

interest has received inspiration and direction from Sir James Mackenzie. The conception, birth, and vigour of the Institute for Clinical Research at St. Andrews constitute the climax of one of the remarkable careers in the annals of present-day medicine. This work is beneficent, not only for the direct results it is achieving, but for its influence in bringing back men's minds to the fundamental importance of studying the patient—a study which had become somewhat overshadowed by the advances in laboratory methods.

From another aspect biochemistry will, I venture to think, more and more throw light on the changes premonitory of disease. By the co-ordination of the two methods of inquiry the surest progress will be achieved.

Corresponding to this trend of thought within the profession there is a notable change in the attitude of the public, in whose mind health has become a positive conception, and is no longer regarded as the same thing as freedom from disease. Strength and perfection of frame are coming to be regarded as both a duty and pride of achievement, and people will pay more attention to digression from this high standard. To be too fat or purple and breathless in the prime of life will be the object of censure, just as now it is considered bad form to have a neglected mouth. As a result—if I may indulge in prophecy—methods of treatment will alter. For these early departures from health will not hostels of health replace hospitals to cure disease?

While continuing his employment the man who is lapsing from anatomical or physiological rectitude will reside in a hostel for a brief space, and under a suitable régime of rest, exercise, diet, training, and other treatment will be restored to the joy of fitness. At present this growing sense of the value of health is too exclusively concerned with the physical aspect. The importance of mind health, however, will in time gain recognition unless its significance is obscured by wild advocacy. And that recognition will be followed by a greatly needed change in the opinions and demands concerning popular recreations and amusements.

ORGANIZATION OF MEDICAL INSTITUTIONS.

In conclusion I will consider, briefly, developments which affect our medical organization.

Growth of medical knowledge and the increasing number of sciences associated with it are steadily making diagnosis and treatment rest on collective rather than individual efforts. Collective effort, to be efficient and economical, needs to be aggregated into organizations. It follows that institutions especially equipped as hospitals and clinics, with their laboratories and accessories, will be necessary throughout the country for all classes if the best that medicine can give is to be at the service of the nation.

If we approach the question from an economic point of view the conclusion is the same. Complexity in diagnosis and treatment means increased cost, and as the cost increases the number of people who can defray that cost grows fewer. The result ensues that from this point of view the more medicine improves the less well are people served. The remedy is clearly massed production, which means institutional organization.

The conditions of family and social life point to the same conclusion. At the present time a large and increasing proportion of the population is not getting the best opportunities in illness. Those who frequent existing hospitals are the rich and the poor, but that large mass of people of moderate means (and with existing taxation the word "moderate" carries increasing emphasis) does not.

This is a reproach. It is unfair to the individual and is to the disadvantage of the community. The public very properly looks to us to say what the remedy should be. Its provision requires the co-operation of the public, but it is for us to indicate its nature and guide its application. Hence the importance of agreement amongst ourselves.

Since the growth of such institutions must be gradual it is the more important that the early ones should be on the right lines, so as to set up a good standard for achievement. I will briefly put forward for discussion some of the conditions which in my judgement should be fulfilled.

I. They should be run on economic but not commercial lines. A fixed percentage (say 6 per cent.) should be paid on the capital and the rest of the profit should go to improving the equipment and usefulness of the institution.

II. The laity should co-operate in the administration. The technical direction should be under a committee of medical men. It would be better for the bulk of the capital not to belong to members of the medical profession. There should

be grades of comfort and luxury to suit varying pockets, but, needless to say, only one standard for all essentials, and that the best.

III. There should be provision for a proportion of patients who cannot defray the cost of their treatment. The cost to all others would be at and above a basic economic charge. Professional fees could be included in, or be independent of, the charges for the use of the institution, but broadly the principle that fees are an arrangement to be made between doctor and patient should be maintained.

IV. Patients attending such institutions would retain their own doctors. The idea must never grow up that these institutions are homes for specialists only. There is an advantage in a consultant having an allotment of beds and his own equipment. That gives him his private workshop and yet he rubs shoulders with colleagues. One-man institutions are a mistake from any point of view.

Should such institutions be built as annexes to existing town hospitals? Speaking generally, and in my opinion, emphatically not. Hospitals are situated where the benevolence and conditions of former days put them. No one would put them in their present positions if building them now. An institution such as I have tried to adumbrate should be near enough to the edge of the city to secure adequate space and air.

Such an idea has been realized in part in a few localities—for example, St. Chad's, Birmingham—but not in its entirety.

Institutions on these lines would solve the problem from the point of view of efficient medical treatment, and also for the people better placed from the point of view of cost. But they would not solve it for the people of small means—say those earning £500 to £600 a year. Such as these cannot even under the conditions above described defray the cost of a serious illness out of income or savings. And yet they must be provided for.

The only way I see is through some system of insurance. A State system of insurance for this purpose is neither desirable nor feasible. I should like to see the big insurance companies take the matter up, and cannot but think they would, if assured that the business would meet a public need and receive strong support. I know there are difficulties, such as the question of adequate control without ruinous charges for supervision, but they should not be insurmountable.

I put forward these suggestions for discussion with the strong conviction that it is for the profession to hammer out the best lines of development and give the public responsible advice.

The discussion to-night might perhaps be usefully resumed at a later date.

THE LIGHT SENSE, WITH SPECIAL REFERENCE TO NAVIGATION.

BY

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The last fifty or sixty years have seen much discussion and not a little controversy in this and other countries as to the condition of the eyesight of those entrusted with navigation. Even as far back as 1882, when I was in the laboratory of Donders at Utrecht, certain aspects of the same subject were being investigated, for the colour sense of the railway servants was being examined under his direction. It is not my intention to review in any detail the history of the movement, but rather to point out our present position.

As a preliminary I would like definitely to enumerate those functions of vision which seem to me to be necessary for navigational purposes. These are at least four: (1) good visual acuteness; (2) sufficient form sense, or, as I prefer to call it, field vision; (3) approximately normal colour perception; (4) good light sense.

I felt inclined when drawing out the rough outline of this communication also to include binocular vision. A navigator is none the worse of having binocular fixation, but it is by no means necessary, for I have frequently known officers and seamen of the mercantile marine who had each only one useful eye.

It may seem strange to those who have not followed the controversy as to colour testing, but yet it is true, that persons with defective colour perception have been known to navigate

for many years without on any occasion mistaking the colour of lights. The vast majority of colour-blind persons, however, are dangerous, and it is so difficult to define the limits of safety that I do not object to all persons who are definitely colour-blind being rejected by the Board of Trade.

In passing it may be said that there are several factors which enable a colour-blind person to distinguish between the mast-head and port and starboard lights. To begin with, they invariably differ from each other in what may be called essential luminosity—in other words, their kinetic values, if I may be allowed the expression, are different. Much also seems to depend on the form of colour-blindness. Twice during the controversy on colour testing I found myself in acute disagreement with Sir William Abney. In his well-known book on colour-blindness he gave, in the form of spectra, what he believed to be the colour sensations of colour-blind persons. I think the same diagrams also appeared in the report issued by the committee appointed by the Royal Society. Now inspection of these diagrams showed that he represented the warm and the cold ends of the spectrum as occurring in the different forms of colour-blindness as all but invariably distinctly differing in tint. Were that true, then there could scarcely have been such a thing as dangerous colour-blindness. Nor could I agree with the distinct preference which he gave to Holmgren's wools as a test when he gave evidence before the departmental committee of the Board of Trade. He objected to a lantern test on the ground that the colours exhibited by the lanterns were not pure colours; it never seemed to occur to him that the colours of the wools were equally mixed colours. At any rate, I have never found on spectroscopic examination any wool to give a pure colour. Although I do not altogether like Dr. Edridge-Green's recently published book, I do like his lantern; it seems to me to be a thoroughly reliable test, and the Board of Trade has been well advised in adopting it. This, however, is an echo of a past controversy, and is only mentioned because it illustrates that a good light sense may play a part, although only a subordinate part, in the recognition of lights at sea.

In the next place, I will once more enunciate the difference which I drew a considerable number of years ago between visual acuteness on the one hand and the form sense—or, as I now call it, field vision—on the other; for, so far as I can see, the form sense, or field vision, very largely depends on the light sense. To my mind visual acuteness, strictly so called, is the power of reading ordinary small type, and is purely a macular function. It is best illustrated in the following manner. If a person looks at any page of printed matter and fixes a word at the centre of the page he or she will find that, so long as the attention is directed to the word specially selected, the other words on the page, with perhaps the exception of one or two in the immediate neighbourhood, are quite indistinct. That part of the field of vision which is specially adapted for macular vision I have elsewhere called the "field of visual acuteness." It subtends an angle of only a few degrees at the first nodal point of the eye; its shape differs slightly in different individuals, but, roughly speaking, it is more or less circular. So far as I am aware, it has never been thoroughly investigated.

I reserve the phrase "field vision" for a different set of visual impressions. If a person looks at a particular word in the manner already suggested, and studies his own sensations while doing so, he will find that he is quite well aware of other objects in his neighbourhood. Thus he may be aware that there are other people in the room, although he will be quite unable to recognize them. He also may be aware that there is a clock on the wall and see its general shape, although he will be unable to read the time unless he turns the field of vision on the object. All that part of the field of vision which lies outside the field of visual acuteness I call the "field of form sense." It certainly subserves, if I may so say, at least the following functions—namely, the recognition of shape, of colour, and of differences of luminous intensity; that is, it has light sense. As I shall indicate presently, it is this last that is of special importance for certain purposes of navigation.

A single instance will show what is meant by its function of shape. When the person looks at the selected word, if there be other people in the room he will at once be able to tell that the heads are more or less round, and will be able to distinguish the shape of the shoulders and other parts of the body. He will also have a fairly good idea of the form of the different articles of furniture in the room. It is unnecessary to say anything about the colour perception

functions of the periphery of the field, for they are well enough known to every ophthalmic student who has worked at colour perimetry.

Before saying anything about the perception of differences of luminosity in the field external to the macular area there is one line of thought that I wish to introduce at this point. It is perhaps best introduced by the general statement that in most forms of manual work, and in most acts of daily life, the workman uses what, for want of a better name, I have called his form sense or field vision, and not his visual acuteness; so also, in walking along a thoroughfare, it is the field vision that enables one to avoid collision with other passers-by; it is only a small minority of them that we see sufficiently distinctly to make recognition possible. Another very striking example will further indicate my meaning. In the process of coal-mining the visual acuteness is scarcely used at all; it is chiefly the light sense, for that is what is required to distinguish genuine coal from what is technically called dirt. No doubt, if the miner be of a scientific turn of mind and wishes to examine the fossils contained in the coal measures, he will require to use his visual acuteness, but otherwise he carries on his operations by the field vision, and particularly by that part of it which is called the light sense. Two colliers whom I examined recently on account of miners' nystagmus were found each to have an enormous amount of myopia—roughly, about 18 or 20 diopters—and yet, till the nystagmus supervened, they experienced no difficulty in their work so far as vision was concerned.

At the Toronto meeting of the British Medical Association (1906) I instanced a case of another collier who had about 12 diopters of myopia, and who never suspected that there was anything wrong till he tried to get into the service of a railway company. Now in the first two cases there was no visual acuteness possible, in the proper and restricted sense of the term, at a greater distance than three or four inches from the eyes, and in the last case the extreme distance of visual acuteness was not at a greater distance than four or five inches from the eyes.

The above statement, speaking in general terms, is quite true, although I am well aware that it would have to undergo slight modifications were we to proceed to the discussion of the mental interpretation of blurred images—a very intricate subject to which I would most respectfully call the attention of the psychologists. Manual work has little to do with visual acuteness, as I have shown elsewhere; it practically depends on the field vision and on the sense of projection. Failure to realize this important fact may even lead to a miscarriage of justice. For example, in one case which I was assessing with the Sheriff, a surgeon who had seen the patient on behalf of his union reported, "Visual acuteness of the eye is 6/9 Snellen," and not long afterwards another surgeon reported, "The vision of the eye is 6/18." The learned Sheriff, who was arbiter in the case, immediately and very naturally came to the conclusion that if the visual acuteness was at one period only one-half of what it had been a few weeks before the patient was in a bad way. It was pointed out that the certificates were wrong in form, and that the medical examiners could not tell what the vision really was, but could only record what the patient had thought fit to admit in their presence. I further managed to get the Sheriff to realize the important fact that for the work in which this man was engaged visual acuteness was scarcely required at all, but only field vision. The examination of the visual acuteness is a matter of practically no importance in such cases.

Perhaps I may here be allowed to state my strong preference for Landolt's broken-ring types to any others. No doubt Snellen was the first to standardize visual acuteness, and at present his types are those which are all but universally employed. Thus visual efficiency is expressed in terms of Snellen's types for the navy and army and for the examinations demanded by the Board of Trade. There is, I think, no doubt that Landolt's tests are much more satisfactory than those of Snellen, although Snellen had the great merit of being the first to standardize visual acuteness in terms of the five-minute angle. Landolt's types are equally useful for literates and illiterates. Moreover, I think something is gained by their being circular in form; by their use we can get much greater uniformity than by ordinary letters of the alphabet, which are more or less irregular in shape. Probably the best proof of the defects of test types composed of ordinary letters is the fact that the letters of the same size in a particular line are frequently not all easily read. The only change I would make in Landolt's types is

to have a good number of each of the sizes of the broken circles printed on the card, the break in the successive members of the same line being put at different angles; either that or to make each of the broken circles to rotate so that the angle at which the break occurs may be varied. I beg respectfully to suggest that the Board of Trade be urged to adopt the principle of Landolt's types and to scrap those in ordinary letters because of the irregularity in each line of the latter.

The investigation of the light sense is a matter which I fear is too much neglected. I think its proper examination would often be most helpful to physicians and to neurologists. Probably it is the first function of the optic nerve to become affected in impending diseases of that structure. I am also of opinion that its examination would frequently reveal such diseases as sclerosis and locomotor ataxy in the early stages; but, so far as I am aware at the moment, it is almost entirely neglected in clinical work in medical wards. In a previous part of this communication I have distinguished between what I call macular vision and field vision, and I think it might be of great utility if apparatus were devised to enable the light sense of both macular vision and field vision to be thoroughly investigated separately. At present there seems to be little hope of any such thing being done in the United Kingdom. I am not aware of there being anywhere a thoroughly equipped laboratory for the ophthalmic investigation of disease.

The examination of the light sense should be considered under two headings: first, the examination of the minimum light sense; secondly, the examination of the light difference sense; for both of these functions are important as regards the eyesight of seamen. Recently, considerable light has been thrown on this subject by Mr. Percival of Newcastle-on-Tyne, and he has invented apparatus which is probably the best for testing these important functions. Many years ago I devoted some attention to the testing of the light sense. For the testing of the minimum light sense I used what was to all intents and purposes a Foerster's light sense box, and for testing the light difference sense I used a spot of light seen double through a rhomb of Iceland spar. The double spot was examined by means of a Nicol's prism, which was arranged to rotate about its long axis, the amount of rotation being indicated in ordinary degrees on a scale. The difficulty of course was to determine the zero with such an apparatus—in other words, the place at which both spots appeared equally bright. This was done by adjusting the apparatus so that they seemed to have the same luminosity; the Nicol's prism was then turned in one direction till the spots appeared to differ very slightly in luminosity, and the point at which that occurred was carefully noted on the scale; the prism was then turned in the opposite direction till again a difference was observed, and the spot at which this occurred was also noted; the point on the scale midway between these two positions was taken to be the zero.

I have no hesitation, however, in saying that Mr. Percival's test is a very admirable one. It is much more easily arranged than the somewhat complicated one I have described, and I think ought to be used by the Board of Trade in the testing of seamen's eyesight. The value of such an examination is perhaps best illustrated by the following incident which occurred in my own experience. Once coming in from the Western Ocean, making for the Clyde, several officers of a steamboat were busy trying on a misty day to see one of the islands lying off the west coast of Ireland. Some of them were quite certain that they had seen it, others altogether failed to see it; that I think was probably due to the light difference sense of the officers who failed to see it being defective. On dark nights in narrow waters where the shore lighting is defective the light difference sense is of the first importance. A person with defective light difference sense on such a night is likely to have great difficulty in determining where the water ends and the land begins. So also it is to be observed that such impediments to safe navigation as icebergs and waterlogged derelicts do not carry lights; a man with a defective light sense will not see these dangers as easily as a man with good light sense. I cannot but regard the matter as being one of extreme importance.

Visual acuteness in the strict sense of the term is of importance in navigation. Thus an officer will not be able to read charts or tide tables or the various instruments used in navigation unless he has good macular vision, nor will the ordinary steersman be able to read a compass card unless he also has good macular vision. It is therefore of great

importance in these respects. The picking up of objects at a distance, such as other vessels or buoys or a land fall, is not necessarily a function of macular vision at all, but is chiefly a function of field vision, and very especially of the light difference sense. The images of most objects seen at sea are not, of course, primarily formed on the macula but on some peripheral point of the retina—in other words, the appeal first comes to the field vision and not to the macular. No doubt in a very large proportion of cases, when a new object appears on the horizon line, and by the field vision the officer becomes aware that it is there, he instinctively looks directly at it to see what it is and thus brings the object into the macular field. If, however, the light difference sense be defective there is a very much increased chance that the new object will not be seen at all, and danger may ensue therefrom. Long years ago I advocated strongly that the light sense of all men entrusted with the duties of an officer of the watch should be carefully tested, but up till now, so far as I am aware, no steps have been taken to bring about this desirable change. At that time the apparatus available was not very suitable, but the circles introduced by Mr. Percival seem to me to leave nothing to be desired.

One other question remains to be mentioned, although I am sorry to say that I am not in a position to give any answer—it is as to the effect of errors of refraction on what I now call field vision. I have already pointed out that very high degrees of myopia do not hinder a man from working, and that satisfactorily, at coal-mining. Navigation, except for the reading of charts and other documents and the necessary instruments of navigation, does not involve, or hardly at all, macular vision, but does involve field vision. The question then arises, Can a man with a moderate degree of myopia safely navigate? I am not prepared to give a dogmatic answer to this important question. At the same time if the myopia be high I think it would form an insuperable barrier to his being put in charge of a vessel. Personally I have provided myself with convex glasses of 3 diopters when at sea, and certainly the artificial myopia induced thereby would have rendered me quite incapable of performing navigational duties. Still it must be remembered that that is an artificial myopia, and that I had not been in the habit of subconsciously interpreting blurred images. On the other hand, I have known a master mariner who commanded a ship, for some years, and who had a myopia of about 2 diopters in each eye, a condition which presumably had been with him for most of his life. It is just within the range of the possible that a man who has had for most of his life a fair amount of myopia, and who has been interpreting the consequent blurred images, may be quite fit for navigational duties. The work of a man on the look-out is not a function of macular vision, it is a function of field vision, and although I have no data to go upon, except the case of the master mariner just mentioned, I think it is quite possible that even with a fair amount of myopia the field vision is sufficiently good to render a man safe when on the look-out.

The two points which I desire to emphasize in this paper are: first, that for navigation the light sense should be tested as carefully as the colour sense; and secondly, that most manual work does not depend on macular vision at all, but on what I have called field vision, and that therefore it is idle to attempt to evaluate manual efficiency in terms of visual acuteness as above defined.

THE MECHANISM OF HEARING.

BY

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ALTHOUGH from time to time objections have been made to the theory put forward by Helmholtz that the basilar membrane of the cochlea acts as a series of resonators and that by its means analysis of compound sounds is performed in the peripheral receptor organ, it has to be admitted that rival theories present at least as many difficulties. Theories in which this membrane acts as a whole, like a telephone diaphragm, or by "pressure patterns," are inconsistent with the newer knowledge of the conducting properties of nerve fibres. For these reasons the views put forward by Rutherford, Waller, Wrightson, and Ewald cannot be accepted.

In a recent paper Mr. George Wilkinson, F.R.C.S., of Sheffield, also points out that those of Meyer and of Ter