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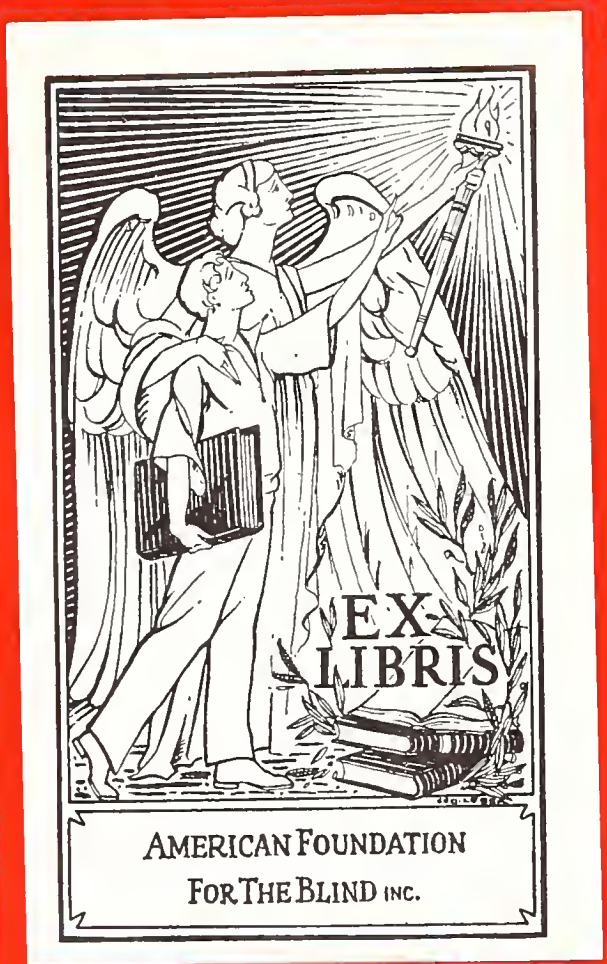

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PREFATORY NOTE

The *Research Bulletin* of the American Foundation for the Blind is intended to be a means of publication for some scientific papers which, for a variety of reasons, may not reach the members of the research community to whom they may prove most useful or helpful. Among these papers one may include theses and dissertations of students, reports from research projects which the Foundation has initiated or contracted for, and reports from other sources which, we feel, merit wider dissemination. Only a few of these find their way even into journals which do not circulate widely; others may never be published because of their length or because of lack of interest in their subject matter.

The *Research Bulletin* thus contains both papers written especially for us and papers previously published elsewhere. The principal focus may be psychological, sociological, technological, or demographic. The primary criterion for selection is that the subject matter should be of interest to researchers seeking information relevant to some aspect or problem of visual impairment; papers must also meet generally accepted standards of research competence.

Since these are the only standards for selection, the papers published here do not necessarily reflect the opinion of the Trustees and staff of the American Foundation for the Blind.

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Since our aim is to maximize the usefulness of this publication to the research community, we solicit materials from every scientific field, and we will welcome reactions to published articles.

M. Robert Barnett
Executive Director
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MOBILITY AND THE BLIND-A SURVEY*

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INTRODUCTION

This paper is intended to be a survey of techniques which have been developed in order to help blind people get about. It will be seen that while many people have had ideas about instrumentation very little has been achieved so far. Basically the reason for this is quite simple: nobody has found out what the real problems are.

The ideal solution for the blind would be to be given full vision, just as the ideal solution for a man without a leg would be to allow him to have a new leg. It must be admitted, however, that the gap between the ideal solution and the technically feasible is so much greater in the case of the blind than in that of the limbless that it is not at all easy to say which intermediate solution would constitute a significant advance. When a man has lost a leg, a good modern artificial leg does represent a significant advance, for the man can now stand and walk without having to use his hands. What is it that comes near to that level of solution in the case of the blind?

This paper sets out to give some background information, and to describe existing and projected solutions.

THE BLIND POPULATION

In England and Wales, every person who is "so blind as to be unable to perform any work for which eyesight is essential" is eligible to have his name put on the Blind Register, an ophthamologist having to make the decision as to whether the person is qualified. We may take it that the Register is fairly complete. There are about 100,000 persons on it, and of these 70 percent are 65 years of age and older. Within each age group there are about 15 percent who are either totally blind or have perception of light only: these are the people whose blindness is such that vision cannot be used to guide their movement. Although many

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people with vision better than that may be restricted in their mobility, it is fairly generally accepted that, little though it may be, their residue of vision is of more help to them than anything yet devised by man.

Among the blind, it is customary to make a distinction between those who were born blind and those who became blind during adolescence and later. Just where one places the dividing line is perhaps a little arbitrary, but people who have become blind within the first few years of life are usually classed with the congenitally blind, from the mobility point of view. The difference between these two classes of blind persons is more than academic; those who are born blind cannot, by definition, have the kind of visual concepts which the sighted share with those who became blind later in life. In an important sense their perception of the world must be different. Whether their adjustment to the environment is any better or worse is quite a different matter.

Mobility Concepts

When considering mobility it is useful to make a distinction between two functions: orientation and object detection. While these two overlap and often complement each other, techniques and aids developed for one need not necessarily be the same as for the other.

There are two factors which determine the extent to which any thing in the path of a blind person is dangerous: the ease with which it can be detected in time and the consequences of any failure of timely detection. Heading almost any list are sudden drops, whether they be curbs or open manhole covers. Similarly anything up to about a foot or so from the ground, like low railings, is dangerous. For most blind people objects propped up by the side of the road or along walls, such as bicycles, are dangerous. Another type of dangerous object is anything jutting out from a post or from a wall, e.g., litter-basket or overhanging awning.

Very much less is known about the factors involved in orientation of the blind, or for that matter of the sighted. But it is reasonable to assume that in both instances orientation is maintained by recognizing and following certain landmarks. The sighted person, having available patterned cues up to considerable distances, probably needs to avail himself of relatively few such landmarks, while the blind person has to carry out a much more frequent "sampling" process. This is however only supposition. What *is* known is that in the absence of known sensory cues from the environment it is very difficult to maintain a straight course for any length of time.

It is customary to talk about travel and travelers when re-

ferring to blind people moving about. There are as yet no standards which enable one to say that a good traveler is one who meets a specified set of criteria. The most useful distinction generally accepted is that between those people who can move about without the help of sighted people and those who cannot. This is of course a matter of degree, and one should not necessarily assume that dependance on the sighted is undesirable at all times.

The type of terrain traversed is usually discussed in terms of the degree of familiarity experienced, and with reference to ambient noise, crowds, and traffic risks.

General Research

The next section deals with two areas of research which are relevant to the problems to be discussed and but for the fact that it is already the title of a well-known book the section might well be labeled "Listening in the Dark" (7).

Obstacle Detection by the Blind

Until not so very long ago it was hard to refute the statement that the ability of some blind people to detect obstacles without actually touching them was due to some sixth sense, uncanny or not. The term "facial vision" was used as a convenient heading for countless anecdotes about blind people who had been observed avoiding objects in their path with the same ease and grace as any sighted person. Most of the anecdotes may not have been very well authenticated (e.g., few people took into account degrees of blindness or of familiarity with the terrain), but the fact remains: there are evidently quite a number of blind persons who have this ability to a greater or lesser extent.

The matter was put to the test in the middle forties of this century in a series of studies initiated by Professor Dallenbach of Cornell University (for a summary see reference 7). Dallenbach, his colleagues, and others after them have demonstrated beyond reasonable doubt that blind persons can and do detect obstacles by means of the existing mechanisms of hearing. Persons who are both completely blind and deaf cannot detect obstacles at a distance (24), and sighted persons blindfolded can acquire the skill reasonably well. Since there is no evidence to suggest that loss of vision brings about any changes in auditory acuity, all the evidence combined suggests at the moment that blind people learn to make use of the auditory information presented and do not have or develop special sensory or central mechanism.

The extent to which auditory information is utilized was demonstrated in two little-known papers by Myers and Jones (17) who asked blind *S*s to detect objects either under conditions of extreme silence, with *S*s allowed to make small head movements, and with the

*S*s able to generate clicks, etc. In the last condition obstacles were detected more frequently than in the first and there were fewer occasions when *S*s made "false positives," i.e., said that there was an object when in fact none was present.

It should be noted that in the final "Cornell" study (1) it was shown that olfactory and thermal cues could be used by blindfolded, deafened *S*s when such cues were present and sound cues not available; and that in Myers and Jones (17) the authors were surprised at the high level of accuracy of detection when *S*s had to remain absolutely still. To quote Ammons *et al.* "Audition is, however, the principal basis of the perception and it is *necessary* only in the sense that its cues are the most reliable, accurate and universal of all the cues yielding perception" (1, p. 553).

The importance of these findings lies not so much in the fact that they served to unravel a widely held myth, as in the encouragement which they gave to those who wanted to help the blind. For one can say now, with rather more conviction than some twenty years ago, that provided a blind person's hearing is normal he has the necessary mechanism to help himself to quite an extent. As will be seen later on, we do not know how many people can make use of the mechanism, nor do we know very much as yet how to train people to make better use of it.

Man is predominantly a visual animal and makes use of other senses for mobility only when deprived of vision. But there are many animals who habitually make use of other sense modalities for that purpose, and it is not surprising that those interested in the problems of blindness in man should have looked to those animals, and with some success.

Obstacle Detection by Bats

Of all the animals which navigate by means other than vision (4), the bat is certainly the one known by most people. For a number of good reasons, it is also the one about which our knowledge is most detailed; in particular it is a good laboratory animal.

In his book, Griffin (7) unfolds the fascinating story of Spallanzani's experiments towards the end of the 18th century, and of how it took 150 years and the development of modern electronic methods to confirm the irrefutable evidence of this brilliant scientist: bats achieve their considerable feats of obstacle avoidance by some sort of echolocation. We know today that at least some species of bat generate ultrasonic sounds and detect obstacles by listening to the reflected echo. The actual mechanism is being slowly uncovered: the two latest areas of interest are the movements of synchronization of external ears with the sound emission, and the electric potentials arising from the bats' inner ears (8, 9, 21).

Generally speaking, bats appear to emit pulsed frequency-swept signals and to adjust the pulse rate as they come closer to an object. Research workers were at one time puzzled because it was very difficult to jam the system with external generators. This was probably because the power of the emitted signal was underestimated; with sufficiently powerful ultrasonic generators one *can* disturb the animals. There still remained the fact that in order to achieve the discriminations which they were able to demonstrate in experiments, the bats had to send out pulses at such a rate that emitted and received pulses must overlap. How was it that the animals did not get confused by their own emitted pulses? In one way or another the suggestion now is that the bats are working on differences between emitted and received pulses. It has been suggested by Kay (11) and Pye (19) that the animals work on the frequency difference, although other suggestions have been made (18). Since bats are blind and yet evidently highly mobile, it is not surprising to find that the system developed by them should have attracted the attention of those who are interested in helping the blind by providing suitable instrumentation (12, 20). It must however be remembered that echolocating bats have evolved more than the chirping apparatus: the whole auditory mechanism is at least quantitatively different from that of other animals, and even from that of *non*echolocating bats. It would appear that all the way from pinnae to auditory cortex there is, as it were, so much "more of it" that it is hard to draw the line between quantitative and qualitative difference. Hence one must be careful when trying to utilize the bats' achievement for the benefit of the blind.

METHODS

For any device to have a chance of survival it has to be better than existing methods, it must be more useful to, and more acceptable by, the blind. It may well be that usefulness may not consist in allowing the blind to do something which they cannot do at present, but rather in allowing them to do it in greater comfort or with more confidence, and this aspect of usefulness may be hard to measure.

Independent Travel Without Aids

There are a certain number of blind people, particularly among the young in this country, who can move about almost any environment with no aids at all. We (15) have motion pictures of blind boys going through busy streets and over obstacle courses completely unaided (see below) and the literature is full of anecdotes on this topic. Although our own observations include cases in which it is hard to realize that a boy moving through traffic is blind, in general it seems fair to say that the boys' mobility was impaired relative to the sighted: they might take two or three times as long as a sighted person covering the same distance, and they would certainly bump into more objects and people. But

these boys, as well as other people we have either observed or heard about, do manage to move about sufficiently well to constitute very little risk to themselves and others. In familiar surroundings they are practically indistinguishable from sighted persons, though closer examination does reveal errors of dead reckoning. Of this group, many will ask sighted people for help when required, i.e., they may find their way to a new destination as far as the street is concerned but they may have to ask a sighted person to take them to the house they are looking for.

Research Areas

As far as is known there is at present no work being carried out dealing specifically with the unaided travel group. One would like to know in more detail just what cues they are using, both for obstacle detection and for orientation. One needs also to know how many people there are in this group, whether there is anything which distinguishes them from other blind persons, what their age distribution is, and how much mental effort goes into traveling without aid. Is it a matter of character, abilities, or skills, or some special combination of the three? Most of all, can some of the techniques used by such blind people be used and taught to other blind persons?

Argument Against Unaided Travel

The main arguments raised are that this form of travel places a very considerable strain on the blind person and that it is in a sense unfair to society and to himself. With varying degrees of severity, this criticism is raised against all forms of independent travel; but there is no real evidence one way or the other.

Cane Travel

This is by far the oldest method of travel and the image of a blind person using a staff goes back a long time. It appears that the first systematic discussion of cane traveling is recorded in 1870 and that it was not until the Second World War that an American service doctor designed a cane-training scheme. There are now numerous rehabilitation centers in the USA, in which cane travel forms a very substantial part of the curriculum. It is claimed that the method in general is very successful and enables many blind people to be independently mobile who would otherwise not be so. Although there is no reason to doubt these claims, there is no hard evidence either as to the benefit of cane instruction in general, or as to any particular method. In this country cane technique is taught on a limited though impressive scale at the Royal National Institute for the Blind (RNIB) rehabilitation center at Torquay and at the London County Council rehabilitation center. Teaching methods are less sophisticated than in the USA.

Very generally speaking, a cane has two functions: it acts as a probe and as a guard. In the American Hoover technique (25) a cane is used which is longer than the conventional walking stick. When walking, it becomes an extension of the arm and is swung in such a manner that the tip always probes the area to be touched by the next footstep, i.e., with the right foot leading, the tip of the cane is brought out well in front of the left foot. The less familiar the terrain, the closer in the cane is brought, the crook beginning to act as a guard with the cane held well below it. The method is undoubtedly conspicuous, even when the cane is rubber tipped to prevent unnecessary tapping noises. The fact that almost any form of cane technique is conspicuous may reduce its acceptability, but it does enable the sighted to note the presence of a blind person. The face is not protected when using a cane, but in the words of a blind colleague, "most obstacles start from ground level."

Using the cane in this way the blind person receives general warning of sudden terrain changes, i.e., step-downs, manholes, and of any obstacles in the path of the cane. But the cane also transmits more detailed and finely structured information; what this information is, and how it is used, is the subject of current work at the Massachusetts Institute of Technology (MIT).

As with other methods of traveling, there are a host of simple procedures which can be taught with respect to the cane: how to negotiate steps, how to align oneself with a straight curb so as to ensure a straight crossing of the road, and so on. It is useful to distinguish between skills and procedures even if the two overlap to a large extent; procedures can often be learned quite easily, whereas the acquisition of skills may give rise to great difficulties.

Research Areas

It appears that active research is being carried out continuously on the design of canes in the USA (16). There are questions not only about the optimum length of canes, but also about the materials from which canes are made. Related to these studies are others dealing with the design of collapsible canes, for one here is caught on the horns of a dilemma: when walking about one wants a long, rigid cane; when reaching one's destination it is often desirable to discard the cane without mislaying it. The collapsible canes available so far are said to lose their rigidity too soon, and therefore cease to be reliable for anything more than the most cursory probing.

A problem interacting with that of the best shape, length, strength, and rigidity of canes is to find what useful information they transmit. Reference has already been made to the MIT project. This is of considerable importance, because the cane is conceived

as a direct extension of the hand and arm. The sensations arising from these are regarded as primary, in the sense that one is prepared to accept the evidence of near receptors when one may doubt that presented by the distance receptors. Within limits therefore, one wants the cane to transmit as much information as the sensors in hand and arm can accept.

A topic which does not seem to have attracted attention is the use blind people actually make of information obtained by the cane. Leaving the auditory aspect aside for a moment, there is the problem of obtaining tactual lead time by the cane. One can of course only sample small segments of the immediate environment at a time; but since the sampling can become well synchronized with the movements, and since response time to tactual stimulation of this kind is likely to be relatively short, quite high rates of movement should be possible, i.e., 2 to 3 mph.

The Argument Against Canes

Some blind people are said to be biased against canes for either or both of two reasons: that it makes them conspicuous, and that they are likely to cause interference with sighted people. Neither of these reasons should be brushed aside lightly. In common with people suffering from other handicaps, the blind do not wish to draw undue attention to their disability. The white stick in particular tends to label people and the label is not always of a pleasant kind. It is also true that unskilled or inconsiderate use of a cane can be awkward to others. One does hear the odd story or two of vigorous blind individuals who use their cane to give expression to their personality. By and large, however, antagonism to the cane is disappearing. In the USA there are many states conferring certain traffic privileges to cane users. In this country more might be done by educating the public, sighted and blind.

Dog Travel

The use of dogs to help blind people is a tremendous achievement. Today it is widespread in the English speaking world, though not quite so popular in other countries. There is an early reference in 1819, with systematic work starting during World War I.

As with exponents of cane travel, the people who train or use guide dogs have claimed considerable degrees of success. Although there is again no hard evidence to go by, the claims can be rather more easily checked. This is because most reputable guide dog organizations provide a thorough and continuous service in order to ensure the well-being of both dog and owner. It is usual for the organizations to stipulate that the dog will be withdrawn if the blind person does not make adequate use of the dog, but this clause has rarely to be invoked.

Dogs can be used over familiar or unfamiliar terrain. They will usually have a repertoire of routes and it may be sufficient for the owner to indicate one of these. Whether covering familiar or unfamiliar routes, dog and owner will go through the drills appropriate for given situations: e.g., the dog will stop and sit down at every curb, the owner will take up crossing position, and the dog will not move until she considers the road safe. The dog will advance as long as there is clearance for herself and her owner whose width and height she will take into acccount.

The relationship between dog and owner is intricate. It is essential for the dog to know both that the owner is her master and that the owner relies on her implicitly. In the last resort it is the dog who can override the owner. But the dog is also a pet. When on duty the link between dog and owner is a stiff handle and as long as the owner holds onto this the dog acts as a guide, and the two together act as a unit. When the handle is dropped the animal is almost transformed and behaves like any other dog which is well-cared for. The organizations supplying guide dogs generally stipulate that only persons with less than guiding vision can qualify to become guide dog owners; they should be at least 16 and not more than 65 years of age. They should be physically fit and have good intelligence. Most important of all, they must be able to get on well with dogs. This last qualification appears to be important, and applies also to the family of the blind person.

A blind perosn going out with a dog is working hard. Certainly physically, for the dog sets a good pace and has to have a minimum of daily exercise; almost certainly mentally, for the blind person is not a passive partner, being dragged along by the dog. It is some measure of the severity of the limitations outlined above that there are some 800 guide dog owners in this country with an estimated potential user population of something between 3000 to 5000 (c.f. "Blind Population" above).

For those who are qualified, the dog appears to be a solution hard to improve upon at the moment.

Research Areas

As far as I am aware the only piece of research which has been carried out with guide dogs is an excellent piece of market research (6) which provides much useful information about blind travel in general. Training methods have been evolved rather than established on strictly scientific grounds, and no comparisons between different approaches to training have been made. In this country at any rate the organization concerned has changed from Alsatian to Labrador because the latter were found more adaptable to a wider range of people. Since guide dogs do appear to offer such a fine solution, research is required to enable more blind people to use them.

Chevigny (5) gives a cogent account of this. Mention has already been made that some people simply do not get on with dogs. And for the dog owner there are the practical difficulties consequent upon owning a dog. Over and above, it is argued that the owner becomes too dependent on the dog, at the cost of becoming less dependent on himself. Again, as in the case of the objections to canes, the point should be taken seriously. There is however, no reason why a guide dog owner should not also have some knowledge of how to get about with a cane on those occasions when he cannot use the dog. There does seem to be a certain amount of prejudice against guide dogs among blind people.

Mobility Training

A brief word about this as it is practiced apart from guide dog training. There are three aspects: route memorizing, cane technique, and sense training. New pupils will start off with simple routes like finding their way about the inside of the training center and gradually progress to walking about crowded streets. Much of this training is learning by heart a succession of geographical cues; corners and steps along corridors, the feel of wooden floor or carpets, the fact that one has to pass three doors to get to the dining hall, etc. Much of it consists of putting certain drills into operation, like road crossing and guarding against probable pitfalls on a particular route. Some of this route learning involves the detection of auditory cues which act as landmarks; kitchen noises, clocks, sounds from certain shops, sounds from one's own footsteps as one goes along a high wall. This is the beginning of sense training, a deliberate attempt to make people more aware of the potential information contained in the auditory environment. These attempts range from simple exercises at auditory localization to elaborate efforts. One such has consisted of recording stereophonically the sounds picked up by a dummy head moving along a busy street on a trolley. Blind people were afterwards asked to listen to the tape and to reconstruct the street scene. The tape was intended for training purposes. In general these efforts have not been very successful; firstly, because we do not really know what sort of cues are relevant, and such cues as are given are probably presented much too early and unselectively. Secondly, because passive listening is in any case not the right way of training, since the pupil does not have the necessary correlation of body movement with position, i.e., the sounds have meaning only in their context. Thirdly, I suspect that there is much in Cade's remark: "Bats are not aware of the fact that they are using echo-location....It is precisely because of this absence of a thinking-out process, because the animals make immediate use of data, that they are so efficient" (4). In trying to make people more aware of sense data at their disposal one may well disrupt their performance more than one would wish. It is like asking a skilled batsman to demonstrate a stroke in

slow motion or a boxer to give a blow-by-blow account. The aim behind sense training is undoubtedly sound, but it will require very careful working out.

Training Duration

In this country a guide dog owner undergoes a four-week, full-time residential training course. The average time spent at the RNIB primary rehabilitation center is three months, but this is considered to be a general period of adjustment to blindness, and mobility is only one of the aspects. A recent survey in the USA found that mean time spent on cane training was about 70 hours. It is as yet not possible to say what one might consider a reasonable minimum training time to reach a given standard of mobility, nor can one say what the factors are which would affect the duration.

INSTRUMENTATION

General Considerations

The existing methods of aiding blind mobility either seek to extend a near receptor (in the case of the cane) or to provide the blind person with a living guide (in the case of the dog). For over half a century attempts have been made to provide the blind with some form of artificial distance receptor. This could not be attempted at all until technology was sufficiently advanced to enable the problem to be considered, and specifically until the first of the sensors, i.e., the photoelectric cell, made its appearance. In some ways it has become a real issue only with the arrival of transistorized circuits and the consequent reduction in the weight and sizes of powerpacks.

There are three reasons why one should want to produce an artificial distance receptor.

1) Implicitly or explicitly inventors have wanted somehow to replace the eye.

2) A distance receptor should provide earlier warning of impending danger.

3) It should be possible to design a distance receptor so that it would be very inconspicuous.

Most of the attempts at instrumentation have consisted of actively radiating, narrow beam systems: "The basic principle of any guiding device would be similar to that of radar equipment, that is, when the exploring beam is intercepted by an object the latter reflects some of the energy in the beam back to the instrument where it is detected and thus informs the user of the presence of an obstacle" (2). But the normal eye does not merely tell one

about the presence of an object anywhere within the field of vision, it can provide information about range, direction, and the extent of the obstacle. This has been attempted too in the case of blind aid instrumentation.

It is important to separate the two functions of a guiding device: that of gathering information from the environment, and that of presenting information to the blind person. Important not merely for purposes of discussion, but as the starting point for any consideration of the role of guidance devices: for having made the separation one can first set about finding out what information is required and what is the best method of acquiring it, then one can consider how best to display that information to the user. In theory any given device could of course be made up of any possible combination of parts serving these two functions. In practice however there has been a tendency to make the two interdependent. In practice, too, very little attention has been paid to the presentation side of the devices: time and again guidance devices have been built which did not take into account the fact that the information which they presented to the blind person had to be acted upon, and acted upon quickly. The reason for this is not that engineers are not able to build suitable displays, but that psychologists have not been asked to find out the properties of good displays for guidance devices.

Following the analogy with the information provided by the eye, one would naturally want to have a guidance device which gathers information over a wide area and displays it in a suitably patterned form. Kuliszewski (14) seeks to do this by an eighty-channel optical device displaying patterned tactual information, and Kay (12) is actively pursuing research on a binaural stereophonic device. In practice, however, almost all devices which have got beyond the breadboard stage have been narrow beam, single channel affairs. With such devices one perceives the environment in a manner analogous to a person having gunbarrel vision. It means that one has to adopt some form of scanning movement to explore the environment and to make a construct of the outside world by joining the outputs from successive scans. The attempt has been made to provide automatic scanning (23) but mostly it is manual. If the scanning is automatic the blind person is more likely to be warned of obstacles within a useful arc than when the scanning is manual. But unless some additional information about the moment-to-moment position of the scan is provided, the user does not know where within the arc an obstacle has turned up. Manual scanning does provide this additional information, plus greater flexibility in the scanning movements, but at the risk of missing some obstacles.

Turning now to the presentation of information, we find firstly that this can be either auditory or tactual; secondly, within these modalities, it can be coded in a variety of dimensions: frequency, intensity, duration, etc. Since blind people rely a

great deal on their ears already, some designers, notably in the USA, prefer using tactual stimulation. On the other hand one has a wider and richer range of possible stimulation in the auditory field.

Design Requirement for Instrumentation

A very full list of these has been given by Dupress (16, pp. 226-229). He is an authority on the subject and four key statements will be quoted:

1) the device should provide more information than is obtained from existing sources,

2) the device should not provide too much information for the individual to process and utilize,

3) the device should not require excessive mental abilities or concentration,

4) it should not require too long a training period.

To these points are added requirements about weight and size, simplicity of operation and maintenance, and the minimum life of batteries. A device obviously has to be reliable and rugged.

Evaluation Requirements

There are two aspects of this: firstly, it is necessary to ensure that the device complies with the physical specifications and that the hardware functions properly; this is essentially a laboratory procedure. Secondly, there must be tests with blind persons under realistic conditions. The ultimate criterion of success is the continued use by blind persons of the device. Failures may be due *either* to the fact that the device did not in fact help the blind persons, *or* that, though it helped, it was not acceptable. The device may not help for a number of inherent reasons, e.g., that it could in fact not provide the blind person with necessary information in a usable form. But it may also not help because the actual piece of tested hardware was insufficiently well engineered. In common with any other piece of equipment which has to be user tested, the transition between breadboard and production is a long and a costly one; on the one hand, one is reluctant to commit oneself to freezing a design on the basis of insufficient data, while on the other, the desirable degree of ruggedness and reliability can usually only be achieved economically on the assumption that there will be reasonably large scale production of the device. The history of evaluation trials of blind guidance devices is not a happy one.

INSTRUMENTATION IN THE UNITED STATES

Shortly after the Second World War, a formidable effort was made by a government-sponsored committee to coordinate the research on aids for reading and mobility for the blind. The impetus for this effort was provided partly by the presence of the recently war blinded exservicemen, and partly by the state of technological development. In particular it was thought that with the experience gained with radar as a technique and miniaturization as a craft, the time was opportune for a concerted attack. All the devices tested were narrow beam devices making use of either sonic or optic information gathering, and using either auditory or tactual methods of displaying presence and range of objects in the beam. Pulse and frequency modulated systems were used (see below). While none of these devices are still in use it is perhaps worth describing briefly one of the more promising. The Signal Corps Optical Guidance Device had a maximum range of 15 feet and a minimum range of 3 feet. An object at maximum range was signaled by a 500 cps tone heard twice a second, while one at minimum range was signaled by the same tone being sounded 32 times a second. A very narrow beam of light was partly reflected to a receiving lens and then on to a rotating coding disc having a different number of holes placed in concentric rings. The closer an object to the device, the further out from center the reflected light would be received. Behind the coding ring was a photocell and it was the activations of this which produced the signal to the user. The whole device was housed in two units, one for light source, receiver, etc., and the other for the powerpack.

This device and a number of others were evaluated both indoors and out of doors. It is of course easy to be wise after the event, and to produce many criticisms of the whole program. The positive outcomes were these:

1) it was concluded that far more effort should be put into analyzing the requirements for guidance devices from the user point of view

2) that future evaluations should be carried out for longer periods and with better experimental designs

3) that priority should be given to the further development of an optical obstacle detector somewhat on the lines of that described above, and to the development of cane-mounted curb detectors.

The optical obstacle detector is still undergoing evaluation at this moment by the U.S. Veterans Administration. If further information about this becomes available in time a note will be added to this paper.

Curb detectors come in two types. There is the Franklin In-

stitute electronic cane which makes use of a capacity change between tip of cane and ground level in order to indicate when a critical distance has been exceeded. An optical method makes use of the so-called hide-and-seek principle: in one proposed version a spot of light coming from a source fixed to the upper part of the cane is "looked" at by a sensor fixed lower down the cane. When there is a sudden drop the spot is lost and the blind person receives a warning signal through the handle of the cane. There is not sufficient user evidence on either of these devices so far.

It is perhaps significant that the Americans, after many years of experience, appear to have gone in for devices which produce a minimum of information for the user.

INSTRUMENTATION IN GREAT BRITAIN

There have been two major efforts in this country, both sponsored by St. Dunstan's. The first was carried out some 15 years ago by Beurle (2) and in the second a device designed by Kay (12), and built by Ultra Electronics Ltd., was evaluated by Leonard and Carpenter (15).

Beurle considered a number of guidance devices then in existence and built several of his own, using light and acoustic energy for the information gathering. Not one of these devices was developed for field trials. Quite apart from miniaturization problems Beurle did not feel that any of his laboratory prototypes were sufficiently useful to warrant their further development, though in point of fact they were more than adequate contemporaries of USA devices at the time. Following his experience with blind people, and seeking to use the fact that they commonly generate clicks and taps in order to detect obstacles, Beurle went on to construct an electronic clicker housed in a directional reflector. This device, although it attracted the attention of other people on account of the noise, was found to be acceptable. It was evaluated with school children and exservicemen. It was possible to detect obstacles from the reflected clicks and people found the device useful. But nobody went on using it for any length of time. What did emerge was that such a device might act as a tool for training: it could make people more aware of the sort of auditory information which could be obtained from the environment by natural means. Beurle concluded that the reason for the failure of guidance aids up to this time was that blind people seemed to be able to do very well without them, that the aids did not add significantly to the blind persons' ability to get about. It is worth noting that Beurle entered a strong plea for more noninstrumented mobility training to be given.

The next attempt was made by Kay. Stimulated by Griffin's work (7) he set about solving the problem posed by the bats and arrived at much the same conclusion as Pye (20), i.e., that the

bats were probably operating on the frequency difference between emitted and received signals. In his paper Kay (12) describes the various systems tried out by him and gives reasons for preferring a frequency modulated system to a pulse system: generally speaking the latter was not capable of producing enough information for the user and specifically it was not possible to estimate the range of objects. On the basis of this work Kay produced a portable FM guidance aid which was subsequently developed for field trials. As shown in Figure 1, the device consists of a hand held "torch" carrying the transmitter and receiver, a box for the circuitry and batteries, and an earpiece.

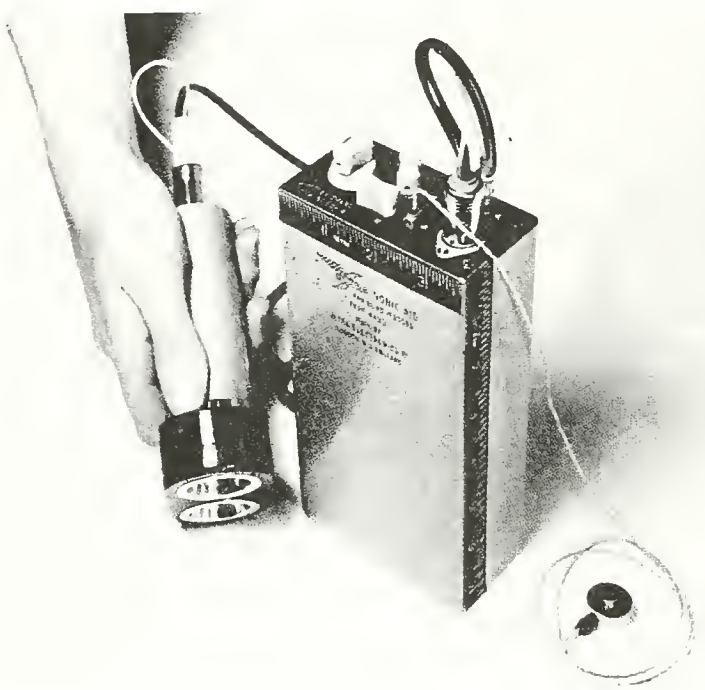

Figure 1. The Blind Guidance Device Designed by L. Kay and Produced by Ultra Electronics Ltd.

The box weighed about two pounds. It had a range switch and a volume control. There was a near range, up to about 10 feet, and a far range, up to about 20 feet.

Kay's device produces a 10-degree ultrasonic beam. There is continuous transmission of a sawtooth-shaped signal which is swept from 60 through 30 kc/sec (see Figure 2) with a repetition rate depending on the setting of the range switch: a slow rate of approximately 4 to 5 sweeps per second for the long range, and a fast rate of approximately 8 to 10 sweeps for the short range.

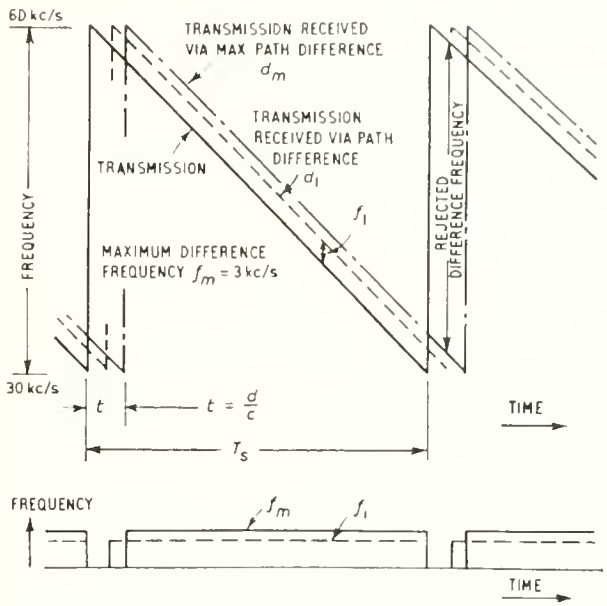

Figure 2. Parameters of the FM system. T_s=200 msec (far range) or 100 msec (near range). See reference 12.

Ideally the listener will only hear a signal when there is an object in the beam. The display is produced by the difference in frequency between emitted and received signal and is therefore in the audible range, except for the flyback period when a filter rejects all frequencies above 3 kc/sec. What one hears is a series of pips (their rate depending on the sweep repetition rate) having a high pitch when the object is far away, and going down in pitch as the object comes closer. Range is therefore indicated by pitch. Intensity of the returned signal gives some indication of the nature of the reflecting surface, since better reflectors return more intense signals. Loudness therefore becomes one of the cues of type of obstacle encountered. There are other sound qualities described by Kay (13) and reported by listeners as "sharp" (as when obtaining the echo from a mirror) and "mushy" (as when listening to the echo from a bush). Direction is given by the position of the hand held "torch."

The properties of ultrasonic radiation are in many ways similar to those of light radiation. Of particular concern here is the specularity of the reflection. This means that a mirror, approached at 45 degrees may not return an echo at all. On the other hand at these very short wavelengths it is possible to trace the outline of an object with fair accuracy by scanning the contours.

In the Kay device the earpiece was not placed directly into the listener's ear but connected to it by means of a plastic tube and a molding fitting into the external meatus. The center of this fitting was drilled through so that external sounds could

reach the eardrum. The reason for this elaboration was that blind people do not like having their ears unduly obstructed.

I have described this particular aid in detail firstly because it is the only one I have used and worked with myself. Secondly, because many of the problems encountered are similar to those of other types of guidance device. And thirdly because it is generally agreed that the Kay aid is the best guidance device yet developed.

Evaluation of the Kay Device

Under the continued sponsorship of St. Dunstan's, Ultra Electronics Ltd. were prepared to make ten prototypes of the Kay device and we were asked to carry out evaluation trials with them (15). As mentioned earlier there are two questions which always have to be asked in an evaluation: firstly, what can be achieved with the device, and secondly, is the device acceptable? As is often the case, the answers to the two questions are not entirely independent and that to the second can usually be obtained in a more unambiguous form. For people not only express their opinions about a device, they also carry on using it or stop doing so after a while. How one interprets the answers is a different matter.

We concentrated therefore on the problem of finding out what could be achieved with the aid under the best possible conditions. Immediately the problem referred to earlier presented itself: nobody could tell us in any concrete form what blind people might be expected to achieve at present, i.e., what the new system had to beat to be considered a starter.

There are various aspects of performance which are measurable. Time taken to cover a route, degree of success achieved in dealing with obstacles, and stress experienced during travel are perhaps the three most obvious. We decided to use the first two only, and in the absence of accepted standards of mobility we decided to use a control group. The first part of the trials we carried out at Worcester College for Blind Boys, a residential grammar school, and the second at Ovingdean, the St. Dunstan's training and holiday center. At Worcester we hoped to find out what could be achieved with the aid under the best possible conditions: our subjects were aged from 12 to 18 years, intelligent, keen, highly mobile and under the discipline associated with a residential school. With the help of headmaster and staff we were able to work with these boys for six weeks, making them go through obstacle courses and the crowded streets of Worcester.

There were eight boys who kept their individual aid throughout the trial, and another eight boys who were similar to the first in as many respects as possible, but did not have use of the aid. We treated the aid as a supplement to ordinary methods of mobility and concentrated mainly on obstacle detection and avoid-

ance, rather than on orientation. Since the boys normally made little use of canes we did not allow them to use canes at all during the trial. For the obstacle courses our measure of performance, apart from time, was a subjective judgment on how well they coped with each obstacle in turn; they were allowed to make contact with obstacles and were not discouraged from using their hands as well as the aids. For the street courses we did not have any measures at all but took some films over a fixed distance. The general plan for the trial was that we would train the boys as best we could and give them tests before and at regular intervals during the trial.

We benefited from the accounts by Haskins (10) and Beurle (3) in many ways: particularly in the choice of obstacles and in the knowledge that blind people making their first acquaintance with such devices are liable to wreck experimental programs by their enthusiasm at being able to detect previously ignored objects.

This is what we found: to begin with, the boys with the aid were indeed more effective in dealing with the obstacles than were the other boys; but this was achieved at a considerable slowing down of the rate of movement. By the end of the trial the two groups of boys were equally good, i.e., they took the same time and had the same accuracy score when going through an obstacle course. Since the obstacle courses were not all the same it is hard to say objectively whether the boys without the aid had become slower, although one can say that they had become relatively more accurate than on earlier occasions. Our impression is that both groups improved, the boys with the aid became faster by concentrating on essentials, and the boys without the aid became more accurate because they had learned to cope with the types of obstacle we were using. In the streets it seemed to us that the boys with the aid were perhaps a little better than the boys without. The aid did seem to help them maintain a straighter course. All but one were full of praise for the aid and would have liked to carry on using it.

A major incidental finding was that the aid presented subjects with signals which were liable to be confusing. Because of the specular nature of some reflections of ultrasonic transmission, an echo from, say, the cornice of a shopfront might come back with very high intensity, though still with the same frequency. The boys would literally jump because they interpreted the sudden loudness as a danger signal. A small controlled experiment showed that most of them were in fact able to separate pitch and loudness information when they had plenty of time to make the judgment.

We also established to our satisfaction that the aid was useful in the presence of external, high intensity noise - a source of trouble frequently encountered by blind people.

One of the most interesting results of this work was that we were able to establish and demonstrate the very high level of ability of the boys who did not use aids.

For the second part of the trial we went to Ovingdean and here the accent was largely on acceptance of the aid by older and/or handicapped men. Once again, expressed enthusiasm for the aid was considerable, but out of some eleven men who had the opportunity only two would have wanted to carry on, and only one showed any proficiency.

Conclusions from Evaluation of Kay Device

We were forced to the conclusion that while the aid did all that was claimed of it, and while it could be used by, and was acceptable to highly intelligent boys, the aid did not appear to give significant help to those who could make use of it. In our recommendations we asked that "the mobility needs and requirements of the potential users of the aid are investigated and that specifications for acoustic aids are considered in relation to the results of such an investigation." We also recommend that "the performance capabilities of acoustic aids be considered in relation to other aids, such as the cane or the guide dog" (15).

It is not my intention to go into lengthy details to back these recommendations, but there are some points which can be made briefly. Firstly, almost any "gunbarrel vision" device such as the present version of the Kay aid has inherent limitations; searching the environment with it is like looking at the outside world through a drinking straw with one eye. Secondly, there are the two functions of it: it has to gather information and it has to present the relevant information to the blind person. There is good reason to believe that the Kay device represents a marked advance on any other device with respect to the first function. It is the manner in which information is presented to the user which does not appear to me satisfactory. Thirdly, I am not yet convinced that the information which the Kay device can gather is of more use than that which could be obtained by intelligent use of the cane.

It only remains to be said that Ultra Electronics are intending to produce a further batch of 100 guidance devices based on Kay's design, that these will be somewhat modified from the original version, and that St. Dunstan's have placed an order for half that number. It is hoped that further evaluation work will be done with these aids.

Orientation Instrumentation

To date there appears to be only one significant effort in this direction. Swail (22) has described a simple modification to any

good quality portable transistor receiver. This enables one to take better advantage of the directionality of ferrite aerials used. By nulling on any given station, by means of the specially provided auditory display, it appears to be possible to achieve accuracies within 5 degrees. The method is now being tried out in Canada. Swail himself points out the obvious dangers in built up areas. In principle this approach does offer rather appealing prospects with large towns providing special beacons for their blind population.

DISCUSSION

In the Introduction, the reason why so little has been achieved by way of instrumentation for blind mobility was said to be that nobody had found out what the real problems are. And qualifying this remark a little, a comparison was made between providing a blind man with full vision and a legless man with a new leg. To what extent can this paper be said to justify the introductory remarks?

1) While it is possible to describe the several techniques developed to help blind people get about, it is not possible to say how many blind people do in fact move about or how well. There are no data on the basis of which one might make comparisons between different groups of blind people, or between blind and sighted people. At the risk of being misunderstood this point may be put another way: we do not know for how many people blindness constitutes an impairment to their mobility, or the extent of such impairment. It is suggested that in a very real sense it is almost meaningless to attempt solutions to unspecified problems.

2) To the extent that it is possible to do so, the considerable potential usefulness of existing methods has been described. It is perhaps worth while emphasizing some simple indices here: some of the blind boys examined moved through crowded streets at speeds similar to that of sighted pedestrians, while the majority moved at about half the speed, this without even a cane. No exact data could be quoted on cane travelers, but it is said that they move at comparable speeds to those mentioned for the boys, and it is theoretically possible for them to do so in reasonably familiar terrain. A guide dog takes his owner through crowded traffic at what may be described as a brisk pace, at least as fast as the surrounding pedestrians and probably a good bit faster. So much for "estimated" indices of proficiency.

3) When describing the blind population the point was made that only those people with perception of light only, or who are totally blind, are considered to be in need of positive aids to mobility, and it is only people whose vision is impaired to that extent who qualify for training with guide dogs. It is generally held that even the very little information provided by "perception of hand movements" is sufficient to provide the blind person with

has probably a higher chance of success. There must of course always be a place for the brilliant inventor to achieve an epoch-making breadthrough, but even he may be grateful of the opportunity to check his assumptions and guesses against reliable data.

SUMMARY

This paper seeks to provide background information about the mobility of the blind with regard to the possibility of providing instrumented mobility aids. The first part of the paper gives some description of the blind population and defines some of the terms used. The second part deals with the status of existing systems, in particular the roles of cane and guide dogs. The last section gives a short account of recent attempts at providing instrumentation and includes the description of an evaluation trial of the most recent guidance aid. The discussion contains suggestions for further research. The theme of the paper is that further advances in the field of blind mobility are limited by lack of knowledge about the characteristics of the blind rather than by physical or engineering considerations.

SUGGESTED READING

There are two books generally available to the interested reader: Zahl (1950) of which there is now a new edition, and Griffin (1958). While all of Zahl is relevant as background information, Part VI deals specifically with the subject matter of this paper. (See References below.)

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REACTIONS TO PHYSICAL DISABILITY BY THE DISABLED AND THE NONDISABLED*

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INTRODUCTION

This paper presents a clinical and theoretical analysis of dynamics underlying (a) reaction to personal physical disability, and (b) negative attitudes of the nondisabled toward the disabled. The theoretical model utilizes the concept of narcissism and directs attention to "depth of narcissistic withdrawal" and to bases of object choice in the disabled.

Surveys of attitudes toward physically disabled persons indicate that although public, verbalized attitudes toward the disabled are usually mildly favorable, a sizable minority openly expresses negative attitudes. Indirect evidence suggests that deeper, unverbalized attitudes are more frequently hostile (2). Valuable insights regarding the implications of negative social valuation of the disabled from the point of view of social psychology, value systems, and anthropology have been uncovered by Meyerson, Barker, Dembo, Hanks and Hanks, and others (1,4,7,9). A basic insight derived from these studies is that self-devaluation occurs in a newly disabled person because of negative attitudes toward the disabled which he himself had before the onset of his own disability.

Barker et al. note that the attitudes of disabled persons toward their own disabilities have been inadequately studied. "The available evidence suggests that these attitudes (a) vary widely, (b) have little relation to the degree of disability, (c) are related to personality characteristics" (2, p. 85).

The purpose of the present paper is to supplement the cited views through a more specific elaboration of those personality characteristics which our experience has shown are important in determining reactions to disability. It is particularly directed toward the description of those aspects of the premorbid personality especially relevant to posttraumatic reactions.

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*This is an extension of a paper presented at the 1959 Convention of the American Psychological Association. I would like to thank Dr. Samuel A. Weiss and my brother, Mr. Harry Siller, for their comments.

Extensive treatment of problems of physical disability has been done by Meng (8) utilizing questionnaires, interviews, and psychoanalysis. He maintains that even the most serious physical disability does not necessarily result in a distorted personality. Factors in the environment of the crippled person tend to increase or decrease the probability of personality distortion. Some of these factors include:

1) narcissistic satisfactions
2) interference with normal play activities in children
3) overcompensation in children due to inferiority feelings caused by overprotection or rejection
4) hypochondriacal development
5) blaming others for the handicap.

Numerous sources of attitudes toward the disabled have been identified. Among these are the guilt and unresolved problems of the parents and the inability to empathize with the disabled individual because of the latter's unusual appearance and postures. Meng adds three more sources based on psychoanalytic investigation: (a) belief that the disability is a punishment for evil, and hence that a disabled person is evil and dangerous; (b) belief that physical distortion is an unjust punishment that motivates the person to do an evil act in order to balance the injustice; (c) projection of one's unacceptable desires upon the disabled which engenders the belief that the latter is evil and dangerous. Chevigny and Braverman (3) place considerable stress on activation of castration fears.

Narcissism in the nondisabled observer has not, until now, been considered as a source of negative attitude.

NARCISSISM AS A GENERAL FACTOR IN REACTION TO DISABILITY

The specific utility of the concept of narcissism as a factor in reaction to disability will be discussed. It is advanced that the degree and fixity of the individual's balance of self to object cathexis is a major determinant of reaction to personal disability and the disabled.

The classic analytic explanation of reaction to disability involves withdrawal of libidinal cathexis back upon the ego and an emphasis of libidinal attachment to the injured part, often with narcissistic satisfactions.

Wittkower (17) states that degree of narcissistic injury depends on the disabled person's constitutional narcissism, on the seriousness of the disability, and on the nature of the disability. All three concepts, however, require considerable amplification in order to be useful.

Freud, in his 1914 paper, "On Narcissism," maintains "the sick withdraws his libidinal cathexes back upon his own ego and sends them forth again when he recovers" (6, p. 39). This pattern is usual in both permanent and temporary disabilities. Initial reactions to disability subsequent to general shock often entail depression and gradual emergence during the rehabilitation period. Chronic disability follows the same pattern as less permanent disablement except that in a majority of cases the libidinal cathexes remain with the ego, and are never again fully extended toward external objects.

The crux of Freud's concept of narcissism as an aid in understanding reactions to disability lies in his treatment of self-regard. "The realization of impotence, of one's own inability to love in consequence of mental or physical disorder has an exceedingly lowering effect upon the self-regard" (6, p. 56). Freud points out that not being loved lowers self-esteem, while being loved raises it. The importance of family support for the disabled readily confirms this observation and leads us to inquire into the reasons for the failure of such support.

Diminished self-regard is intimately bound to now irreparably damaged remnants of infantile omnipotence. Crippling effectively demonstrates the transient nature of life and how puny are our efforts to cope with and to control events. Conditions are favorable for the formation of anaclitic object relationships as exemplified in patient-nurse involvements.

Levels of Narcissistic Regression

The present concern is to systematize what seem to be discrete incidents and interesting bits of information about disability. We are not involved here with the theoretical status of the concept of narcissism.

Reactions of the nondisabled, as well as of the disabled, may be arranged along a continuum, from a basic narcissistic cathexis to a basic object cathexis. Several landmarks heuristically labeled as "depth of narcissistic regression" can be identified. More will undoubtedly evolve with further consideration from this framework. Each of these (landmarks when viewed developmentally, types when viewed characterologically) is discussed from the vantage points of both the disabled and nondisabled.

Characteristics of each type, their amenability to attitudinal modification, and their relation to object choice are discussed. Five levels ranging from "slight" to "considerable" regression are described, first for the nondisabled reaction and then for the disabled.

Individuals Who Have Attained
Mature Object Relationships

In the nondisabled only transient aversions (if any) to the disabled characterize these individuals. Personal insecurities are not activated, and it is likely that really strong identifications with the disabled do not occur. When stricken by disability, emotional recovery is quick and adequate. Self-regard is not impaired and libidinal cathexes, after a relatively short while, are again directed toward the object world. These individuals are realistically independent, recognizing the implicit devaluation of the person to whom assistance is offered. However, they can accept proferred help and are able to ask for it under appropriate circumstances. Their attitude of self-acceptance makes it easy for others to accept them on a basis of equality. Characteristic reactions to disability include compensation, sublimation, and nonmorbid introspection. Little to average sensitivity about appearance is shown.

Individuals Who Have Attained
Object Relationships Based Primarily
On Physical Appearance or Physique (Type I)

These persons have found their chief source of social rewards in their physical prowess or appearance and are basically anaclitically object oriented. Their security is dependent upon social acceptance and approval

The nondisabled at this level "would rather not think of it." Disability is imagined to be unpleasant but, because of inability to relate the condition to themselves, aversion is not too great. External support, particularly by the family, is of crucial importance upon being disabled. They mourn the impairment but almost as disturbing as the damage or loss is the necessary reassessment of their "worth." Contact with well rehabilitated persons is particularly beneficial as it provides the basis for ego recovery in persons receptive to rehabilitation and who have sufficient ego strength to profit from it. Most important is ability to develop new sources of social gratifications if the former no longer suffice. Compensations for the disability are frequent and often relationships are formed in which the disabled individual plays a basically dependent role. Independence is highly prized in the form of a reaction formation to dependency feelings as it serves to enhance self-regard and to prevent status devaluation. Others resort to invalidism for its secondary gains.

A combination of these elements operates in amputees who become "prosthetic athletes," i.e., who attain very superior prosthetic functioning. Their prowess serves to expedite development of successful compensatory efforts, permits a high level of independence, enhances feelings of worth and competence, and evokes social rewards through the admiration and respect of others. Al-

though such performance requires considerable narcissistic attention to the injured part, libidinal attachments are object directed. Reestablishment of semblances of infantile omnipotence, reinforced by social acceptance, provides the basis for a high level of self-regard.

Individuals Dominated by Castration Anxiety

These are included in the narcissistic model because disturbance of normal object cathexis development and disruption of omnipotence feelings are involved. In the nondisabled castration anxieties are readily activated by the presence of disability, and the strength of this reaction is useful in determining the strength of fear. In most cases of this type one may suspect that the major mode of interaction is based on a narcissitic object choice, and that disability severely interferes with identification.

One nondisabled patient reacted to castration fears, generated by entrance into the vagina, by inability to attain an erection. He always avoided the physically ill and was extremely distressed at the sight of physical disability. Suspicion that his fiancee might have an ulcer condition led him to break off their relationship.

As there is general analytic agreement about the potential of disability to activate castration anxieties, this point will not be discussed further here.

Interestingly enough, Meng, himself a psychoanalyst, found no indication that physical disability increases the castration complex (8). He feels that the physically handicapped are not fearful of castration since they already have experienced it. Experimental evidence in an unpublished study by Block and Ventur, who used the Blacky test with amputees, indicates that there is an increase in castration fears in some and a decrease in others. Our own experience is in accord with these findings. At the present time the relationship between pretraumatic castration fears and posttraumatic castration fears remains indefinable.

Individuals Who Have Attained
Object Relationships Based Primarily
On Physical Appearance or Physique (Type II)

This type, while superficially similar to Type I, involves much more regression which is rooted considerably deeper in primary narcissism. Whereas Type I is basically anaclitically object directed, Type II is essentially narcissistically object oriented. Personal disability is always drastic; disability in others is always a threat. The greater negative reaction of women than men to disability is related to dynamics at this level. (This does not negate or minimize the importance of the differential social premiums of disability for the sexes.) The highly narcissistic woman is the

prototype of this group.

Security is based only secondarily upon acceptance and approval of others, because it is principally centered around exaltation of the self. An exaggerated sense of perfection or superiority exists, based not on reaction to feelings of inferiority but rather on infantile megalomania. The approval of others is merely comfirmation of approval of self. The presence of disability cannot be ignored (as with Type I) because it interjects reality principle functioning in an area dominated by pleasure principle thought processes. Physical insult is synonymous with psychological insult. Although castration anxieties are almost always seen, the level of psychosexual fixation is more oral than phallic. Attitudinal modification is difficult. Considerable sensitivity about appearance is shown. Defensive reactions are directed toward avoidance of the personal and social implications of the disability. As a consequence, withdrawal and repressive mechanisms are more important than are restitutive ones.

Type II individuals are benefitted less than Type I by external support because security is based on an internal value system dependent upon assurances of omnipotence. It has already been observed that family and external support is generally exceedingly helpful with Type I cases. It is our belief that differentiating between Type I and Type II individuals may cast some light on the reasons for the fact that some patients benefit from family support and rehabilitation efforts while others do not.

Individuals With A Basic Defensive Narcissism

The deepest regression involves individuals with strong narcissistic fixation points due to insecurity in the earliest experiences involving object cathexis. All subsequent object relationships are tentative, and basic defenses and gratifications lie within self boundaries only. The physical body is a border between self and non self, and also a prime object of narcissistic gratifications. Disability poses a threat of demolishing the ego in a person primarily ego oriented. Object cathexis gratifications are trivial and readily yielded. Castration anxieties are secondary to pregenital fears. These individuals have the strongest aversion to the disabled.

When disabled, profound and prolonged depression is accompanied by continued self-hate. Under ordinary circumstances recovery of adequate self-esteem or security is unlikely and pathological reactions are most frequent among these persons. Object choice must be narcissistic, and not infrequently a general withdrawal from all objects occurs. Independence is essential; but, unlike those individuals with little narcissistic regression, this is a pseudoindependence, masking an inability to accept the reality situation and a fearfulness of exposure in a hostile world. Pseudoindependence in its clearest form can be identified by the

compulsive need to act for oneself and by unwillingness or even complete inability to accept help, regardless of the manner or circumstances under which it is proferred.

The primary orientation is towards avoidance of the implications of disablement. Specific reactions to disability include depression, withdrawal, repression, shame, overcompensation, and denial of disability. Considerable sensitivity about the disability is felt and feelings of inferiority are reacted to by generalized hostility.

The work of Fisher and Cleveland on body image boundaries is particularly relevant for study of such individuals (5).

The preceding characterizations are preliminary formulations and are only a few of those that may be identified eventually, using the construct of narcissism.

Finally, Freud's conception of the various narcissistic and anaclitic types of object choice can briefly be described in terms of disability.

To Freud, a person may love, according to the narcissistic type:

1. *What he is himself (actually himself)*

Applied to disability this involves indifference or even aversion to those who differ from the person too greatly physically.

2. *What he once was*

Illustrative is the identification of some disabled with persons, places, and things strongly and positively cathected before disablement. In effect, by being with or phantasizing about pretraumatic objects the person becomes at one with his previous self. If no serious distortion of reality results, this may safely serve to provide satisfactions not otherwise available.

3. *What he would like to be*

The usual hero-worship for athletes, actresses, etc., is found among disabled children as well as nondisabled children. Among disabled adults, this identification is more restrained and socialized and the dynamic basis is probably no different than that of nondisabled adults. In rarer instances the disabled person may assume the role of "loyal follower."

4. *Someone who was once part of himself*

Best sublimated is the disabled person living through his children. Generalization of this reaction is possible when

constituents of the extented self are considered.

To Freud, a person may love according to the anaclitic type:

1. *The woman who tends*

In many instances this is the nurse or other medical personnel. The excellent therapeutic effect of good family support undoubtedly has roots in this quality of object cathexis.

2. *The man who protects*

Certainly the physician as a parental surrogate is recipient of such cathexis. Later he may be replaced by the employer. It is of considerable interest to note that an extended form of this type, involving the government who protects, is often confused with supposed "reality" factors. Thus it is possible to understand the motivation of many of the disabled who hold down relatively poor paying and personally unrewarded positions as Civil Service employees for fear of disrupting this basic dependency relationship.

CONCLUSION

In conclusion, the aim of this paper has been to relate some of the discrete phenomena of disability by employing the concept of narcissism. By this means it has been possible to draw some tentative sketches of classes of reaction to disability. A specific goal has been to highlight the relationship of premorbid personality structures to posttraumatic reaction in terms of level of narcissistic regression. No serious attempt was made to relate levels of narcissistic regression to stages of psychosexual development. However, it was believed that a definable relationship exists. In closing, the applicability of Freud's conception of anaclitic and narcissistic types of object choice for the disabled was shown.

Considerable work needs to be done on understanding the reactions to physical disability. It is suggested that experimental work relating ego strength and self-regard to attitudes towards disability will prove rewarding. Research of this nature has been in progress under the sponsorship of the Vocational Rehabilitation Administration, and reports made (10, 11, 12, 13, 14, 15). The results, to date, have again shown the difficulty in eliciting strong relationships between psychodynamic material of the nature discussed above and the usual psychological techniques for measuring personality variables, e.g., self-report inventories and projective techniques. However, there is some confirmation of the basic relationship between personality structure and attitudes toward the disabled. Data from interviews have been considerably more generative of insights into the dynamics of reactions to the disabled by the nondisabled, and a monograph is near completion

reporting the results of three years of intensive studies on this and related problems (16).

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PERSONALITY DETERMINANTS OF REACTION TO THE PHYSICALLY DISABLED*

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INTRODUCTION

The basic principles underlying this work are that a positive self-image and attainment of stable object relationships are necessary for nondistorted (accepting) feelings toward the disabled. Conversely, it is believed that such factors as low ego strength, poor self-acceptance, insecurity, and anxiety act against free acceptance of the disabled. To our knowledge, only Winkler (6) and Steingisser (5) have studied experimentally the relationship of personality structure to reaction to the disabled. Winkler found disturbed empathic relationships as a factor in nonacceptance. Steingisser hypothesized that individuals who are well adjusted (using discrepancy between ideal and actual self ratings) will have more positive attitudes toward the blind (as measured by her own scale) than a poorly adjusted group and will be less influenced by a lecture unfavorable to the blind. These hypotheses were substantiated.

Ongoing work which I hope to report on at another time, has been yielding data on the relationship of such variables as body image barriers and castration anxiety to attitudes toward the disabled. This latter work is devoted to depth investigations of selected subjects by means of projective techniques and intensive interviews on disability related experiences and attitudes. In this paper I will present results of the more quantitative phase of our work which involved administration of self-report instruments to large numbers of subjects.

METHOD

A 574-item self-report personality questionnaire was group administered to 284 college students. An overlapping 362-item questionnaire was given to junior high school (N=235) and high school (N=229) classes. The sexes were fairly evenly divided. Sampling was relatively well diversified in that a number of urban and suburban school systems were used. The population was almost entirely

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white and mostly of middle socioeconomic status. Subjects, who responded anonymously, were informed of the nature of the study, i.e., "to relate the way a person feels about himself to the way he feels about the physically disabled," and a nondefensive test atmosphere was promoted.

Attitude toward the disabled was measured at all three educational levels by the Attitude Toward Disabled Persons Scale (ATDP of Yuker, Block, and Campbell [7]) and two experimental scales. The type and number of variables measured are indicated in Table 1.

TABLE 1

TYPE AND NUMBER OF INSTRUMENTS

Variable	Number in College	Number in Subcollege
Disability	3	3
Actuarial	3	3
Personality	36	8
Response Set	7	6
Total Number	49	20

The selection of a test battery was based on presenting a variety of personality and stylistic measures and available classroom time. A listing and description of the tests are enclosed as Appendix A. They include the Gough Adjective Check List, and Minesota Multiphasic Personality Inventory (MMPI) scales like the Welsh A and R, and the Barron Ego Strength. The ATDP is a 20-item Likert-type scale measuring the extent to which subjects agree that disabled persons are the same as physically normal individuals. One experimental disability scale was a Social Distance Scale (SDS) where the subject checked those social relationships to which he would admit a person with a physical handicap. The other experimental scale, the Feeling Check List (FCL), was designed to elicit direct statements of strong feelings. Subjects checked all of the following feelings about the disabled that were applicable: very uncomfortable, somewhat uneasy, no different than with anyone else, sympathetic, repelled, indifferent, attracted.

A matrix of Pearson product moment coefficients of correlation was computed for each educational level and factored by the centroid method, using the highest coefficient per column as the communality estimate, without iteration. The factors were rotated

by the quartimax analytic rotational procedure (1). All computations were performed on the IBM 650 electronic computer. In the college sample the capacity of the computing program available for centroid extraction is 40 variables. Nine of the 49 variables judged least important were omitted from the factor analysis. The Couch-Keniston Acquiescence Response Scale (ARS) was one of those dropped because a similar, larger scale (Overall Agreement Scores II [OAS II]) was in the matrix and because the pattern of correlations for ARS was virtually identical to that of the Fulkerson scale. Although separate analyses were not run for each sex, the original matrix included sex as a variable. The few sex differences found in the intercorrelations were similar to those found for the Berdie Femininity Scale which, as a marker variable, is retained in the 40 by 40 factor analysis. Secondary analyses were made by comparing high and low scorers on the disability measures on the other test scores.

RESULTS

Evaluation of Disability Measures

Attitude Toward Disabled Persons Scale

The mean and standard deviation for the college group is very similar to that of the college standardization sample of Yuker, et al. (7). The high school and junior high groups have standard deviations similar to the college group but the mean scores are about 5 points lower. An *F* test of the means of the three groups was significant beyond the .01 level.

Social Distance Scale

Table 2 presents frequency data for the SDS. It may be seen that the least frequently selected was Spouse followed by Itimate Friend. It seems that intimate personal relationships with the disabled are rejected but work situations are not.

Feeling Check List

Table 3 presents frequency data for the FCL. Only a very small percentage of the respondents checked the frankly aversive attitudes. However, the second most popular response was Somewhat Uneasy. The most frequent response was Sympathetic.

Intercorrelations Between Disability Measures

A summary score was assigned to each of the experimental scales and their correlations with the ATDP calculated. Table 4 presents a summary of these intercorrelations. It is evident that there is a slight commonality but not nearly as high as one might expect.

TABLE 2

SOCIAL DISTANCE SCALE

Relationship	J.H.S. N=232 %	H.S. N=222 %	College N=281 %
Intimate Friend	66	72	78
Cordial Acquaintance	82	81	87
Mere Friendly Acquaintance	75	82	84
Speaking Acquaintance	78	82	86
Fellow Worker	83	84	92
Spouse	34	36	37

TABLE 3

FEELING CHECK LIST

	J.H.S. N=232 %	H.S. N=222 %	College N=281 %
Very Uncomfortable	05	10	03
Somewhat Uneasy	53	61	50
No Different	49	34	49
Sympathetic	72	74	72
Repelled	04	09	05
Indifferent	17	25	16
Attracted	24	17	13

On the basis of these and other data, new forms of the FCL and SDS were devised which are now being used for subsequent work. The major criticism of all of these instruments seems to lie in their attempt to deal with disability in general. Our present scales provide the opportunity to respond to specific disability types as well as to obtain a general disability score.

TABLE 4

INTERCORRELATIONS BETWEEN DISABILITY MEASURES

	Social Distance Scale			Feeling Check List		
	Coll.	H.S.	J.H.S.	Coll.	H.S.	J.H.S.
Feeling Check List	14*	14*	16*			
Attitude Toward Disabled Persons Scale	30**	34**	16*	21**	32**	22**

* Significant at 5% level.
** Significant at 1% level.

Zero Order Correlations Between Disability and Other Measures

Correlations will be reported only in terms of whether they were significant below the 5 percent level or not. In practice, most of the significant correlations were well beyond the 1 percent level. However, with samples as large as the present, a correlation of even .12 meets the 5 percent criterion, and about .15 the 1 percent criterion. It will help us from overstressing the meaning of individual correlations if we keep in mind that only one *r* reached as high as .34 and that most were below .20. Table 5 indicates the number of significant correlations found out of the total number computed. Disability intercorrelations are not included. The other variables include age, sex, personality measures, and response set measures.

It can be seen that the SDS does not correlate with the other variables while the FCL and ATDP do so very consistently and nearly always in the directions hypothesized. That is, such factors as ego strength, security, affiliation, and intraception are positively correlated with disability attitude while such variables as anxiety, hostility, and rigidity are negatively correlated. Interpretation of the data becomes more confused when one tries to evaluate the impact of response sets. Generally, the social desirability measures seem to be positively, and the acquiescence measures negatively, correlated with disability measures. A number of correlations between disability and personality scores were computed with various response set measures singly and multiply partialed out. While individual correlations shifted somewhat at times, the structure of results remained essentially the same.

Examination of Extreme Attitude Holders

Subjects whose ATDP or FCL scores indicated extremely favorable

TABLE 5

SIGNIFICANT CORRELATIONS BETWEEN DISABILITY AND OTHER VARIABLES

Disability Measure		Number of Significant Correlations	Number of Correlations
SDS	J	1	10
	H	4	17
	C	1	47
FCL	J	4	10
	H	13	17
	C	11	47
ATDP	J	6	10
	H	10	17
	C	23	47

or extremely unfavorable attitudes were compared on the other variables. The direction of differences was almost uniformly confirmatory of our basic orientation and supportive of the findings on the zero order correlations. In fact, the magnitude of the results was far greater than that indicated in the intercorrelation matrix of the total population.

Results of Factor Analysis

Appendix B contains complete Tables of the ordered orthogonal rotations for each educational level. A full interpretation of these data is made in Siller & Chipman (4). The results of the factor analyses indicate that acceptance of the handicapped as measured by the present instruments is almost entirely independent of other major factorial dimensions at all age levels. Within the disability factor, femininity is most related to acceptance of the disabled, a finding confirmed in other studies. Other loadings within this factor include low Rigidity, low Authoritarianism, and low Aggressiveness. Positive loadings are found with Endurance, Nurturance, Affiliation, and Change. Both positive and negative loadings are in accord with our position.

Developmental Data

The major conclusion reached is that college subjects are consistently more accepting of the disabled than are subcollege subjects. There do not seem to be appreciable differences between high school and junior high school subjects on the ATDP and SDS. However, the

high school groups distinctly express greater aversion toward the disabled on the FCL than do the other two educational levels.

CONCLUSION

The totality of the data gives a slight but general confirmation of the idea that a positive self-image and stable object relationships are related to acceptance of the disabled. While there is no strong characteristic personality pattern that leads to acceptance of the handicapped, a negative self-image and disturbed object relationships are strongly conducive to an aversive reaction.

APPENDIX A: INSTRUMENTS

There is considerable overlap among the tests administered to the various educational groups. The college students were from academic and community college institutions, while the younger subjects were from public high schools and junior high schools.

Disability Measures (discussed in text)

Attitudes Toward Disabled Persons Scale (ATDP)

Social Distance Scale (SDS)

The subject checks all of the following that apply: very intimate friend, cordial acquaintance, mere friendly acquaintance, speaking acquaintance, fellow worker, husband or wife.

Feeling Check List (FCL)

Personality Measures

Adjective Check Lists (ACL)

1. Shippee-Blum's - This 75-item check list was administered to high school and junior high school subjects. A self-acceptance score was derived.

2. Gough's - This is a 300-item list from which a host of subscores can be derived. Administered to the college groups, it was scored for the following scales: self-acceptance, rigidity, positive character integration, role playing, social poise and presence, self-insight, potential success, originality, self-criticism, good judgment, personal adjustment, likeability, responsibility, flexibility, dominance, change, aggression, heterosexuality, endurance, abasement, intraception, succorance, autonomy,

exhibition, deference, affiliation, and achievement. These scales have been developed by Gough in some instances, and Heilbrun in others. A 52-item scale by Berdie, measuring Femininity, is also part of the list.

3. Zuckerman has developed an Affect Adjective Check List for the measurement of anxiety. This 21-item scale was added to the Gough and Shippee-Blum scales to provide a measure of anxiety.

The instructions here employed for the ACL differed from those usually given. *S*s were instructed not merely to check only those adjectives which applied to them but to check every item as being true or false of them. The present method permits both a direct acquiescence index, based on the number of true's on the ACL, and, in our opinion, a more effective control of acquiescence within each scale than the standard score conversion for acquiescence recommended by Heilbrun (2). Our major criticism of Heilbrun's standard conversion technique is the fact that only four categories of number of words checked are provided, the highest of which covers the extremely heterogeneous score range of 122 to 300. Raw scores were used throughout our study, and our data are therefore not directly comparable to what would be given by Heilbrun's method.

True-False Type Item Scales

The following scales were administered to all populations and are answered as true or false. They are either derived from the MMPI or are of that type.

1. Maslow's Security-Insecurity Inventory - Only items 1 through 25 were used as they provide a reliable estimate of the total test score.

2. Welsh A scale - a 39-item anxiety scale.

3. Welsh R scale - a 40-item repression or defensiveness scale.

4. Barron Ego Strength Scale - a 60-item measure.

5. Zaks-Walters Hostility Scale - a 12-item scale.

6. Couch-Keniston Low F Scale - This 5-item scale purportedly is a refined measure of authoritarian orientation that is not confounded by the tendency to respond in an acquiescent direction on true-false tests.

Response Set Measures

The following were administered to all populations:

Couch-Keniston Acquiescence Scale

In the course of a major study examining personality correlates of the tendency to acquiesce on personality inventories, Couch and Keniston indicated 15 items which correlated most highly with an acquiescence score based on 360 items. These items were recommended as an abbreviated acquiescence measure and are so used here.

Fulkerson's Acquiescence Response Scale

The 24 items were obtained by Fulkerson as a measure of acquiescence independent of adjustment status.

Edwards Social Desirability Scale

The 39-item scale is probably the most used of any measure of response tendency. Derived from the MMPI, it has significant correlations with practically all self-report scales and therefore is worth using here as a checking device.

Marlowe-Crowne Social Desirability Scale

This 33-item scale was developed as an answer to criticisms of the Edwards Social Desirability Scale. Marlowe and Crowne's contention is that Edwards' scale is based on pathological items and that the denial of pathology is not identical with the need to give socially desirable responses. They therefore developed their scale as a measure of the social desirability response set, but one which is independent of pathology. For example, while Edwards may have an item such as, "I find it hard to keep my mind on a task or a job," Marlowe and Crowne have items such as, "I like to gossip at times."

Overall Agreement Scores (OAS)

The total number of nondisability items to which the subject answers "True" was obtained. OAS I is for the adjective items, and OSA II for MMPI-type items.

Deviance Scale

Grigg and Thorpe constructed this scale of adjectives infrequently checked by college students. On cross-validation, the scale dis-

criminated between students who sought psychiatric or counseling help from the university and a control group.

The resulting test battery was administered in three test booklets. All subjects were first given a three-page booklet containing the disability measures. This was followed by a second booklet containing 356 items (college groups) or 170 items (subcollege groups). A third booklet containing 221 items (college) or 192 items (subcollege) was then administered. Splitting the nondisability items into two booklets was necessary as high school and junior high school subjects sometimes had to be tested in two sessions, generally a week apart. Not all of the junior high subjects took every test.

APPENDIX B:
QUARTIMAX-ROTATED
CENTROID FACTOR LOADINGS

JUNIOR HIGH SCHOOL, N=235

	I	II	III	h^2
Agreement Score: MMPI-Type Items	92	-18	09	88
Edwards: Social Desirability	-82	-18	04	71
Zaks-Walters: Hostility	73	-21	-02	57
Welsh: Anxiety	70	25	-11	57
Barron: Ego Strength	-62	-29	-01	47
Fulkerson: Acquiescence	59	-46	-09	56
Sex (High = F; Low = M)	03	42	01	18
Welsh: Repression	-26	38	-10	22
Age	04	17	-13	05
Attitudes Toward Disabled Persons Scale	-23	-09	52	33
Feeling Check List	-14	08	44	22
Disability Familiarity	03	08	39	16
Social Distance Scale	-02	15	28	10
Σa^2	3.41	.85	.74	5.00
Percentage of Variability	68.18	16.98	14.85	100.00

QUARTIMAX-ROTATED
CENTROID FACTOR LOADINGS

HIGH SCHOOL, N=229

	I	II	III	IV	h^2
Welsh: Anxiety	90	17	-16	02	87
Edwards: Social Desirability	-88	-05	22	03	82
Agreement Score: MMPI-Type Items	80	45	05	-11	86
Barron: Ego Strength	-80	13	-02	-09	66
Maslow: Security-Insecurity Inventory	-56	11	52	02	59
Zaks-Walters: Hostility	48	36	-01	-38	50
Welsh: Repression	-21	-80	-18	-01	71
Fulkerson: Acquiescence	40	68	10	-14	66
Couch-Keniston: Acquiescence	37	50	-14	-05	41
Agreement Score: Adjectives	16	40	17	16	24
Shippee-Blum: Self Acceptance	-41	24	75	02	79
Zuckerman: Affect Adjective Check List	43	-05	-74	06	74
Marlowe-Crowne: Social Desirability	-21	-37	40	17	37
Age	-07	08	-11	-06	03
Attitudes Toward Disabled Persons	-23	-07	-16	55	39
Sex	17	-38	17	50	45
Social Distance Scale	-05	-09	-04	47	23
Disability Familiarity	-01	08	-01	41	18
Feeling Check List	-20	-19	07	41	25

HIGH SCHOOL, N=229
(Continued)

	I	II	III	IV	h^2
Couch-Keniston: Low F	15	29	-18	-37	27
Σa^2	4.31	2.38	1.80	1.49	9.98
Percentage of Variability	43.20	23.86	18.02	14.92	100.00

QUARTIMAX-ROTATED
CENTROID FACTOR LOADINGS

COLLEGE, N=284

	I	II	III	IV	h^2
Adjective Check List: Likeability	86	-09	13	10	78
Grigg & Thorp: ACL Deviance	-84	04	-02	-03	70
ACL: Personal Adjustment	83	-10	10	12	73
ACL: Self Criticism	-81	15	32	-13	79
ACL: Nurturance	80	-27	01	39	87
ACL: Intraception	79	-07	15	-04	65
ACL: Social Poise and Presence	77	-08	-12	03	61
ACL: Endurance	76	-02	07	-40	74
Zuckerman: Affect Adjective Check List	-75	-17	19	-05	63
ACL: Self Acceptance	73	17	42	-07	75
ACL: Succorance	-71	-28	18	01	61
ACL: Self Insight	70	-08	02	-18	53
Edwards: Social Desirability	70	32	-39	-18	77
ACL: Affiliation	70	-07	21	45	74
Maslow: Security-Insecurity Inventory	68	39	-17	01	64
Welsh: Anxiety	-68	-38	44	19	83
ACL: Responsibility	66	-42	00	-27	67
ACL: Achievement	62	40	23	-26	66
ACL: Potential Success	53	-23	-40	-14	51
Zaks-Walters: Hostility	-51	-03	43	12	47

COLLEGE, N=284
(continued)

	I	II	III	IV	h^2
Marlowe-Crowne: Social Desirability	47	01	-12	04	24
Barron: Ego Strength	41	24	-37	-13	43
ACL: Role Playing	37	-24	-34	23	36
Couch-Keniston: Low F	-20	-01	11	08	06
ACL: Abasement	-29	-80	05	04	73
ACL: Exhibition	-05	77	08	26	67
ACL: Autonomy	-32	75	11	-11	69
ACL: Aggression	-59	62	06	-13	76
ACL: Dominance	43	56	10	-11	52
ACL: Change	-11	50	15	40	44
ACL: Heterosexuality	32	40	28	39	49
Agreement Score: ACL-Type Items	-24	33	67	-14	63
Agreement Score: MMPI-Type Items	-55	-09	65	19	76
Fulkerson: Acquiescence	-35	13	56	05	46
Welsh: Repression	08	-30	-52	-01	36
ACL: Rigidity	12	-49	-04	-51	52
Berdie: Femininity (ACL)	-14	-01	25	39	24
Attitudes Toward Disabled Persons	17	11	-12	30	14
Feeling Check List	08	19	-03	25	11
Social Distance Scale	-01	06	-01	21	05
Σa^2	12.51	4.64	3.18	2.01	22.34
Percentage of Variability	55.99	20.76	14.23	9.01	100.00

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GENERAL CONSIDERATIONS ON GUIDANCE DEVICES*

C.M. Witcher

INTRODUCTION

The following discussion is an attempt to summarize the thinking of a group of people, most of them blind, concerning the problems connected with the development of an acceptable guidance device for use by the blind. Many of the ideas presented have evolved directly out of the experiences of blind people with the problem of traveling independently. In addition, several members of the group have been in a position to combine their personal travel experiences with technical knowledge of the possibilities and limitations involved in the operation of physically conceivable guidance devices. Before preparation of the final draft of this paper, it was presented for consideration and amendment at a meeting at which most of the people concerned with its philosophy were present. On many points agreement was not unanimous, but in every case the majority opinion prevails.

A basic assumption which has long been taken for granted by those interested in the problem is that, in order to be acceptable, a guidance device should provide a means for independent travel by the blind which is definitely superior to existing means, i.e., use of canes and auditory obstacle detection. This implies that an acceptable device 1) shall provide more useful data about the user's immediate environment than he could obtain from existing sources, 2) that its use shall not make its possessor conspicuous nor require unduly great physical or mental effort, and 3) that it shall not demand any exceptional abilities or unduly rigorous training for its use.

Still another basic assumption is the idea that, before a device can be considered acceptable, it must be simple and rugged enough to eliminate serious maintenance problems, and there must be some assurance that its production cost and the cost of maintaining its power supply can be held low enough to make it available to a reasonable proportion of blind people.

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*Prepared by the late Dr. Witcher, Research Engineer at the Massachusetts Institute of Technology, in cooperation with the Technical Advisory Council of the American Foundation for the Blind and presented to a meeting of that body on 25 March 1949.

SPECIFICATIONS

On the basis of these assumptions, a set of tentative specifications for an acceptable guidance device has been suggested. It should be borne in mind that most of the figures included in these specifications are of necessity somewhat arbitrary, but in all cases they represent the best estimates derivable from the collective thinking of those interested in the problem. The specifications may be summarized as follows:

1. total weight not to exceed four pounds

2. unit production cost in quantities of 1000 to 5000 not to exceed $250.00

3. form of signal presentation to be such that it shall not interfere with normal use of the ears for acquiring information about the immediate environment

4. device to be capable of informing user of presence of obstacles within a distance of 10 ft, roughly indicating the position of each and presenting information at sufficient speed to allow user to travel at 4 to 5 ft/sec

5. provision for detecting step-down or drops at distances not less than 5 ft, this to be achieved simultaneously with and independently of the obstacle detecting function

6. device to be usable under all weather conditions normally encountered.

SIGNIFICANT IMPLICATIONS

The specifications just listed are useful chiefly through the fact that they permit a number of logical inferences to be drawn concerning the nature and operating characteristics of an acceptable device. The remainder of this paper comprises an attempt to examine some of these implications.

Components of Guidance Device

Perhaps the most significant inference as to the physical nature of a guidance device is that it must embody at least three, and probably four, basic components. The three parts which are absolutely necessary are: an obstacle detector, a step-down or drop indicator, and a power supply. The fourth component is whatever means is used to present to the user of the device the information which the device yields. In the case of sonic devices, this component is the ear, but in all other types it must be regarded as a necessary physical component of the device.

It is advisable here to think of both the obstacle detector and the step-down indicator as each consisting of two parts. In the case of the obstacle detector, we may say that it must comprise some form of obstacle irradiator plus facilities for detecting reflected energy and thereby the *location* of the obstacle. Similarly, the step-down indicator will, so far as we can now infer, consist of a nonspecular surface irradiator plus some means for detecting any discontinuity in level greater than 1 or 2 in. when this discontinuity is at a point 5 or 6 ft in front of the device.

It is probably desirable that the step-down indicator should not present any sort of signal to the user except at points where discontinuities occur. The obstacles detector should likewise probably be of a type which presents no signal until an obstacle comes within its range. However, when this does take place, the obstacle detector must be capable of yielding adequate information to ensure the avoidance of the obstacle under the conditions stated in the above specifications. The question as to what constitutes adequate avoidance will be discussed more fully below. It should perhaps be noted that, in the case of sonic devices, the ears can take over completely the obstacle location function so that the obstacle detector is, in this case, reduced to simply an obstacle irradiator. It is this observation, together with that pointed out above with reference to signal presentation, which make devices of the sonic type appear so much more promising at the present time than any other type of device.

Adequate Avoidance Information

The Information needed for avoidance of obstacles obviously consists of data on their distances from the observer (range) and on their positions with respect to the observer's path (azimuth). For devices with narrow, circularly symmetric beams, additional data concerning the altitudes of obstacles are also necessary. The specifications stated above can be used to yield some rough quantitative notions as to the extent and degree of refinement of the required data, as well as the rate at which this must be perceived by the user. Some further ideas as to the quality of the data needed can be gained by reference to previous tests with obstacle detectors.

It is now quite generally agreed by all workers in the field of guidance device development that extremely accurate obstacle range data are definitely not desirable. Accurate range determination is time consuming, and it contributes nothing to the ability of the user of a device to avoid obstacles. It is now felt that the usable range of a device might well be thought of as being divided into three parts: 1) the part most remote from the observer, which may be called the "awareness region"; 2) the middle part of the range, which we might call the "attention re-

gion"; and 3) the part nearest the observer, which may be termed the "avoidance region." The boundary separating the awareness and attention regions would then be the point at which an observer approaching an obstacle should begin contemplating a decision as to whether or not he must alter his course in order to avoid the obstacle. The boundary between the avoidance and attention regions will here be taken as the point nearest to the observer at which he still has time to make an obstacle avoidance decision and carry it out. The distances from the observer at which these two boundary points probably are located may roughly be inferred by considering several factors, as will be seen presently.

All previous experience with obstacle detectors has indicated conclusively that, for rates of travel as great as 4 or 5 ft/sec, the use of manual scanning to determine the azimuths of obstacles is entirely out of the question. Furthermore, even aside from the experimental data, it is inconceivable that any individual using a guidance device would be willing to add to his conspicuousness by the use of this scanning technique. We are thus forced to consider the problem of automatic scanning.

Before proceeding to this problem, however, it is well to consider a question frequently brought up in connection with scanning. One might ask whether or not the use of a highly divergent beam of energy from the obstacle irradiator might not eliminate the need for scanning entirely. If such a beam were used, it would still be necessary to have some means by which the device could furnish azimuth information. This could be accomplished through auditory localization in the case of sonic type devices, but for every other type thus far conceived there would still have to be some form of scanning mechanism associated with the detecting part of the device in order to make it provide azimuth information. Aside from these considerations, the great waste of energy through the use of a highly divergent beam is inadmissible. It is generally agreed, however, that the obstacle irradiator beam should have some divergence in a *vertical* plane, so as to eliminate the necessity of presenting altitude information through the device. Under this condition, obstacles of all altitude comparable with the height of the observer would be detected indiscriminately.

The form of automatic scanning which appears to be most desirable is that obtainable by a sinusoidal angular oscillation of the radiating and detecting system of the device. There are two reasons for the superiority of this type of automatic scanning. In the first place, it can be obtained with less mechanical power than can any other type. If the system is resonant at the desired scanning frequency, the only energy losses occur through air damping and bearing friction. In the second place, sinusoidal scanning implies that the system spends most of its time near the ends of its scanning path, i.e., near the outer limits of azimuth.

If an observer knows that an obstacle is directly, or almost directly, in front of him, he knows equally well that he must change his course to avoid it. On the other hand, the obstacles more remote from the center of his path require a more careful contemplation in order to arrive at a decision with regard to avoiding them. Sinusoidal scanning provides the added time for decision in the regions where it is most needed.

It seems quite probable, on the basis of energy and signal presentation requirements, that it is best to make use of the *minimum* scanning rate consistent with acceptable performance of the device. It must be concluded that, unless an obstacle were *certainly* scanned *once* within the attention region of the range, the notion of this region would be meaningless. We thus have our first quantitative conclusion, viz., that the minimum scanning *period* is the time required for the observer to move through a distance equal to the attention region of the range.

By introducing another reasonable assumption, we can obtain a rough quantitative idea of the angular limits of the scanning oscillation. The most difficult obstacles which the observer has to contend with in making avoidance decisions will be those detected by the device just at the boundary between the avoidance and attention regions and at points somewhat to the right or left of the center of the observer's path. The question of scanning oscillation limits is thus equivalent to the question of how wide the detection path should be at the outer boundary of the avoidance region. A reasonable answer is that this path should be of such width that any obstacle which is *not* detected by the device is so far to the side of the observer that he will be certain to avoid it with no change in the direction of his course.

We can be guided in attempting to get a quantitative estimate of this path width by considering the fact that the avoidance region for a guidance device is closely analogous to the region covered by a cane when properly used. However, since the specified rate of travel with a guidance device is greater than that generally attained with a cane, the proportions of the avoidance region must be relatively increased. The range of a cane when properly used is approximately equal to one stride of the user (1). For an observer of average height this is about 30 in. Ordinarily the sweep of the cane from right to left extends from 3 to 6 in. on each side of the observer's body. Thus for a cane, the protected path width, at a distance of 30 in. in front of the average observer, is approximately equal to the width of the observer's body plus 6 in. to 1 ft. If we take the average width of the observer as 18 in. and use 1 ft as the excess clearance this path width will be equal to 30 in. In the case of the avoidance region of a guidance device, it is probably advisable to add another foot of path width to take account of the increased rate of travel. Therefore the tangent of the maximum scanning azimuth

will be roughly equal to 21 in. divided by the length of the avoidance region.

In accordance with our definition the length of the avoidance region is the minimum distance at which an observer, traveling at a given rate of speed, can detect an obstacle, decide whether or not avoidance action is needed, and act on his decision. The justification for this method of specifying the length of the avoidance region follows from our assumption of minimum scanning rate, i.e., only one *certain* scan of an obstacle within the attention region. If this scan happened to be at one of the azimuth limits and just at the boundary between the avoidance and attention regions, it might represent the only datum available to the observer for making and carrying out his avoidance decision.

The minimum *temporal* length of the avoidance region can be determined by suitable psychological experiments. The situation is essentially one of stimulus, judgment, and response. Based on psychological data already available for similar situations, a reasonable approximation for the time duration of the avoidance region is 0.5 to 0.6 sec. For reasons given below in connection with signal presentation it is advisable to add approximately 0.2 sec to this figure. Assuming a speed of 5 ft/sec, this would give a length of 3.5 to 4 ft for the avoidance region. For a length of 3.5 ft the angular amplitude of scanning oscillation would be 26.6 deg. and for 4 ft it would be 23.6 deg.

It is of interest to compare these estimates of the required length of the avoidance region with the figure of 5 ft specified for the minimum distance of step-down indication. This figure was arrived at as a consensus of opinion of those concerned with the guidance device problem without conscious attempts at analysis. It is probably justifiable to set the step-down indication distance slightly in excess of the minimum obstacle avoidance distance, since the potential danger of step-downs or drop-offs is in general greater than that of obstacles.

There seems to be no very definite way of fixing the outer limit of the attention region. However, it is highly desirable to have a definite limit for this region in mind when considering the performance requirements which the design of a guidance device must take into account. We have postulated that at least one *certain indication* of every obstacle must be given within the attention region. This implies that a guidance device must be designed so as to be certain to indicate the existence and position of obstacle at the outer limit of this region. Actually, this requirement cannot be made quite as absolute as we have just stated it. It is always necessary to formulate the requirement on the basis of a minimum *width* of obstacle. It is not at present conceivable, for example, that a device could be made which would detect a stretched vertical thread at a distance of (say) 7 or 8 ft. For that matter, the human eye might well fail to

detect it. The smallest type of harmful obstacles commonly encountered are in the forms of ropes, thin rods, and guy wires. Since these seldom have diameters less than 3/8 to 1/2 in., it is desirable to set the minimum obstacle width at about this order of magnitude.

A reasonable, but arbitrary, specification of the length of the attention region may be to require that its length shall be equal to that of the avoidance region. On the basis of the figures given above, this would mean a scanning period of 0.7 to 0.8 sec which is physically realizable without great difficulty.

The outermost region of the range (awareness region) is obviously of little importance under ordinary conditions. It must necessarily exist on account of the obstacle detection requirements which have been inferred for the attention region. However, we need not discuss it further here.

Before concluding this section some mention should be made of the problem of moving objects. It should be quite clear that a device which performs roughly in accordance with our previous consideration could never be expected to be usable as an aid in avoiding vehicular traffic. This limitation is unanimously accepted in the present thinking of those concerned with the problem. In the case of other moving objects, such as pedestrians, push carts, etc., we must bear in mind the fact that the vast majority of them provide their own warning signals through the sounds they make. It is for this reason that all our discussion has been based strictly on the observer's own rate of travel rather than the relative velocity of the observer with respect to other moving objects.

Other Considerations

A few comments regarding the problem of signal presentation are advisable. Our inferences in regard to range, azimuth, and minimum scanning rate in turn impose very severe requirements on whatever means is used to transfer the avoidance information from device to observer. It is, for example, quite difficult to see how any form of signal presentation system in which the time lag in perceiving information is greater than 0.1 to 0.2 sec can be regarded as at all usable. It was to allow for a possible lag of this magnitude that the time required for an avoidance decision plus avoidance action was arbitrarily increased by 0.2 sec. Up to the present time no system of signal presentation except that afforded by the ears in the case of sonic type devices has even been able to provide range information at this rate. (This statement is based on the times tabulated in ranging tests at Haskins Laboratories. Some of the systems used might have been able to provide the simple range information which we have assumed to be adequate with no more than 0.2 sec lag.) However, the added requirement of azimuth information greatly increases

the difficulty of the problem. Only for sonic detection systems are the problems of range and azimuth already solved through the action of auditory localization. The step-down indicator signal offers no difficulty since it is only required to present one specific piece of information.

No general discussion of the problem of guidance device development should omit or evade the consideration of power requirements. At least up to the present, the only practical form of power supply which has been conceived of is electrical energy from batteries. Numerous schemes for utilizing the bodily energy of the user have been examined, but none has thus far appeared to be practical. However, further research along this line is highly advisable.

Recently, promising suggestions have been made with reference to the use of highly compressed gas or chemical means for the production of suitable noise sources for sonic type devices. Thermal energy sources might yield several times more energy per pound of weight than electrical sources, but no one has as yet conceived of a usuable thermal arrangement. Probably the highest yield of electrical energy per unit weight is furnished by the recently developed mercury type cell; this is of the order of 35 to 40 watt hours per pound. Since it is difficult to anticipate assigning more than one pound of weight for the power supply, the total energy available before batteries have to be replaced is at best about 35 Wh. Hence a guidance device with a power drain of only 2 W will require battery replacement after about 18 hours of use. With present battery cost, this rate of replacement implies a rather high maintenance cost for the user. Many of the simple obstacle detectors thus far developed have required considerably more than 2 W. The most economical type developed so far (sonic beam devices) have required 0.6 to 0.75 W. The question of power consumption is one of the most significant factors which *must* be thoroughly investigated before even contemplating the development of a guidance device in accordance with any particular operating principle.

From what has been said, it should be only too clear that the problem of developing a usable guidance device is a very difficult one. In view of the large number of trial forms of devices already constructed, some of which should have been foreseen to be completely absurd at the outset, the members of this group feel that it is of the greatest importance in the course of future developments *never* to lose sight of the factors such as maintenance, production cost, acceptable performance characteristics, and power consumption which have been pointed out in the present discussion.

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THE ISOLATION OF THE RURAL BLIND ADULTS IN UTAH*

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INTRODUCTION

The American Foundation for the Blind during 1960-1961 conducted studies to ascertain facts concerning the social characteristics, mobility, activities, and interests of blind individuals in Massachusetts, Minnesota, North Carolina, and Oregon. (Hereafter, this four-state study will be referred to as The Foundation Survey.) A similar study was conducted during the summer of 1962 by members of the Graduate School of Social Work at the University of Utah. The material for this paper is a part of the latter study conducted at the University and also a condensation of a thesis written by Nolene George in partial fulfillment for a Masters Degree in Social Work at the University of Utah.

Historically, the problem of blindness has evoked an emotional reaction to people in general. The blind person has been an outcast, pitied or despised, left to struggle on his own, to beg or steal a meager existence and to depend upon the charity of his neighbors or his clan for survival. Gradually over the years compassion became the popular attitude toward blindness, but the blind individual has still too often been set apart because of his handicap and relegated to an inferior social role. "It has been less than fifty years since our evolving democratic ideals, combined with a growing body of professional knowledge gave rise to the concept of rehabilitation of the blind into full participation in our society" (4, p. 361).

Any democratic philosophy is based on each member of society having the opportunity to realize his individual potential and become a contributing member in his community. If the blind individual isolates himself from sighted members, he suffers from a lack of personal fulfillment and the community loses a contributing member.

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PURPOSE OF THE STUDY

The purpose of this study was to evaluate the conformity with, and the involvement of, the blind in their social environment. The approach consisted of a description and analysis of factors which affect "isolation or nonisolation" of legally blind adults in rural areas in Utah. The specific objectives were:

1. To determine if blind adults in Utah rural areas are more or less isolated than blind adults studied in Massachusetts, Minnesota, North Carolina, and Oregon.

2. To determine the factors which affect isolation or nonisolation of legally blind adults in Utah rural areas.

3. To find areas where further research is needed to gain better understanding in order to help blind individuals live more normal lives as members of families and neighborhoods and as productive and socially responsible members of their communities.

Data were gathered to determine: (1) What were the psychosocial characteristics of the rural blind in Utah which affected their isolation or nonisolation? (2) Did their major social roles affect their isolation or nonisolation? (3) Were there significant differences in the services received from public or private agencies or financial assistance received by individuals in the sample? (4) What mobility was there in the sample studied? (5) Did geographical influence affect the isolation or nonisolation of the individuals and (6) Did the immediate social surroundings affect their isolation or nonisolation?

Cutsforth has stated that it is much more convenient to blame the environmental situation for our failure to achieve the social competence we covet than it is to search out the causal factor and do something about it. He further stated that a great many different objective situations and personal circumstances contribute to the final personality of the individual and to his attitudes. In his opinion, two of the most important factors are geographical influence and the make-up of the immediate social surroundings (1).

METHODOLOGY

A total of 291 names of legally blind adults living in Utah was obtained from the Utah Commission for the Blind, excluding residents in counties which were designated as urban counties for the purposes of this study. Age and domocile factors were considered in selecting the sample which reduced the population to 121; of this number, 100 individuals were interviewed. In designating urban and rural counties, any county with a city which has a popu-

lation of 10,000 or over was considered urban and was eliminated from the study. Five counties in Utah fell into this category: Cache, Davis, Salt Lake, Utah, and Weber counties.

When comparisons were made between the Utah Study and the Foundation Survey regarding differences as measured by the isolation index, it was found that there was a significant difference at the 1 percent level of confidence with a χ^2 value of 42.08 and 4 degrees of freedom.

The index was composed of five categories which includes those individuals rated least isolated and progressing to category Five including individuals rated most isolated.

Category One: visits at least three times a week and attends meetings once in a while; visits once or twice and attends meetings regularly

Category Two: visits once or twice a week and attends meetings either practically never or once in a while, visits less often than once a month, but attends organizations regularly; visits at least three times a week, but practically never attends meetings

Category Three: visits at least three times a week with no organizations, visits less than once a month with occasional attendance at meetings; visits not at all but regularly attends meetings

Category Four: visits less than once a month with practically no meeting attendance; visits not at all, but attends meetings at least once in a while, visits once or twice a week, no organization at all

Category Five: no organization activity, may visit up to 3 times a month.

When it was found that significantly more of the individuals in Utah were less isolated than the blind interviewed in the Foundation Survey, the 46 individuals in the Utah Study who were rated least isolated were placed in Group 1 and 9 individuals in category Four of the isolation index were combined with the 4 individuals in category Five to form Group 2 designated as the most isolated (see Table I).

Presentation of Data

The adults in both categories were all white; the least isolated category was evenly divided according to male and female, and the most isolated group had one more male than female. The most isolated group was older than the least isolated. In this former

TABLE I

DISTRIBUTION OF UTAH AND NATIONAL
BLIND CLIENTS ON THE ISOLATION INDEX

Group	Isolation Categories*											
	1		2		3		4		5		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Utah	46	46	27	27	14	14	9	9	4	4	100	100
Foundation	125	22	100	18	114	20	102	18	119	21	560	99
Total	171	26	127	19	128	19	111	17	123	19	660	100

*This table does not include 124 clients in the Foundation Survey who were over 80 years of age.

group, there were no individuals less than 40 years of age, whereas in the least isolated group, there were 13 percent under 40 years of age. Seventy-seven percent of the individuals in the most isolated group were over 65 years of age compared to 44 percent in the least isolated group.

TABLE II

DEGREE OF VISION OF THE TWO UTAH GROUPS

Degree of Vision	Category One Least Isolated		Categories Four & Five Most Isolated	
	No.	%	No.	%
Totally Blind	10	22	0	0
See Light	4	9	1	8
See Movement	12	26	4	31
Recognize Face	17	37	5	38
Read Newsprint	3	6	3	23
TOTAL	46	100	13	100

One would be prone to speculate from the above Table that the degree of blindness was correlated with the degree of isolation. Of the totally blind individuals (ten in number), all were in the least isolated category indicating that factors other than their blindness work to compensate for this disability and help to integrate those individuals into the community.

Approximately one-fourth in the least isolated category were 60 years of age or over at onset of trouble with seeing compared with one-third in the most isolated category. In regard to education, 38 percent of those in the least isolated category had completed their education beyond the eighth grade compared to 8 percent in the most isolated group. This difference was significant at the 5 percent level of confidence with a χ^2 of 4.62 and 1 degree of freedom. All of the individuals in the most isolated group and half of those in the least isolated group had ailments or conditions other than difficulty with seeing which have continued over many years. The most prevalent ailments in Group 1 were arthritis, rheumatism, and deafness; in Group 2, they were heart disease and diabetes. When the individuals were asked "Which condition would you consider the most serious for a person to have?" more people in the least isolated group said paralysis; in the most isolated group blindness was the response.

When church membership was considered, only five individuals were not members of the Church of Jesus Christ of Latter-day Saints commonly known as the Mormon Church.

Dr. Lowry Nelson has stated the Mormon Church dominates and ramifies much of the social organization in the community. Next to the family, the religious organization is the most important social institution in the Mormon community. The ward is the local unit in the Mormon Church corresponding to the parish or the congregation in other churches. People are expected to belong to, attend, and support the ward to which they belong (6). Not only are religious services held in the ward house, but also many social functions. One of the aims of the Mormon Church is to involve as many individuals as possible in church activities. This means that there are few individuals in the community who do not hold at least one position of responsibility and very often several positions in the Mormon Church. Members are encouraged to attend religious services regularly and also participate in the many social functions sponsored by the Church.

There was no significant difference in how long the person had lived in his town or village, nor in how long he had lived at his present address. However, 86 percent of Group 1 and 100 percent of Group 2 have lived in the present domicile over 10 years, and 72 percent of Group 1 and 69 percent of Group 2 have lived at their present address for over 10 years. These figures indicate the stability of the sample. There is very little mobility with the Utah rural blind and also with the Utah rural people in general. There was no significant difference as to whether or not a person owns his home, since 76 percent in Group 1 and 77 percent in Group 2 owned their own home.

In considering Dr. Cutsforth's factor of "geographical influence," the ratio of blind individuals to sighted individuals

was studied. In the 1960 census, the population for Utah was 890,627. The total population in the 17 counties studied was 168,012. When a comparison is made between a total population of 291 blind individuals with a total population of 168,012 in an area of 84,990 square miles, it is readily apparent that because of the sparse blind population and the large geographical area, it has been necessary for blind individuals to identify with sighted members in their community.

Dr. Cutsforth further stated that if a sufficient number of blind individuals have an opportunity to get together for social relations, there is a tendency for them to segregate themselves into groups apart from sighted individuals in the community. To further evaluate whether blind individuals in Utah were segregating themselves into groups apart from sighted individuals in the community the question was asked, "Do any of your friends have serious trouble with seeing?". Seventy percent in Group 1 and 54 percent in Group 2 had no friends with seeing difficulties and 26 percent in Group 1 and 46 percent in Group 2 stated most of their friends had normal vision.

The limited number of blind adults in rural Utah restricts their opportunity to segregate themselves from their sighted neighbors for social relations and has encouraged their identification with sighted members in the community.

Findings

1. In analyzing psychosocial characteristics, it was found:

    a) There were no significant differences in sex, race, the degree of vision the person had, or the age of onset of his trouble with seeing.

    b) Individuals rated "least isolated" had significantly more education than individuals rated "most isolated."

    c) There were significantly more persons over 65 years of age in the "most isolated" category.

    d) Significantly more individuals in the "most isolated" category had another ailment or condition in addition to their trouble with seeing.

    e) A significant number of individuals in the "most isolated" group considered trouble with seeing the most serious condition a person can have.

2. In analyzing social roles, it was found:

    a) There were no significant differences in marital

status, whether a person lived alone or with others, or in relationship to the head of the house.

b) Significantly more individuals in the "least isolated" group visited friends at least once a week.

c) There was no significant difference in whether or not a person belonged to a church, however, significantly more individuals in the "least isolated" category attended church during the last month.

d) There were no significant differences in whether the individuals were employed at the time of interview or whether they were employed prior to the onset of their difficulty with seeing.

3. There were no significant differences in whether or not the individuals were receiving or had received services or financial assistance from either a public or private agency.

4. The individuals in the sample were found to be very stable with little mobility. Most of them have lived in the same house or in the same city or town for many years.

Conclusions

Through analysis of the findings of this study, the following conclusions can be made:

1. The blind individuals studied have not taken on the character of a subcultural group in our society. The differences found in the study support the assumption held by many in the field that blind persons, despite their handicap, should be evaluated and treated just the same as sighted individuals.

2. The significant difference found in education would apply to sighted individuals in our society as well as to blind individuals. The adjustment and/or integration into society of an individual is highly correlated with education.

3. The significant number of individuals 65 years of age and over in the "most isolated" group supports the expectation one would have that individuals tend to become more isolated with advancing age.

4. Those individuals who considered blindness the most serious condition were significantly more isolated than those who did not. It would be expected that this attitude would be reflected in other areas of social functioning on the part of the "most isolated" individuals.

5. The integration into community activities of the Utah Group

was indicated by their visiting with friends, their attendance at church meetings, and their activity in church and civic organizations. The philosophy of the Mormon Church and the practice of Mormons to contact members and encourage participation in both religious and social activities of the church significantly lessens the degree of isolation of the blind individuals studied.

6. The geographical influence of a low ratio of blind individuals to sighted individuals and the large grographic area in which the communities studied are situated has been a factor which has encouraged identification with sighted members and integration into the community.

7. The limited number of blind adults in rural Utah has restricted their opportunity to segregate themselves from their sighted neighbors for social relations, and they have identified with sighted members in the community.

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CLINICAL EVALUATION OF SCHOOL-AGE CHILDREN WITH RETROLENTAL FIBROPLASIA*

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INTRODUCTION

Terry (9) first described retrolental fibroplasia in 1942, and its course has since been thoroughly studied (10). This condition is usually divided into an acute and a cicatricial phase. The acute phase consists of retinal vessel dilatation and tortuosity, vitreous haze, retinal edema and hemorrhages, neovascularization, retinal detachment and retrolental membrane formation. The residue of the acute phase includes retrolental masses of varying extent, malformations of the optic disc, optic atrophy with pigmentation of the fundus, attenuation of the retinal vessels, shallow anterior chamber, elongation and/or dislocation of the ciliary processes, posterior synechia, corneal opacities, cataract, secondary glaucoma, microphthalmos, enophthalmos, nystagmus, photophobia, and myopia. The retrolental mass is composed of retinal angioblastic tissue, and/or organized vitreous.

In the earliest stages, the pathologic changes consist of capillary endothelial proliferation, glial cell infiltration with edema and hemorrhages in the nerve fiber layer (4). In a more advanced stage, the newly proliferated capillary net, accompanied by a delicate network of fibrous tissue, extends through the internal limiting membrane on to the surface of the retina and thence into the vitreous. In a further advanced stage, the retina is detached into small folds, the summits of which are bridged by a newly formed vascular mesh. In the most advanced stage, the entire retina is detached and extends like a stalk from the optic disc through the vitreous to the back of the lens.

The clinical picture of the condition may vary considerably. It is generally felt that the time of onset is usually between the

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third and the sixth weeks of life, and the acute process lasts from three to five months. Although spontaneous regression during the acute phase may occur in as high as 60 percent of the cases, with no serious residual damage, all gradations of severity from very slight damage to complete opaque membranes may be found. The degree of damage varies with the extent of involvement during the acute phase. There may also be a difference in degree of pathology between the two eyes. Functional changes reflect the physical damage and total blindness results from complete retinal detachment and membrane formation.

This condition occurs almost exclusively in premature infants, and some authors report an inverse relationship between birth weight and the appearance of detectable symptoms (6). However, it has been known to occur occasionally in full-term infants. The etiology of this condition appears to be due to postnatal hyperoxygenation and oxygen sensitivity, occurring usually in a premature infant with an immature retina and its developing vasculature. No complete explanation for the pathogenesis has been established but it is known that oxygen toxicity in the retina manifests in intracellular edema. Gyllensten (5) proposes that the changes may be due to changes in the cellular (endothelial or vasular) membranes both in the retina and the cerebral cortex. Ashton, et al. (1) interpreted the early disappearance of vessels in the first stage of retrolental fibroplasia as a result of passive obliteration due to swelling of the tissues surrounding the capillaries. ACTH, cortisone, electrolyte manipulation, vitamins, and temperature variations were found not to be of etiologic significance. However, the limitation of oxygen concentration to a 40-percent level in prematures has dramatically reduced the incidence of this disease (3).

SUBJECTS

This is a longitudinal interdisciplinary study of 43 children with retrolental fibroplasia, from a total research group of 66 blind children born in the Chicago area between 1945 and 1954, which has been previously described by Norris, et al. (8). All but Cases 1,23, and 34 were in the same group of children, and those 3 were added because comparable background data were available when they were referred for study. Others of that group are excluded because some moved away and some were blind due to other etiologies.

The status of 107 children with retrolental fibroplasia born before 1952 is reported by Krause (7) and 18 children of the present group are identified from his study, as indicated in Table 1. The present results will be compared with what he reported in a later section. Eighty-five percent of the retrolental fibroplasia group were diagnosed before six months of age, and all were diagnosed by one year. All of the children who are mentally qualified

attend public or parochial day schools in the Chicago area.

Psychologic tests were administered and neurologic and pediatric examinations were done in addition to the eye studies. Appropriate studies such as electroencephalography, roentgenology, blood counts, and other laboratory procedures to disclose central nervous system or other impairments were done. A summary of these findings is included in Table 1.

History

Each mother was interviewed concerning the details of gestation, labor, and birth of the child. Questions were asked pertaining to the following: duration of gestation; incidence of prenatal illness or symptoms such as hypertension, convulsions, fever, rashes or bleeding, albumin in the urine; duration of labor; type of delivery; presence of postnatal anoxia; and the presence of ocular abnormalities in other members of the family. Also noted were the birth weight and whether oxygen was administered to the infant after the delivery. If the infant received oxygen, the duration of oxygen administration was ascertained. Unfortunately, records of actual oxygen concentration in the incubators were unobtainable, so the degree of oxygenation is indeterminate. All mothers' responses were checked against the original hospital records if these were available.

Gestation Time

The duration of gestation was determined in 41 of the 43 cases and it ranged from twenty-four weeks to almost full-term. In 10 (25 percent) [10] of the cases it was six months or less; in 24 cases (59 percent) it was between six months and seven months; and in 7 cases (17 percent) it was between seven months and eight months. It can readily be seen from Table 2 that 34 cases (83 percent) had a gestation period of seven months or less.

Duration of Labor

The duration of labor could be ascertained in only 27 cases. It ranged from precipitous delivery to a week of intermittent labor (Table 1). In 19 of these 27 cases (70 percent), the labor lasted five hours or less. The median labor was two hours, 1 birth was precipitous and 8 others took one hour or less.

Presentation and Method of Delivery

It was possible to determine the presentation in 29 of the 43 cases. In 16 (55 percent) cases, the presentation was cephalic; in 9 (34 percent), breech; in 1 case, transverse; and in 3 cases (9 percent), delivery was by a Caesarean section. Of the 43 cases, forceps were used in 10 (23 percent) of the deliveries;

Case No.[1]	Sex	Age[2]	Paranatal Data								Opthalmologic Findings				
			Pre-natal Illness	Gestation Weeks	Labor Hours	Delivery[3]	Birth Wt. (gm.)	Anoxia	Incubation (wk.)	O_2 (da.)	Visual Acuity R	Visual Acuity L	Lids & Fissures O.U.**	Conjunctiva O.U.	Cornea O.U.
1	F	11–5	Heartburn	24	4–5	Forceps	879	Yes	12	Yes[4]	Nil	Nil	Normal	Normal	Clear & small
2	F	9–10	None	33	<1	Breech	1276	—	3–4	17	Nil	Nil	Normal	Marked hyperemia	R clear L enlrged., opaq.
3	M	12–0	Vomiting	28	—	—	987	—	8–12	56	Nil	Nil	—	—	—
4	F	12–6	Bleeding	27	2	Breech	1375	Yes	17	>28	Nil	Nil	Small	Pale	Small, band keratopathy
5†	F	12–2	None	30	2	Caesrn.	1540	—	6	25	Nil	Nil	—	—	—
6	M	11–6	Psychiat.	27	2	Cephalic	1221	—	7	20	Nil	Nil	Short	Clear	R opaque, ectatic L enlrgd., kerat.
7†	F	12–11	None	33	<1	Forceps	2160	No	3½	7	Nil	Nil	—	—	—
8†	F	16–10	Polyhydramnios	30	18	Cephalic	1344	Yes	10	28	Nil	Nil	Normal	Normal	R opaque, ectatic L normal
9†	F	14–10	—	31	—	Abruptia plac. O. F.	1530	—	4	15–20	Nil	Nil	Normal	Normal	R microcornea L calcareous deg.
10	M	12–11	—	29	—	Normal	1392	—	8–12	—	Nil	Nil	—	—	—
11	F	11–5	—	28	1	Cephalic	1588	No	4–5	—	Nil	Nil	Normal, eyes recessed	R hyperemia L normal	R opaque L clr. center only
12† (36)	F	14–0	Bleeding	28	15–26	Caesrn. w. Hyster.	1170	—	8	56	Nil	Nil	—	—	Cloudy
13†	F	12–11	—	32	—	O.F.	1455	—	6	30	Nil	Nil	—	—	—
14† (38)	F	11–0	—	35	—	Normal	1560	—	4–8	7–14	Nil	Nil	—	—	—
15†	F	15–7	Nausea	29	6	Breech O.F.	1456	No	6–7	35	Nil	Nil	Normal	R mod. hyp. L normal	R hazy L sl. enlarged
16	F	12–1	Bleeding Kdny. inf.	28	—	—	1079	—	6–7	—	Nil	Nil	—	—	—
17†	F	13–1	—	28	15	Normal	907	—	12	—	Nil	Nil	—	—	—
18†	F	11–3	Bleeding	30	—	—	1474	—	4–8	—	Nil	Nil	Normal	Secondary infection	Microphthalmic, opaque
19	M	12–3	Bleeding	26	<1	Forceps	1292	No	>7	35	Nil	Nil	R enopth. L normal	Normal	R enlrgd. opa. edem. L small, opaque
20 (33)	F	12–4	None	31	<1	Normal	1761	—	6	42	Bil	Nil	Normal	Minimal infection	Band keratitis, more R eye

† This case included in Table 1 of article by Krause (9).
Number in ( ) is that of sibling or twin.

[2] Age is of January 1962 which is the time when most of the testing was completed.

[3] O.F. is outlet forceps.

[4] O_2 duration not known.

[5] 8–12/sec. rhythm, regardless of blocking to light.

[6] Abnormalities

sl. slow waves from 2–6 sec.
sp. spikes
spd. spike-dome complex
sh. sharp waves
VL voltage low in one or more leads compared to average
FW fusion of waves

[7] Alpha rhythm only in parietal leads.

SUMMARY OF DATA IN 43 CASES OF RETROLENTAL FIBROPLASIA*

Ophthalmologic Findings						Electroencephalography						
Anterior Chamber O.U.	Pupils O.U.	Iris O.U.	Lens O.U.	Fundus O.U.	Tactile Tension O.U.	Neurologic Findings	Rating Δ	Alpha[4]	Abnormalities[4]	Skull X ray	Intelligence[8]	Other Medical
Deep	Miotic, fixed	Sl. atrophic	Clear	RLF membrane	Soft	Mild, CP weakness	3	Par.[1]	Parox. sl.	Pineal calc.	4	None
R deep L obliterated	R dilated, fixed L obliterated	Atrophic	R clear L opaque	R RLF membrane L not seen	R normal L hard	Normal	—	—	—	—	2	Advise enucleation
—	—	—	—	—		Normal	2	Par.	sl. vl	Normal	2	None
Shallow	R 3mm & fixed L 2 mm & fixed	Atrophic	Clear	RLF membrane	Soft	Normal	2	No	Sl. sp on rt	Possible osteoma	3	None
—	—	—	—	—	—	Normal	3	No	Sp, sl	—	2	Enucleated
Deep	R small, bound down L 4 mm & fixed	Atrophic	R obscured L clear	R not seen L RLF membrane	R firm L hard	General brain impairment	2	Par.	Sp, spd	Pers. metopic sut.	4	Underdeveloped
—	—	—	—	—	—	Normal	—	—	—	—	1	—
R obliterated L average	R obliterated L adheres to lens	R adhere L atrophic	R incor. into pup. L opaque	Not seen	R hard L soft	Normal	3	No	Sl, sp, sh	—	3	None
Obliterated	R 4 mm, rigid L obliterated	R atrophic	—	—	R normal L —	Isolated convulsion	2	Poor par.	Dysrhythmia	L occip. bulge	4	None
—	—	—	—	—	—	Occas. petit mal	—	—	—	—	2	None
Obliterated	R obliterated L miotic, bound dwn.	R atro. adherent L atrophic	R not seen L opaque	Not seen	R normal L soft	Normal	3	No	Sp, sh	Normal	2	Enucleation
Shallow	—	Atrophic	Opaque	Not seen	—	L hemiparesis Convulsions	4	No	Sp, spd, sl	Pers. metopic sut.	4	Short L leg
Shallow	—	—	R — L opaque	—	R firm L —	Normal	2	Par.	Sp, sl	12 mm. dens. L orbit	3	Pes planus hypotonicity
—	—	—	—	—	—	Normal	2	No	L occip. & par. FW, VL	—	2	Pyelonephritis nitro. retent.
R normal L deep	Miotic	Atrophic	Posterior polar opacity	RLF membrane	R very soft L soft	Normal	2	No	Sp	Normal	2	None
—	—	—	—	—	—	—	—	—	—	—	2	—
—	—	—	—	—	—	Asymmet. plantar ref.	2	No	Parox. sl.	—	2	Dermatitis herpetiformis
Obliterated	Small	Atrophic	Not seen	Not seen	Soft	Possible extrapyramidal involvem.	4	Par.	Sh, sp, spd.	Normal	3	Advise enucleation
Obliterated	Obliterated	Atrophic	Opaque	Not seen	Soft	Normal	2	No	Sl, VL, FW	—	1	None
Shallow	Normal	Nnrmal	Clear, peripheral membrane	No red reflex	Normal	Normal	3	No	Sl, sh.	—	2	None

* Dash in space means either that information is unknown or could not be observed.

Δ** Both eyes.

[4] 1. is normal
2. is mildly abnormal
3. is moderately abnormal with frequent localized or generalized slow waves or spikes
4. is severely abnormal with very frequent slow waves or spikes of high amplitude

[1] vision with glasses.

[8] Intelligence
1 Superior: IQ above 110
2 Normal: IQ 90–110
3 Below Normal: IQ 80–90
4 Retarded: IQ below 70

Case No.[1]	Sex	Age[2]	Pre-natal Illness	Paranatal Data							Opthalmologic Findings				
				Gestation Weeks	Labor Hours	Delivery[3]	Birth Wt. (gm.)	Anoxia	Incubation (wk.)	O_2 (da.)	Visual Acuity R	Visual Acuity L	Lids & Fissures O.U.**	Conjunctiva O.U.	Cornea O.U.
21†	F	12–6	Toxemia Anemia	24	—	—	865	—	14	90	Nil	Nil	Small-2 cm. apertures	Normal	Opaque
22	M	11–5	Psychiat. Bleeding	31	Precip.	—	682	—	14	42	Nil	Nil	—	—	R — L dystrophia
23	F	7–10	—	—	—	—	907	—	8–12	—	Nil	Nil	—	—	—
24	F	11–9	Rash	35	1	Cephalic	1304	No	7–8	—	Nil	Nil	Recessed	Clear	Clear, entire eye small
25	F	13–0	Hyperten. Edema Nausea	31	2	Breech	1732	No	6	24	Nil	Nil	Normal	Normal	R 16 mm. opaque. calcified L 16 mm. clear cent.
26 (42)	M	14–10	Headache Bleeding	30	5	Breech Forceps	1620	Yes	7	5	Nil	Vague LP	Enophth.	—	R small, opaque L clear
27†	F	11–6	—	31	—	Normal	1460	—	8	—	LP	LP	—	—	—
28	M	13–1	None	29	9	Cephalic	923	No	10	70	LP	Nil	Normal, eye recessed	Normal	R small L band kerat. opaq.
29†	M	14–7	None	31	—	Normal	1030	—	11	49	LP	Nil	—	Normal	Clear
30	M	11–9	None	32	—	Normal O.F.	1965	—	4–8	28	Nil	Faint LP	—	—	—
31	F	11–9	None	—	—	Normal	1616	—	7–8	—	LP	LP	—	—	—
32	M	12–0	Bleeding	31	<1	Forceps	1460	Yes	4–8	—	LP	LP	—	—	—
33 (20)	F	12–4	None	31	<1	Normal	1690	—	6	42	LP	LP	Normal	Normal	Normal
34	F	9–7	Bleeding Nausea	27	4–5	Normal	1332	No	13	—	LP	LP	Normal	Normal	R kerectasia L normal
35†	F	11–5	Heart disease	27	—	Normal breech	907	—	10	70	LP	Lrge. object	Normal	Normal	R band keratopathy L normal
36† (12)	F	14–0	Bleeding	28	15–16	Caesrn. w. hyster.	1300	—	8	30	2/200	? LP	Normal	Normal	R normal L band keratopathy
37	F	12–0	Bleeding	27	5	Breech	1079	No	12	84	CF 3 ft.	5/200	Normal, eye recessed	Normal Normal	R eye small L normal
38† (14)	F	11–0	—	35	—	Normal breech	1793	—	1–2	10	20/200 20/50[x]	20/200 20/65[x]	—	—	—
39†	F	14–0	Hyperten. Bleeding	25	1 wk.	Forceps	1075	—	8	56	LP LP	LP 20/200[x]	Normal	Clear	Clear
40	M	13–1	—	27	—	Normal	1136	—	9	—	CF	20/200	Normal	Normal	Normal, clear
41†	M	13–10	Hyperten.	31	22	Breech/ forceps	1350	Yes	8	58	20/70 20/50[x]	20/200 Same[x]	Normal	Normal	Normal
42 (26)	M	14–10	Headache Bleeding	30	5	Transv.	1899	No	7–8	13	20/100[x]	20/25[x]	—	—	Clear
43	F	11–5	Partial placenta praevia	29	2 3	—	1276	—	4–8	—	(o.u.)	Lrge. object	—	—	—

Continued

Ophthalmologic Findings						Electroencephalography						
Anterior Chamber O.U.	Pupils O.U.	Iris O.U.	Lens O.U.	Fundus O.U.	Tactile Tension O.U.	Neurologic Findings	Rating	Alpha	Abnormalities	Skull X ray	Intelligence	Other Medical
Obliterated, shallow	Not visible	Not visible	Not visible	Not visible	Unreliable microphth.	Spastic quadriplegia	3	No	Sp	Normal	3	+ hearing loss
R — L obliterated	—	—	—	—	—	Asymmet. plantar reflex	3	No	Sp, hi. volt. sl	—	4	Hearing loss hypotonia
—	—	—	—	—	—	Spastic quadriplegia	4	Par.	Sl.	Normal	3	Hearing loss
R shallow L deep	Reacts to light	Normal	R clear L opaque	R RLF membrane L not seen	Soft	Seizures	—	—	—	Normal	4	Obesity
R oblitd., ant., staphyl. L deep	R obliterated L seclusia, 2 mm bound to lens	R drawn up to cornea L sl. atrophic	R clear L center clr. periph. opaque	R RLF membrane L white reflex nasal red reflex	—	Normal	3	No	Sh. sl. sp.	—	1	None
—	R — L miotic, no react. bound down	R atrophic L normal	—	R not seen L RLF membrane	R soft L —	Seizures, arrested hydrocephaly	2	Par.	Sl	Oxycephaly Asymmetry	2	None
—	No reaction to light	—	—	—	—	Seizures	3	No	Mult. sp.	Normal	3	Pes planus Hpotonic
R irr. shallow L Obliterated	R small, irregular L partially oblit.	R depigmented L atrophic	R clear L not seen	R clear L not seen	Soft	Seizures	3	Par.	Sp	Assymm. Orbital calcific.	3	Hypotonic
—	Occluded	—	—	—	—	Spastic diplegia	3	No	Sp	Normal	2	None
—	Fixed	—	—	Not seen	Soft	General brain impairment	2	No	Sp. spd	Sl. asymmet. brachycephaly	3	Mod. hypotonia
—	—	—	—	—	—	Normal	3	Par.	Sl. sp. VL	—	1	None
—	—	—	—	—	—	Petit mal	3	Par.	Sl. sp. sh.	—	2	Mild auditory loss
Shallow	? normal	Normal	Anter. cataract	No red reflex	Normal	Normal	3	Par.	Sl.	—	2	None
R obliterated L average	R obliterated L round	Atrophic	R opaque L opaque	Not seen	Appears normal	Normal	3	No	Sl.	—	1	Obesity
R shallow L normal	R miotic, fixed L normal	R bound, atrophic L normal	Clear	R RLF membrane L half detach.	Normal	Minimal incoordination	2	No	VL, sp, sl	—	2	None
R normal L shallow	R sluggish L bound down	R normal L atrophic	R clear L opaque	R myopic, red reflex L not seen	R normal L soft	Slight spastic diplegia	4	No	Sp.	—	2	Hypotonicity
R shallow L normal	Dilated, react poorly	Normal	Clear	Vitreous clear	Normal	Possible cerebellar deficit	3	No	Sp, sh	—	3	Cong. heart surgery
—	—	—	—	—	—	Normal	4	Poor	Sl, FW, VL	—	2	Short L leg, Scoliosis
R deep L shallow	R semi-dilated, fxd. L normal	Normal	R opaque, breaking down L clear	R not seen L atrophic, pale	Normal	—	2	Poor	Sl.	—	2	None
Shallow	4 mm.	Normal	Clear	Myopic fundus	Soft	Normal	1	Norm	Normal	Normal	2	None
Normal	Normal	Normal	Clear	Nasal retract. blood vessels	Normal	Nerve paresis Weak L leg	3	No	Sl.	—	3	Poliomyelitis Obesity
Normal	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—

in 27 cases (63 percent), no forceps were employed; and in 6 cases (14 percent) it could not be determined whether forceps were used.

TABLE 2

GESTATION TIME IN 43 CASES
OF RETROLENTAL FIBROPLASIA

Duration of Gestation (Mo.)	Number of Cases	Percent of Cases
5-1/2	2	5
6	8	18
6-1/2	10	23
7	14	33
7-1/2	4	10
8	3	7
8-1/2	-	-
9	-	-
Not known	2	5
TOTAL	43	

TABLE 3

MATERNAL PRENATAL ILLNESSES IN
43 CASES OF RETROLENTAL FIBROPLASIA

Malady	Number of Cases	Percent of Cases
Bleeding*	10	26
Heart burn	1	3
Hypertension	3	7
Rash	1	3
Anemia and toxemia	1	3
Polyhydramnia	1	3
Heart disease	1	3
Psychiatric	2	5
No prenatal illnesses	9	23
Unknown	10	26
TOTAL	39	

*Each case is entered only once. One mother listed as bleeding also had a kidney infection, and two of the mothers with hypertension also had bleeding, so 12 mothers in all had bleeding during pregnancy. One case of hypertension also had edema.

Prenatal Illnesses

Thirty-nine mothers delivered the 43 babies; included in the group are four pairs of twins. Prenatal illnesses are presented in Table 3. Nineteen mothers reported no evidence of any of the following prenatal illnesses: hypertension, edema, bleeding, fever, rash, or toxemia. Of the 20 cases which showed some evidence of prenatal complications, vascular problems predominated with bleeding present in 10 cases (26 percent); 1 case (3 percent) developed anemia with toxemia; 3 (7 percent) developed hypertension; 1 case (3 percent) developed a polyhydramnios; 1 suffered from heart disease; 1 patient (3 percent) complained of prolonged heartburn; 1 (3 percent) developed a rash; and 2 cases (5 percent) developed psychiatric symptoms.

Postnatal Anoxia

The occurrence of postnatal anoxia in these 43 subjects was as follows: 6 cases (14 percent) showed some degree of postnatal anoxia and cyanosis; 10 cases (23 percent) revealed no postnatal anoxia; and 27 cases (63 percent) did not have this information available. It would be assumed that if severe postnatal anoxia had been present in these cases, it would have been recorded. It was common practice to administer oxygen even through anoxia did not exist.

Birth Weight

The birth weight in the 43 cases ranged from one pound and eight ounces to five pounds. Six babies (14 percent) weighed one to two pounds; 17 (40 percent) weighed between two and three pounds; 17 (40 percent) weighed between three and four pounds; and 3 (7 percent) weighed between four and five pounds at birth.

Oxygen Administration

In 42 of the 43 cases the duration of incubation of the infant was determined either from the hospital records or from the mothers' reports. The length of time in the incubator ranged from ten days to three and one-half months. Seventeen cases (40 percent) required from six to eight weeks; 9 cases (23 percent), from eight to ten weeks; 4 cases (10 percent), from ten to twelve weeks; 7 cases (16 percent), twelve or more weeks; and 5 cases (12 percent), less than six weeks.

The duration of oxygen administration was recorded in 29 cases in this study and ranged from four to ninety days. Four cases (15 percent) were in oxygen ten days or less; 9 cases (33 percent), from ten to thirty days; 8 cases (28 percent), from thirty to forty-five days; 5 cases (17 percent), from forty-five to sixty days; 2 cases (7 percent), for about seventy days; and 1 case

(3 percent), for about ninety days. Summaries of the degree of oxygenation were not available, but the duration expresses something of the estimate of the physical condition of the infant, with the stronger baby being removed from oxygen earlier than the weaker one.

Age

The 43 children with retrolental fibroplasia were born between March, 1945, and March, 1954. One each were born in 1945 and 1946; 4 were born in 1947; 8 in 1948; 10 in 1949; 14 in 1950; 2 each in 1951 and 1952; and 1 in 1954. The children ranged in age from seven to sixteen years, with a median age of twelve years at the time of the tabulation of data.

EYE FINDINGS

Visual Acuity

The visual acuity was recorded in 43 cases, with a total of 84 eyes studied (Table 4). It ranged from absolute blindness (no

TABLE 4

BIRTH WEIGHT IN 43 CASES OF RETROLENTAL FIBROPLASIA

Birth Weight (gm.)	Number of Cases	Percent of Cases
Under 454	0	0
455- 907	6	14
908-1361	17	40
1362-1814	17	40
1815-2268	3	7
Over 2269	0	0
TOTAL	43	

light perception) to a best corrected visual acuity of 20/25. Fifty-four eyes (63 percent) had no light perception; 17 eyes (20 percent) had light perception with some projection; 3 eyes (3 percent) could detect hand movements; in 2 eyes (2 percent) the vision was reduced to counting fingers; in 5 eyes (8 percent) the vision acuity ranged from 20/400 to 20/200; in 1 eye (1 percent) the visual acuity was 20/100; in 3 eyes (3 percent) it was 20/50; and in 1 eye it was 20/25. Twenty-five children (58 percent) were

totally blind; 9 (21 percent) had light perception or projection; and 2 (5 percent) could only see large objects or hand movements. The degree of vision in each case is presented in Table 5.

TABLE 5

VISUAL ACUITY IN 43 CASES OF RETROLENTAL FIBROPLASIA*

Vision	No. of Eyes	% of Eyes	No. of Cases (Vision of Best Eye)	% of Cases
No light preception	54	63	25	48
Light perception	17	20	9	21
Hand movements	3	3	2	5
Count fingers	2	2	-	-
20/400-20/200	5	8	4	9
20/100	1	1	-	-
20/50	3	3	2	5
20/25	1	1	1	2
TOTAL number of eyes in 43 patients	86		43	

*With glasses if worn.

Anterior Segment Examination

Examination of the anterior segment was performed in 27 of the 43 patients. The lids and fissure were normal in 36 (65 percent); whereas, in 18 eyes (35 percent) the fissures were short and narrow and the eyes were enophthalmic. Examination of the palpebral and bulbar conjunctiva was noted in 48 eyes. The conjunctiva were normal in 38 eyes (79 percent), hyperemic with ciliary injection in 8 eyes (16 percent), and pale and atrophic in 2 eyes (4 percent).

Cornea

Examination of the cornea was made in 54 eyes of 27 patients. The corneal size was normal in 26 (48 percent) of these eyes, was smaller than normal in 19 eyes (35 percent), larger in 6 eyes (11 percent), and ectatic in 3 eyes (6 percent). The corneas were completely clear in 26 eyes (48 percent), partially opaque in 7 (13 percent), completely opaque in 9 (17 percent); and a band-shaped keratopathy was present in 12 eyes (22 percent).

Anterior Chamber

The examination of the anterior chamber was recorded in 54 eyes of 27 patients. The anterior chamber was of normal depth in 9 eyes (17 percent), shallow in 21 (39 percent), deep in 10 (19 percent), and obliterated in 14 eyes (26 percent).

Iris and Pupil

The characteristics of the iris were noted in 50 eyes of 25 patients. The iris stroma was reported as normal in 16 eyes (32 percent), moderately atrophic in 4 eyes (8 percent), and markedly atrophic in 30 eyes (60 percent). In those 14 eyes where the anterior chamber was obliterated, the iris was adherent to the posterior surface of the cornea.

The characteristics of the pupil were noted in 52 eyes of 26 cases. The pupils were of normal size in 14 eyes (27 percent), moitic and irregular in 32 (61 percent), markedly dilated in 3 (6 percent), and partially dilated in 3 (6 percent).

The pupillary reaction to light was recorded in 46 eyes or 23 patients. In 32 eyes (70 percent) the pupils were fixed. Seven (15 percent) showed a sluggish reaction to light, while 7 (15 percent) had pupils which reacted normally to light. The shape of the pupil was recorded in 52 eyes of 26 patients and was recorded as round in 33 eyes (65 percent), irregular in 7 (11 percent), and obliterated in 12 (23 percent).

Lens

The lenses were examined in 52 eyes of 26 patients. In 20 of these eyes (38 percent), the lenses were clear; in 11 (21 percent), they were partially opaque; and in 21 (40 percent), they were completely opaque.

Fundus Examination

Examination of the fundus was recorded in 52 eyes of 26 cases. In 22 eyes (42 percent), the details of the fundus were completely obscured by either the corneal or lens opacity or both. In 16 (30 percent) there was a complete opaque retrolental membrane obscuring the fundus. In 6 eyes (12 percent) the vitreous haze was so intense that only a red reflex and no details of the fundus could be seen. Three (6 percent) revealed a normal fundus resembling that seen in a moderately high degree of myopia. One eye (2 percent) had a temporal detachment of the retina with marked pigmentary changes. One (2 percent) presented a normal fundus except for some nasal retraction of the blood vessels with moderate pigment dispersion throughout the posterior pole. Another fundus (2 percent) presented a similar picture with the addi-

tion of a fibrous tissue sheath in the superior nasal quadrant. Two fundi (4 percent) presented the picture of nasal retraction of the blood vessels, with pigment dispersion and optic atrophy. Of the 6 eyes with intense vitreous haze, 1 case was due to a long-standing vitreous hemorrhage and 2 of these 6 had a severe asteroid hyalitis (Table 6).

TABLE 6

FUNDUS EXAMINATION

Fundus	Number of Eyes	Percent of Cases
Obscured by corneal or lens opacification	22	42
Obscured by opaque retrolental membrane	16	30
Intense vitreous haze obscuring fundus details	6	12
Fundi resemble that of high myopia	3	6
Total retraction of retinal vessels with pigmentary dispersion	1	2
Nasal retraction of vessels with pigmentary dispersion	1	2
Same as above with optic atrophy	2	4
Nasal retraction of vessels, pigmentary dispersion and fibrous tissue sheath along superior nasal vessels	1	2
TOTAL	52	

Tactile Tension

The tactile ocular tension was recorded in 52 eyes of 26 patients. The tactile tension was recorded as normal in 19 eyes (36 percent), soft in 24 (46 percent), and firm or hard in 9 (17 percent).

Miscellaneous Eye Findings

The coordination of the two eyes was surprisingly good despite the poor or absent functional vision. Of the 43 children the eyes were convergent in only two cases, and divergent in two others.

In one case there was a conjugate deviation of the eyes to the right side. In 8 cases there was an ocular nystagmus. Nine eyes were phthisical. One of these occurred following surgery for a secondary glaucoma. Two eyes were buphthalmic. Enucleation was advised for 8 eyes but was carried out in only 2 cases. The indication for enucleation in those totally blind eyes were prolonged and severe pain, photophobia and tearing. In spite of the fact that some of the eyes are indeed "physical wrecks," complaints of pain, photophobia, lacrimation, and blepharospasm were not common and were persistent in only 6 of the 43 cases. Due to the marked damage to the cornea, pupil, lens, and retina in most eyes, a satisfactory refraction could not be performed and failed to improve the visual acuity to any significant degree. Two eyes showed a refraction error of a minus 12.5 sphere in each eye.

PSYCHOLOGIC AND NEUROLOGIC FINDINGS

Psychologic Status

The level of intellectual functioning was determined in 42 cases by use of the Hayes-Binet Interim Test of Intelligence and the verbal battery of the Wechsler Intelligence Scale for Children (4). Six children (15 percent) were considerably above normal (intelligence quotient above 110), and 19 more cases (45 percent) were within the average range of 90 to 110 IQ, so that 25 (59 percent) were functioning at the normal or higher level. Eleven children (27 percent) were below normal or mildly retarded with IQ's falling between 70 and 89, and 6 (15 percent) of the children were severely retarded with IQ's below 70.

Other tests of personality, perceptual and cognitive functioning were also applied, but an extensive analysis of the results in the psychologic area goes beyond the scope of the present paper.

Neurologic and Other Medical Findings

A complete neurologic examination was made including the electroencephalogram and skull X-ray films when possible. Definite overt clinical indications of abnormalities were present from the examination or case histories in 15 (35 percent) of the children. The most common accompaniment of retrolental fibroplasia is a convulsive disorder of the petit mal, psychomotor, or grand mal type which was present in 8 (18 percent) cases. Next common was cerebral palsy which was also present in two of the children who had seizures and in four others, ranging from severe spastic quadriplegia to slight spasticity of one limb. Two children showed evidence of generalized brain impairment from clinical and behavioral indications, and one child had a hemiparesis of the VII cranial nerve and a weakness of a leg resulting from poliomyelitis.

Other minimal neurologic signs were present in 4 more cases (10 percent); either the examination was normal or not performed, but at least no neurologic involvement was suspected, in 22 cases (51 percent). Two cases (5 percent) had asymmetrical plantar reflexes, and 2 cases (5 percent) had a possible cerebellar deficit because of incoordination greater than seen in other blind children. One of these had undergone corrective heart surgery for a congenital valve defect.

Serial roentgenograms of the skull, both orbits and optic foramina, were performed in 19 cases and illustrative abnormalities are shown in Figure 1 through 4. In two cases without neurologic involvement, there were intraorbital calcifications in the left orbit, in one case measuring 7 mm. in diameter and in the second case measuring 12 mm. in diameter (Figure 1).

The following cases had neurologic impairment and skull X-ray findings. Three cases showed an asymmetry of the skull. One revealed a bulging in the occipital region, greater on the left side (Figure 2). One case revealed a brachycephaly with asymmetry of the skull, the left hemicranium being of smaller volume than the right (Figure 3: A and B). One case showed oxycephaly, also with calcification of the dura markings, and was suggestive of an arrested hydrocephaly (Figure 3: C and D). Two cases showed increased vascular markings, one with increases digital markings and both were associated with some prominence of the metopic suture lines. The orbits in one case were asymmetrical, the left being smaller than the right and the latter showing a definite large intraorbital calcification (Figure 4).

One case had pyelonephritis with nitrogen retention. Four children had some impairment of hearing usually with spasticity. General hypotonicity with pes planus or a tendency to obesity was found in about one fourth of the cases, presumably due to insufficient exercise.

Electroencephalographic Findings

The findings in 28 children in this group have already been reported by Cohen, et al. (2). Electroencephalographic tracings were performed in 37 of these 43 cases and produced results consistent with the earlier findings. All of these tracings were abnormal except those of an eleven-year-old boy who had a visual acuity in the better eye of 20/200 associated with a highly myopic error of refraction (Case 40). The electroencephalographer rated the degree of abnormality of the tracings in three categories in addition to "normal" as illustrated in Figures 5 and 6; these are listed in Table 1. Of the 36 abnormal tracings, 14 (40 percent) were mildly abnormal, 18 (50 percent) were moderately abnormal, and 4 (10 percent) were severely abnormal. The most common abnormalities were occipital spikes and generalized slow waves

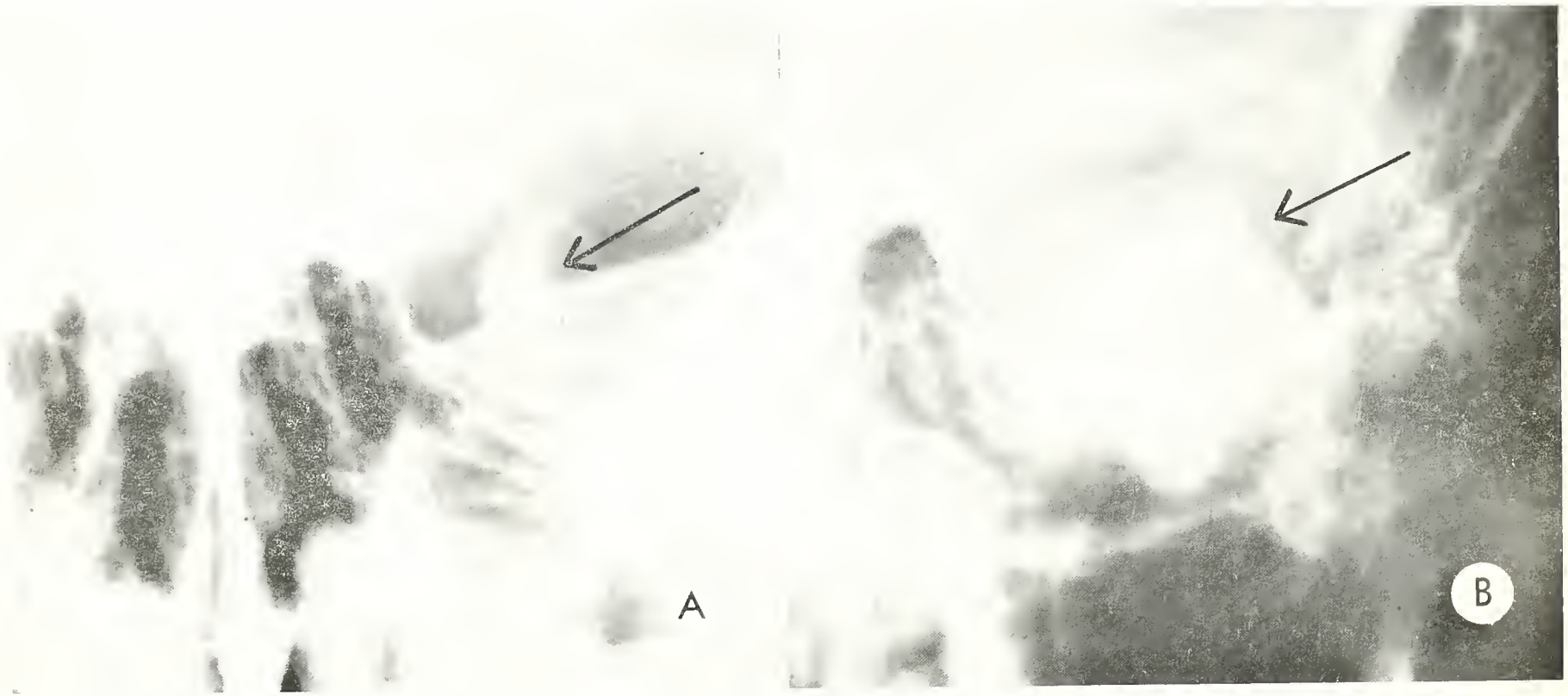

Figure 1. Intraorbital calcifications: (A) Case 4. Left orbit, frontal view; (B) Case 13. Left orbit, frontal view. (Cohen, Alfano, Boshes, and Palmgren)

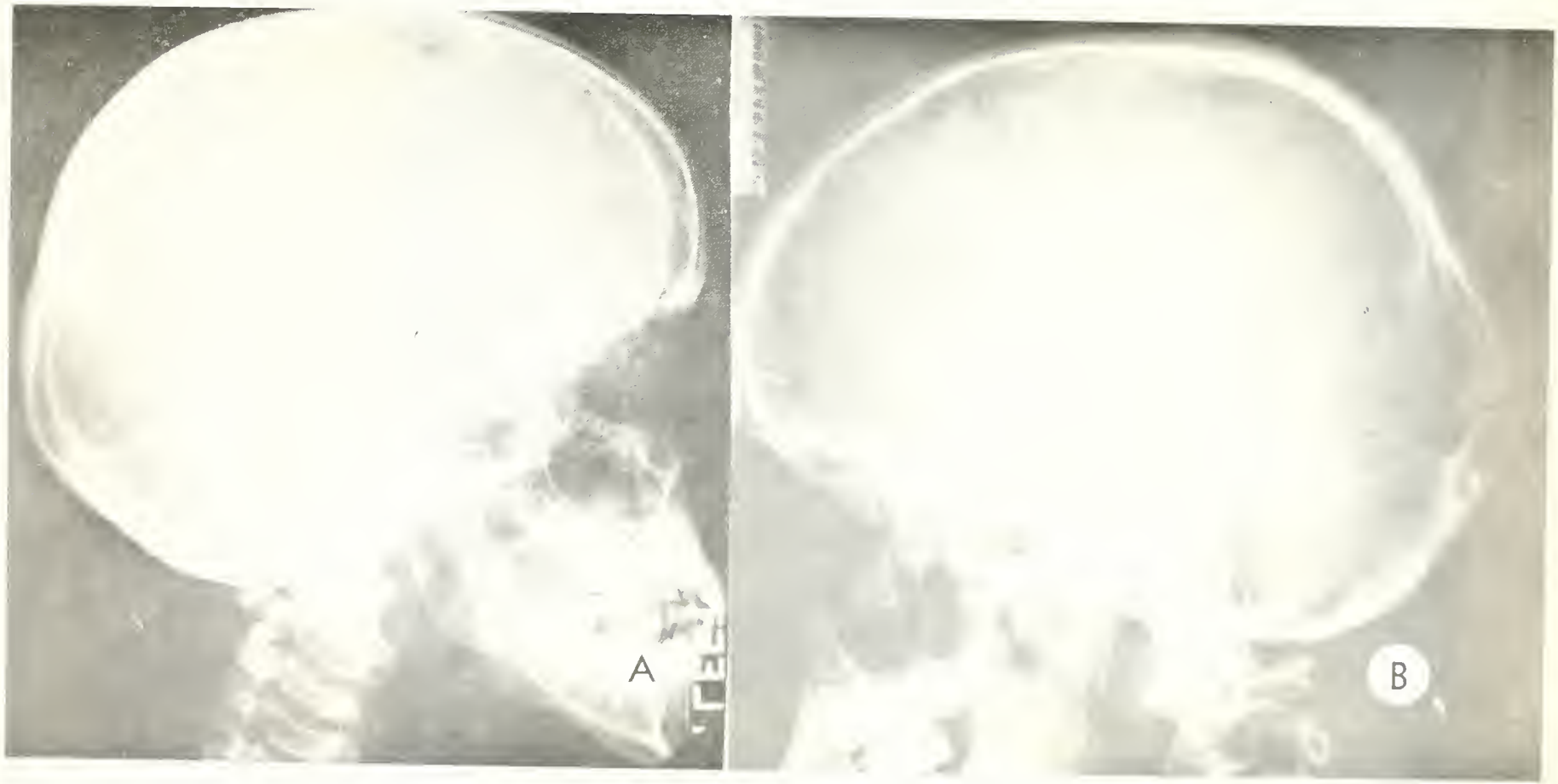

Figure 2. Case 9. Asymmetrical skull with left occipital bulge: (A) Right lateral view; (B) Left lateral view. (Cohen, Alfano, Boshes, and Palmgren)

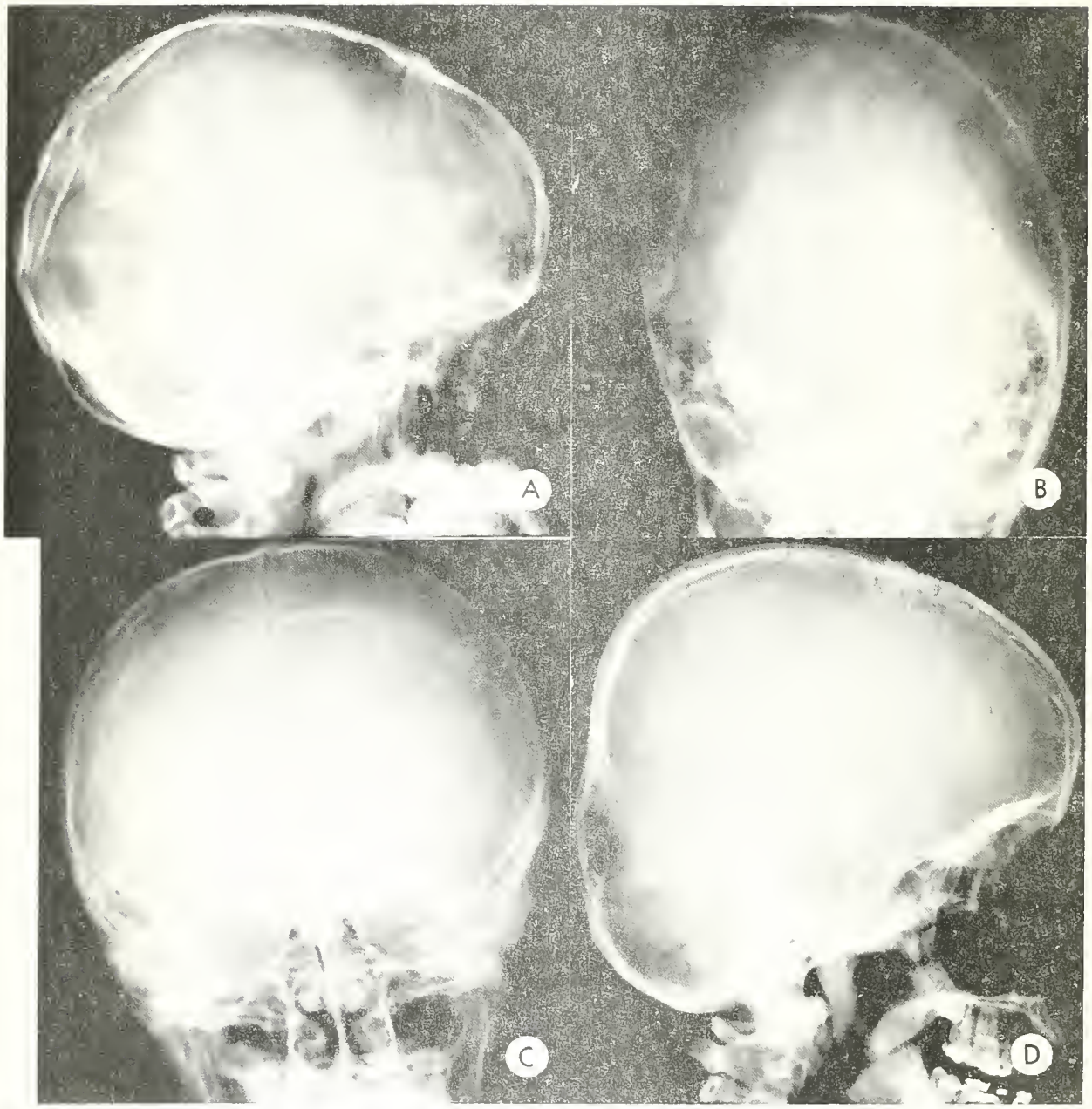

Figure 3. Asymmetrical skull: (A) Case 30. Asymmetrical brachycephaly - Lateral view; (B) Case 30. Left cranial flattening - Posterior view; (C) Case 26. Calcification of the dura markings; (D) Case 26. Oxycephaly - Lateral view. (Cohen, Alfano, Boshes, and Palmgren)

Figure 4. Case 12. Increased vascular markings, persistent metopic suture, and right intraorbital calcification - Frontal view. (Cohen, Alfano, Boshes, and Palmgren)

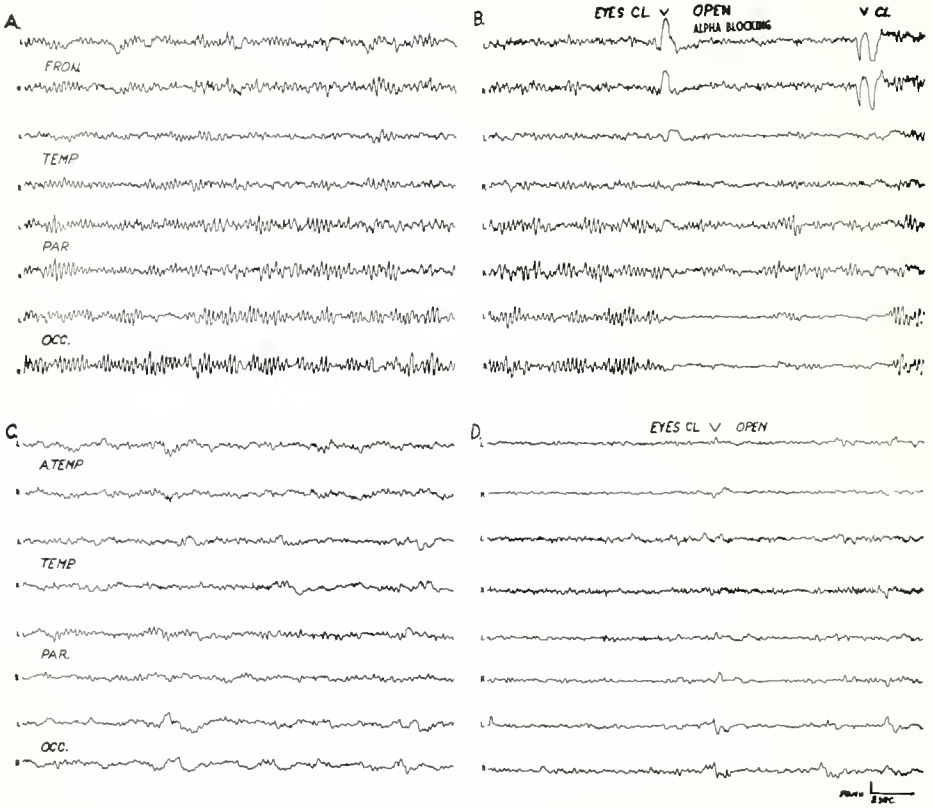

Figure 5. (A and B) Normal sighted control. Normal tracing (rating 1). Girl, aged 13 years, premature birth. Note well-developed 10-per-second alpha rhythm, most prominent in the occipital lobes (B) shows desynchronization when the eyes are open and return of the rhythm when eyes are again closed. (C and D) Case 13. Totally blind girl, aged 13 years. Mildly abnormal tracing (rating 2). Note absence of occipital rhythm, but some parietal alpha is present. Opening and closing the eyes caused no change in the record. The top line is the left-sided lead and the bottom line is the right-sided lead for each lobe. Monopolar leads are recorded against the average of all leads as the reference electrode. (Cohen, Alfano, Boshes, and Palmgren)

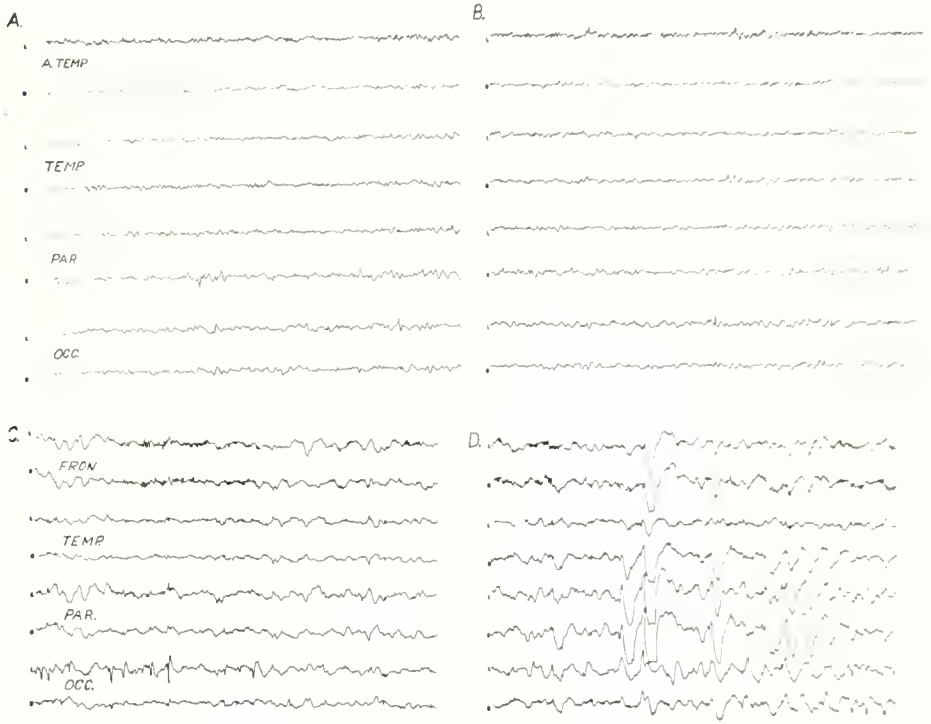

Figure 6. (A and B) Case 30. Boy with light perception in right eye. Aged 12 years. Abnormal tracing (rating 3). Dysrhythmic flat record with biparietal and bioccipital slowing and spikes in the left occipital lead. (A) is during 12 cps photic stimulation in the left eye and (B) is the right eye, but the light had no effect despite unilateral light perception. (C and D) Totally blind boy, aged 10 years with epileptic seizures. Severely abnormal tracing (rating 4). (C) is during deep sleep. Severe left occipital spikes. (D) is arousal. Left occipital spikes and severe generalized two or three per second slowing. The top line is the left lead and the bottom line is the right lead for each lobe. Monopolar leads were recorded against the average of all leads as the reference electrode. (Cohen, Alfano, Boshes, and Palmgren)

(Figure 6). Occipital alpha was either poorly developed or lacking in blind children and parietal alphalike frequency was observed (Figure 5 C). These results strongly suggest the importance of vision for the development of the normal alpha rhythm.

Most subjects exhibited more than one kind of abnormality, most commonly in the occipital lobes but often other areas of the cerebral cortex were also involved. The abnormal findings include spikes, sharp and slow waves, fusion of waves, and voltage loss. The total number of abnormalities decreases as the distance from the occipital lobe is increased for spikes, sharp and slow waves, whereas fusion of waves and voltage loss appear equally throughout all areas. The occurrence of spikes and spike-dome waves is more common in the group with light perception than in the totally blind. Slowing is most frequent in the totally blind group. The light perception group shows the highest incidence of wave fusion and voltage loss.

Many of these blind children with abnormal records suggesting a seizure state (spikes and spike-domes) have to date demonstrated no clinical evidence of convulsions. The relationship between the EEG tracings and clinical evaluation of the blind subjects did not always follow the usual pattern. Three of the five children with highly abnormal EEG records were considered normal by neurologic examination and had normal IQ's. A mildly abnormal EEG was associated with a normal psychologic and neurologic examination in both the blind and partially sighted. These results tend to show that the interpretation of the EEG must be considered as part of the total study of a child with retrolental fibroplasia and that a highly abnormal EEG by itself does not substantiate a concomitant neurologic deficit in blind children but is often present in well-functioning blind children. No special pattern of waves emerges with retrolental fibroplasia but diagnostic use can be made of the EEG as with sighted children, when there is clinical evidence of existing neurologic impairment.

COMPARISON TO KRAUSE'S STUDY

Krause (7) reported on the visual status of 107 children with retrolental fibroplasia, including 18 who have also been identified in this study, and the two evaluations indicate the changes to be expected with the passage of time in the visual ability of young children with retrolental fibroplasia. Since Krause does not list his subjects by number, direct reference to his Table 1 is difficult but a summary of comparative findings is presented.

Out of the 18 patients ranging in age from almost seventeen years to eleven years, 9 became worse, 8 were unchanged and 1 case seemingly improved. There is a lapse of at least eight years between the two evaluations, so the eleven-year-olds now

were no more than three at the time of his evaluation.

The one case (27) which seemingly improved from no vision to light perception was under three years of age at the time of the earlier study and is below average in intelligence. At that age it is difficult to determine the existence of light perception, since the verbal report of the child is likely to be unreliable. The best assumption is that the child could always see light but that no evidence for that was found during Krause's study.

Of five patients who earlier had only light perception, two had retained it and three had lost it by the present time. Four cases which had only object perception before also became totally blind and one case retained the same degree of vision. A five-year-old child with vision of 20/50 in both eyes maintained it in one eye while vision in the other eye was reduced to 20/200. Another five-year-old's vision was reduced from 20/70 in one eye to object perception, and 20/50 in the other eye to 20/200. A four-year-old with 20/100 vision in both eyes lost it completely when her stage III condition gradually deteriorated to complete retrolental membrane formation.

The five children who were totally blind at first showed no change of significance. In the nine cases which became worse, the fundus picture showed complete retrolental membranes and, frequently, deterioration of the globes. It may be assumed that the loss resulted from progressive changes in the retina due to retrolental fibroplasia. Often loss of visual ability was also accompanied by a decrease in the level of intelligence or emotional adjustment.

SUMMARY

The ophthalmologic portion of this report concerns itself with the evaluation of 84 eyes of 43 patients with the established diagnosis of retrolental fibroplasia, who ranged in age from seven to sixteen years. In 25 percent of the cases, the gestation period was six months or less, whereas in 83 percent of the cases, the gestation period was seven months or less.

In 64 percent of the cases, the duration of labor was ten hours or less, and in one case it was precipitous. In 55 percent of the cases, the presentation was cephalic, whereas in 34 percent of the cases the presentation was a breech. Forceps were used in 23 percent of the cases, and 9 percent were delivered by a caesarean section.

In half of the cases, there was some evidence of prenatal illness, including bleeding, hypertension, edema, anemia, and hemangiomas. There was some degree of immediate postnatal anoxia in 14 percent of the cases. In this series, there was no child

with a birth weight under one pound or over five pounds. In 94 percent of the cases, the birth weight ranged from one and one-half to four pounds. Forty-seven percent of the patients were in an incubator from four to ten weeks and all received oxygen from four to ninety days.

Eighty-two percent of the children were either totally blind or had only light perception. Thirty-five percent showed a marked degree of enophthalmos. The conjunctiva was abnormal in 21 percent of the cases. In 52 percent of the cases, the cornea revealed marked abnormality, including ectasis, opacification, and band-shaped keratitis.

The anterior chambers were shallow or obliterated in 65 percent of the cases and unusually deep in 19 percent of the cases. The structure of the iris was abnormal in 68 percent of the cases. The pupils were abnormal in size, shape, and light reactions in 73 percent of the eyes examined. Some degree of lens opacification was present in 61 percent of the eyes.

Because of changes in the cornea and the lenses, a view of the fundus could be obtained in only 58 percent of the eyes. Of this latter group, 30 percent showed a complete retrolental membrane and 27 percent showed alterations in the vitreous, retina and optic nervehead. The tactile tension was soft in 46 percent and firm or hard in 17 percent of the eyes.

Roentgenograms of the skull, orbits, and optic foramina were performed in 19 cases and were normal in all but 5 cases. In addition 3 other cases showed intraorbital calcifications. In 2 cases there was an asymmetry of the skull and in 1 case an asymmetry of the orbits.

Electroencephalograms were recorded in 37 of these 43 cases and 36 showed some degree of abnormality. All of the blind children had abnormal records, and the one normal electroencephalogram was found in a well-functioning child of eleven years of age who had 20/200 vision in his better eye. All types of abnormalities were seen in the tracings, including spikes, sharp and slow waves, fusion of waves, and voltage loss. The abnormalities were most common in the occipital lobes but involved other areas of the cerebral cortex as well.

A highly abnormal electroencephalogram does not in itself substantiate a neurologic deficit in a blind child; rather, an abnormal record may be expected in well-functioning blind children. No special pattern emerges with retrolental fibroplasia. The absence of the alpha occipital pattern in blind children suggests that the normal alpha pattern cannot be established in children without sufficient vision for form perception.

The intellectual level in these 43 cases was found to be above normal in 14 percent of the cases, normal in 45 percent, mildly retarded in 27 percent, and grossly retarded in 15 percent of the cases.

Thirty-five percent of these 43 children showed some evidence of a pediatric disorder. The most common finding in the pediatric examination was a muscle hypotonicity, probably resulting from insufficient exercise. Other pediatric abnormalities including hearing deficit, heart disorders, poor appetite, poor teeth, nutritional disorders, chronic constipation, and pes planus. Neurologic disorders included spastic diplegia, hemiplegia, quadriplegia and convulsive states, and extrapyramidal manifestations, such as choreiform and athetoid activity.

Eighteen subjects were reported by Krause (7) and a comparison of the visual ability was made after a lapse of eight years. Half of the group retained the same vision and half showed deterioration in one or both eyes ranging from loss of light perception to the total loss of 20/100 vision in both eyes of one child. The deterioration is due to the progressive changes in the retina caused by retrolental fibroplasia, though the condition seems stabilized in the group of subjects at this time, and little change was found to occur after the age of six years.

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