used to express the limits of excursion of the eyes outward or inward in the act of fixation.

The words convergence and divergence have similarly been employed to express different classes of phenomena. As the words abduction and adduction are necessary to express the power of moving outward and inward of either eye singly, and as the terms convergence and divergence must in all cases imply the approach or the separation of the axes of the two eyes, whether in the act of overcoming a prism or otherwise, there might be an advantage in employing the word *convergence* to indicate the highest degree of power of blending images at a distance of twenty feet when a prism with its base out is interposed; and the term *divergence* to indicate the limit of power to overcome a prism with its base in. This latter would also be less liable to objection for the reason that, while each eye is habitually directed in abduction and adduction, the two are rarely by voluntary effort caused to diverge except by the influence of a prism. The fact, however, that Graefe in his classic treatise on muscular asthenopia employed the words abduction and adduction to indicate the ability to overcome prisms must, beyond a doubt, determine the point, and these words

should, therefore, represent the diverging and converging power with prisms. The standard of distance should, however, be uniform with that for the test for ortho- and heterophoria.

It often happens that images can be united when a prism is placed before an eye with its base up or down, but that diplopia is produced if the prism is reversed, or if it is placed in the first position before the other eye. In other words, the tendency of one visual line being higher than the other, the power to blend images is greater when the prism is placed in one than when placed in the opposite direction.

This condition is one of great importance, and no examination of muscular equilibrium should be regarded as complete in which its presence or absence is not determined. The ability to overcome a prism with its base down may be called *sursumduction*, and the eye before which the prism is placed is indicated by the word "right" or "left."

It remains to consider the relations of the muscles when the eyes are directed to objects at the usual reading distance.

These relations may be uniform with those manifested at a distance, or they may vary in degree or in the direction of greatest apparent energy. To these conditions it might at first appear best to apply the familiar terms "insufficiency of the interni" or "externi."

The objections are that the terms have already been employed to express the relations of the eyes in accommodation and also in repose, and that only two of many conditions can be described.

The relations of the visual lines in accommodation do not always depend upon the comparative strength or weakness of the opposing muscles, but upon a peculiar state of innervation of the muscles.

The habit of maintaining an excessive tension upon the outer muscles in order to overcome esophoria frequently manifests itself in the near test as "insufficiency of the interni."

These considerations render it desirable that a uniformity in the descriptive terms for the near and distant tests should be maintained. The terms already employed for distance may, therefore, be properly used if the modifying phrase "in accommodation" is added. Thus we should have for insufficiency of the interni *exophoria in accommodation*, etc.

The relations of the ocular muscles should, as Graefe has shown, occupy a prominent place in the record of all examinations of the eyes for asthenopia or kindred troubles.

If the system of words here introduced at first appears to be superfluous and therefore unnecessary, a careful consideration of the subject will be likely to convince a candid observer that new and more definite terms are needed to convey uniform meanings, and to express more conditions than are described by terms now in use. The terms here proposed are explicit in meaning, and the system, by arranging the various deviating tendencies into classes, suggests to the examiner the conditions concerning which he should inform himself.

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