personality. Nevertheless a milder form of operation may greatly diminish anxiety and so take some of the compelling power from phobic symptoms and allow disabling modes of adaptation to resolve owing to lack of emotional reinforcement. A field even more suitable for operative treatment than the typical obsessional neurotic will probably be found in those neurotic patients who show much anxiety, some mild obsessional traits, and perhaps a degree of hysterical overlay. These patients rarely respond to psychotherapy and are often made worse by E.C.T.; but their symptoms are of a kind to respond to leucotomy, and the underlying personality is not so rigid as in the obsessional. In our experience when the anxiety and tension are relieved the hysterical component of the picture also diminishes. Such patients, however, must be distinguished from those in whom hysterical mechanisms are primary rather than secondary, who do not react well to surgery.

Research is now proceeding into the results of surgical treatment of other neurotic states, and is likely to be fruitful. We may particularly mention psychosomatic disorders in which anxiety and rumination are causing more distress than is warranted by the organic factors, other types of hypochondriasis, intractable anorexia nervosa, the mental reactions to intractable pain, tinnitus, organic dystonias, etc. All patients falling into the neurotic group will be considered only if the illness is of some years' duration, and treatment by other physical, psychological, or social means is not indicated or has already been tried and has failed.

The older the patient is the better he is likely to do, as the greater stability and even rigidity of habits of behaviour offer what we might call a margin of error. The increased emotional liability produced by the operation is more upsetting to the young. Furthermore, young persons suffering from a chronic mental illness, even though it be apparently neurotic in form, often prove in the end to be schizophrenic. Practitioners would be well advised, in seeking a second opinion on surgical treatment, not to pay too much heed to the advice of those whose minds are finally made up on grounds of principle. Every patient has to be judged on the merits of his case; and no unbiased judgment will be obtained either from the consultant who believes that all incurable schizophrenics should be leucotomized, or from the psychotherapist who believes that surgery is inadvisable in any case of neurotic illness.

Failures of Operation

The mortality of the operation, in patients who are not in an impaired state of physical health, is in the region of 1%. In few cases will the persons concerned be deterred by such a risk. Much more seriously worth considering are the twin risks of failure to improve and of impairment of personality. Although progress is slow there are good grounds for hoping that improvement in operative technique, itself dependent on increasing knowledge of the function and connexions of the frontal lobe, will permit a much greater degree of precision than at present. Some failures to respond may be due to an inadequate operation, and in some of these cases a second operation has been more successful. Many patients, especially in the schizophrenic group, fail to improve because of the severity of their mental illness. The operation may bring about a greater social accessibility but reveal an unsuspected degree of deterioration of personality and flattening of emotional responsiveness. Such defects in these cases should be

attributed to their true cause, the sequelae of the schizophrenic process, and not in the absence of evidence laid to the discredit of the operation.

Damage to the personality is most to be feared in those whose livelihood depends on its full preservation. What may represent a negligible danger to a man engaged in routine duties may be too serious to face in the case of a writer who needs all his capacity for imaginative and constructive thinking. In the same way the loosening of a sense of responsibility which may follow operation may be a contraindication to surgery in the case of a man with antisocial tendencies, while it is positively desirable in the overscrupulous.

GUIDING THE BLIND

BY

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The question of finding their way about has always been a problem to the blind. The experiences of a great number of young men in the technical arms of the Services, and especially in the R.A.F., who used radar, led many of those who became blinded as a result of their war service to suggest that some adaptation of radar might aid them. This led to a consideration of the scientific possibilities of aiding the blind.

The Problem

To be practical, a guiding aid should give sufficient information about surrounding objects to enable a blind man to walk freely at a moderate speed along streets or inside buildings. To do this it must indicate the distance and direction of any obstacle within 6 ft. sufficiently rapidly to allow the path to be chosen accordingly. Moreover, it must be very light in weight, compact, and inconspicuous. At a range of only a few feet it is impracticable to use a normal radar beam as an exploring medium, and light, or ultrasonic energy, must be used.

A factor to be borne in mind is the natural ability of many blind men to find their way about with little assistance. A blind person who has the ability and inclination to learn how to use an instrument is usually able also to learn to find his way largely unassisted. Then, with the aid of only a walking-stick, or even without this, he can go to and from work, to a friend's house in the evening, or on any journey he knows well. The chief use of a guiding instrument might therefore be to help on totally new routes.

Several different devices,¹ including two based on the use of light beams and three on ultrasonic energy beams of different frequencies, were first constructed at St. Dunstan's. The beam was narrow, about 2 in. square at 6 ft., to enable objects to be located. Range was measured in the ultrasonic devices in terms of the time delay between the transmission of an ultrasonic pulse and the reception of the echo returned by an object in the path. The blind man was informed of the presence of this obstacle by hearing a new sound, the pitch of which indicated the range. Light travels so fast that it is reflected back over 6 ft. or so in an

¹ See *Electronic Engineering*, January, 1951, pp. 2-7.

immeasurably short time, so the range in this case was determined by triangulation. That is to say, the transmitted beam of light was divided into several sections each of which could be reflected into the photocell only by objects at a certain different range. The sections were modulated by tones of different pitch, and the presence of these tones in headphones served to indicate the presence and range of the obstacle.

These narrow-beam devices were found to have the great inherent disadvantage that at any instant the narrow beam allows the user to obtain information about only a very small part of his surroundings. The beam must be continually swung to and fro and up and down as he moves forwards, yet must rest for an appreciable time on any object of small dimensions to allow it to be detected. This slow elaborate scanning procedure necessary for safe progress made the instrument of no practical use. A wider detecting beam, however, means using more power.

With an ultrasonic device transmitting a wide beam and each ear hearing the echo separately through its own receiver it was certainly possible to obtain an approximate idea of the direction from which an echo was returning. There were, however, many disadvantages. Perhaps the most important was that the necessity for maintaining high sensitivity with low-power consumption and for limiting the size of the device by using miniature valves made it impossible to avoid the echoes being, to some extent, distorted in the receiver. As a result it was only possible to locate one single object at any given time, and then only if the echo from that object was considerably stronger than the echoes from other surrounding objects. If several objects were present in the vicinity at roughly the same distance the distortion caused echoes from these to become confused with one another and the resultant sound was completely unintelligible.

A further device was constructed which, instead of transmitting ultrasonic energy, transmitted a succession of high-pitched audible clicks. This was relatively simple: the source was placed near the focus of a parabolic reflector to produce a fairly wide beam with a concentration of sound towards its centre. Its advantages included a lower bulk and weight and a longer battery life than the other instruments, and, since the wearing of earphones was unnecessary, the blind user's ears were free for normal use. The choice of a succession of clicks as the best form of sound to employ was based on a series of tests with blind people. Although the clicks were not the best under all circumstances they did give the greatest amount of assistance over a wide range of different conditions.

The composition of the sound beam—that is, a wide beam, with a concentration of sound on the centre line—was also chosen as a result of tests with various types of beam. It was found that the concentration of sound in the centre made it possible to pick out objects such as trees, pillar-boxes, etc., some way ahead on the line of advance, in the presence of larger objects close beside the user. On the other hand, the presence of at least some sound radiated towards each side made it possible to estimate the position of, for example, a wall beside which the user was walking, so that he could keep his distance from it without the necessity of continuously swinging the beam round towards it. These factors did not greatly alter the reliability or the

accuracy with which an object could be located. They affected rather the speed with which an object could be detected, and by rendering a complex scanning technique unnecessary made it possible to move at a reasonable walking pace.

Experiments with the Clicker

This simple acoustic device, which became known as the "Clicker," had two marked disadvantages. The noise of heavy traffic drowned the click and made it quite impossible to hear echoes from an obstacle, and at other times passers-by could notice the clicker in action. It was decided to test the clicker device extensively under favourable conditions. Three groups of totally blind people—ex-Service men at St. Dunstan's, a number of adults who had been blind since childhood, and children from three schools in the London area—were given training in its use.

The results of the tests were at first very encouraging. Blind men who already had some experience in getting about alone found that the clicker could reveal to them many objects of which they had previously been ignorant. People with less experience were surprised, not so much at the new information, which they were at first less able to appreciate, but at the fact that they could walk about unaided at all. Nearly all were keen on using the device, and some inquired about the possibility of having one for personal use.

The clicker is held in the hand like a torch: it measures 9 in. by 2½ in. (22.8 by 6.3 cm.), has a reflector of 5½ in. (13.3 cm.) diameter, and weighs 2 lb.

Later the attitude of many changed. The more experienced found that the extra information provided by the clicker, though useful in strange surroundings, did not make much difference on routes which were familiar. The less experienced also, as they learned to use the device, learned in addition much about their surroundings which enabled them to move more freely even without it. As they thus gained in experience their outlook tended more towards that of the blind man who had always been able to find his way around. Thus, the device, while apparently useful in initiating people into the appreciation of echoes, would very probably be discarded later.

Results with Blind Children

The period of training at the three schools culminated in a test in which the children were allowed to find their way under supervision, but without assistance, along

an unknown route. The results are interesting in that they show how the speed with which a route is traversed increases as the route becomes familiar even if, as in this case, the route is being traversed only for the second time and in the opposite direction. The average speed at which test routes were covered with the clicker on the outward journey was 2 m.p.h., while without any form of aid it was 1.6 m.p.h. On the return journey, when the children knew the route because of their experience on the outward journey, the average times were 2.5 m.p.h. with the clicker and 3 m.p.h. without the clicker. It seems significant that the differences between outward and inward speeds, with and without the clicker, showed the same trend at different schools. The figures again show clearly that, so far as speed is concerned, the device was of assistance only when the route was unfamiliar.

Throughout these trials, in fact, we found that experienced blind people were well able to travel to and fro on regular journeys, the details of which they had come to know well, and that any attempt to give additional assistance by any form of device was of value only on unfamiliar ground. Indeed, on well-known routes speed was frequently reduced because attention was drawn away from the familiar signs which the blind man had been accustomed to use.

It is worth while remembering that one of the principal handicaps of a blind man is the inability to make use of so much essential information displayed in notices and signs—for instance, on buses, in the street, and in shops. Imagine searching for a house with a certain number in an unfamiliar road. To a blind man no guiding device short of a miraculous “artificial eye” could be of any assistance. Our experience during the tests confirmed that these difficulties were sufficient to deter all but a very small percentage of blind people from exploring new routes completely unassisted, either without a device or with any device which is likely to be practicable at the present time. Apart from any physical danger from undetected obstacles the mental concentration required is very great, because of the inability to use ordinary signs. No doubt a man may sometimes wander down an unknown street out of curiosity, but this would be done in an exploratory spirit rather than as a means of reaching a destination.

A blind man, then, must be reconciled to the necessity of knowing what route he is to take to his destination. Provided he knows where to find his bus stop or tube station, where to turn left or right, etc., he will not be worried by the inability to read notices. If he is thus confined to known routes he will know the positions of obstacles such as trees, lamp posts, etc., and an obstacle-detecting instrument becomes almost redundant.

Besides route-finding and obstacle detection, sight also helps in maintaining poise or balance. A blind man, however, must rely on such sensations as the variation in pressure over the soles of the feet, and when he has to traverse rough or steeply sloping ground there are additional variations in the pressures, and it is less easy to determine the balance. In such circumstances many blind people appear to find that the third reference point provided by the tip of a walking-stick assists materially in walking straight. No doubt the long base line from the feet to the tip of the stick also helps.

The functions of obstacle detection and route-following are the two fields in which it was hoped that a

guiding device might be useful. Now a blind person with well-developed hearing will, in a quiet situation, be able to detect most large obstacles by footfall echoes. If his route runs beside a wall or hedge, he will be able to follow it without any difficulty, and deduce from the cessation of the echoes at what point the wall turns a corner and hence the probable position of turnings in the road.

Experimental Conclusions

We were thus faced with the fact that a guiding device appears to be of little assistance to an experienced blind man on a well-known route, while, even though it might make progress easier on unknown routes, there is still so much it cannot cope with that few blind people are likely to trust to it on new ground. Nevertheless, during the tests a number of interesting facts emerged. Particularly noticeable was the great variation in the ability of different blind people to get about unaided, and together with this the difference that even a small amount of practice made to their ability to co-ordinate all the information at their disposal. Very few seem to lack the potential ability to detect echoes and make use of them, but the percentage of adults who had developed this and made any practical use of it was very small. Among blind children it was exceptional to find one who could not learn to follow a route after being taken along it a few times, and experience gained in this way increased ability to learn a second route.

Importance of Encouraging Independence

This marked discrepancy between the potential ability of most children and the actual development of route-finding ability in only a small percentage of adults demands some explanation. It became clear after discussion of the question that in almost all cases those who had not developed the ability to go about unaided had failed because of lack of opportunity or encouragement. Frequently their family had never let them try to find their own way about and would have been shocked at the thought of them doing so. They probably had not gone to a school for blind children where they could learn with the help of other children, or they had gone to a school where little effort was made to encourage independence and self-reliance. It was noticeable that between the schools where the tests were carried out there was a marked difference in the degree of development of route-finding ability. This ability appeared much more developed where the children had the benefit of large grounds to roam about in by themselves.

The benefit to blind children of opportunities like this for developing their natural abilities cannot be overstressed. They need some early deliberate instruction in the art of getting about. Those, too, who become blind later in life would benefit from some deliberate instruction at an early stage by experienced blind instructors. It is in these early stages that a device such as the clicker may prove useful in demonstrating the significance of echoes. Of course, on many journeys a blind person will prefer the company of a friend or relation who may be going the same way, and in any case not all will develop the ability to find their way alone with any amount of instruction. But it is certain that those blind men who have been able or who through force of circumstances have had to learn to find their own way would be very sorry to lose the independence thus gained.